BMJ Open

Understanding the influence of the MomConnect programme on antenatal and postnatal care service utilisation in two South African Provinces: A Realist Evaluation Protocol

SCHOLARONE™
Manuscripts

Understanding the influence of the MomConnect programme on antenatal and postnatal care service utilisation in two South African Provinces: A Realist Evaluation Protocol

Eveline M. Kabongo[1*], Ferdinand C. Mukumbang[2], Edward Nicol[1,3], Peter Delobelle[2]

[1] *Division of Health Systems and Public Health, Stellenbosch University, Cape Town, South Africa,*

[2] *School of Public Health, University of the Western Cape, South Africa,*

[3] *South African Medical Research Council (SA MRC) Cape Town, South Africa*

*Corresponding author

Ferdinand C. Mukumbang: mukumbang@gmail.com

Eveline M. Kabongo: https://orcid.org/0000-0002-6651-9097

Ferdinand C. Mukumbang: https://orcid.org/0000-0003-1441-2172

Edward Nicol: https://orcid.org/0000-0001-6019-9259

Peter Delobelle: https://orcid.org/0000-0002-9016-7458

Word count : 3980

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

28 # ABSTRACT

29 **Introduction:** Timely antenatal care (ANC) and postnatal care (PNC) attendance decrease
30 maternal and child mortality by improving maternal and child health (MCH) outcomes. Mobile
31 health or mHealth has been identified as an effective way of improving the uptake of MCH
32 services. The MomConnect is a mHealth initiative launched by the National Department of
33 Health of South Africa in August 2014 to support MCH. Although widely used in South Africa,
34 there is a limited understanding of how, why, for whom and under which health system
35 conditions, the implementation of MomConnect improves the health-seeking behaviours of
36 pregnant women and mothers of infants in ANC and PNC facilities. This paper describes the
37 protocol for a realist evaluation of the MomConnect programme.

38 **Method and analysis:** The study will use the realist evaluation approach through its research
39 cycle conducted in three phases. In phase one, a multi-method elicitation study design will be
40 used, including document review, key informant interviews and a scoping review to formulate
41 an initial programme theory of the MomConnect intervention. Content and thematic analytic
42 approaches will be used to analyse the data that will be fitted into a realist framework to
43 formulate the initial programme theory. In phase two, a multi-case study design will be applied
44 using a multimethod approach in two South African provinces. In each case, a theory-testing
45 approach underpinned by the hypothetico-deduction analytic model will be used to test the
46 initial programme theory. Surveys, interviews and focus group discussions will be collected
47 from various programme actors and analysed using appropriate approaches. Phase three will
48 focus on refining the tested/modified programme theory through cross-case analysis.

49 **Ethics and dissemination:** Ethics approval was granted by the Stellenbosch University ethics
50 committee (S18/09/189). The protocol has been designed and the study will be conducted in
51 line with the principles of the Declaration of Helsinki (1964).

52
53
54
55
56
57
58
59

2

Strengths and limitations of the study

- It provides a blueprint on how our understanding of how and why the MomConnect programme works (or not) within the South African context.

- The proposed study will employ a multi-case study approach applying a mixed-methods approach, which allows for valid theories to be elicited, tested and refined.

- Although cross-case analysis and abstraction allows for theory refining, the cross-case analysis of four or more cases can be very challenging.

- The identification of what constitute a mechanism and context in some cases can be confusing.

Key words: mHealth, maternal health services, antenatal care, postnatal care, realist evaluation

3

INTRODUCTION

In recent decades, there has been greater use of antenatal (ANC) and postnatal care (PNC) services in South Africa, with higher rates of delivery assisted by professional healthcare providers.[1] ANC facilitates timely follow-up of pregnant women, to prevent complications such as premature delivery and pre-eclampsia, as well predict the type of delivery, thereby reducing pregnancy-related morbidity and mortality.[2–4] Early PNC is important for the wellbeing of both mothers and new-borns, since it allows clinicians to screen for psychological and physical changes in the first days following birth.[4] However, despite increasing utilization in the country as a whole, access to early ANC and PNC services remains limited in certain provinces.[1]

The maternal mortality ratio in South Africa declined from 2014 to 2017, [5] with an institutional maternal mortality rate (iMMR) of 134/100 000 live births being reported in 2016. The case fatality rate (CFRs) for excessive bleeding associated with caesarean delivery (BLDACD) dropped from 33.1 (2011 - 2013) to 31 (2014 - 2016) deaths per 100 000 caesarean deliveries.[5] In total, almost all (98%) of these cases occurred at tertiary hospitals in the public sector, where the majority of caesarean deliveries were performed. Most deaths occurred at provincial tertiary hospitals, attributable to referral from district hospitals after caesarean delivery with unresolved bleeding.[5] Complications of hypertension in pregnancy and obstetric haemorrhaging are still major causes of maternal mortality which can be prevented through early uptake of ANC and PNC services.[5]

South Africa is striving to achieve the health outcomes enshrined under the Sustainable Development Goals (SDGs), which include addressing the challenges faced by maternal and child health (MCH) service delivery.[4, 6, 7] In keeping with SDG-3 targets, South Africa developed a strategic plan for MCH to reduce maternal and child mortality by improving the uptake of ANC and PNC services. The plan included integrating mobile health technology (mHealth) into the healthcare system as a strategy to overcome barriers to universal health coverage.[7]

The present paper presents a protocol developed for evaluating the MomConnect programme implemented in South Africa. Towards this end, a realist evaluation is proposed to understand how, why, for whom and under what health systems conditions the MomConnect intervention achieves its goal of improving the uptake of MCH services.

4

BACKGROUND

mHealth is an element of electronic health (eHealth) used for the provision of healthcare services using information and communication technology (ICT).[8] mHealth places specific focus on the use of mobile phone technology based on text messages, regarded as a quick and cost-effective form of communication.[9] Since mobile phone broadband coverage reaches 69 % of the global population, the growing accessibility of mobile phones has supported the use of mHealth in public health.[10] Even people living in rural areas in Low and Middle-income Countries (LMICs) have access to smart phones with internet connectivity [11, 12] and about eight out of every ten people living in LMICs own a mobile phone.[13] In 2017, South Africa reached a mobile-cellular subscription rate of 162%.[14]

There is interest in the use of mHealth in MCH, since health facilities in LMICs are sometimes difficult to access due to long distances. The use of mHealth in LMICs may support MCH [12] by promoting healthier lifestyle habits, enhancing medication adherence, and enforcing regular attendance of follow-up visits, thereby helping to prevent perinatal complications.[15–17] In addition, the use of mHealth facilitates improves the communication between health care service providers and users [18], and promote the uptake of MCH services. Furthermore, a study by Feroz et al. [17] confirmed the relevance of mHealth initiatives in MCH as a tool for promoting health education and behavioural change, in turn leading to improved uptake of MCH services.[17] For example, the "Text4 Baby" intervention in the USA and Russia examined preparedness among new mothers towards improved MCH.[19] Mothers who received the Text4 Baby messages were three times more likely to feel ready and prepared to be a mother compared to the control group.

In South Africa, there has been specific interest in the Cell-Life Mobile Alliance for Maternal Action (MAMA) SMS application as a tool for improving MCH outcomes. This service targets pregnant women and mothers with babies up to three months' old and focuses on HIV prevention as well as the prevention of mother to child transmission of HIV (PMTCT). The use of this application improved health-seeking behaviour in the target population, and increased the rates of exclusive breastfeeding, delivery in health facilities, use of skilled birth attendants for delivery, and adherence to recommended ANC and PNC visits.[20, 21]

The MomConnect intervention or initiative

The MomConnect intervention is a prototype for mHealth in South Africa.[22] It was launched in August 2014 as a National Department of Health (NDoH) initiative, to support MCH through

153   the use of mobile phone technology.[23] The ultimate goal of the MomConnect program is to

154   register all pregnant women on a national database and provide users with important health

155   information via a platform for feedback, free of charge.[24]

156   By dialling *120*550#, on a mobile phone, users subscribe to the MomConnect service and

157   receive messages which encourage them to register at the nearest clinic offering ANC services.

158   Once registered at a clinic, the user gains access to a two-way interactive system through

159   unstructured supplementary service data (USSD)-based surveys and help desk assistance.[25,

160   26] The help desk service is mostly used to obtain information on maternal health rather than

161   discussing the services received at a clinic.[26] Engelhard et al. [27] demonstrated the

162   feasibility and efficacy of the helpdesk in improving quality of care, but also emphasised the

163   need to benchmark its performance and explore opportunities for improvement elsewhere.[27]

164   Since its inception, the MomConnect programme has registered about 1.7 million pregnant

165   women at over 95% of public health facilities, suggesting that the programme is meeting its

166   target of identifying and responding to users' needs.[28] An evaluation of the MomConnect

167   programme in 2016 showed that participants reported that the service empowered them to

168   better manage their health during pregnancy as well as that of their babies, and that mothers

169   developed a particular connection with, and trusted the source of the messages.[29]

170   MomConnect has seen rapid scaling-up through strong government support and partnerships

171   between key stakeholders. Because of its expanding coverage, MomConnect represents a

172   powerful platform for real-time data collection and linkage to additional services to improve

173   patient care.[30] The MomConnect initiative has contributed to the integration of information

174   systems to support MCH clinical services [31], and represents an important starting point to

175   link other health services and databases.[32] The challenges experienced during the use of the

176   MomConnect intervention in most clinics was related to poor network coverage.[29] The need

177   for improvement in areas such as registration and language has also been highlighted.[29]

178   Studies to date have largely focused on the effectiveness of mHealth programmes such as the

179   use of SMS services to remind patients of the timely use of ANC and PNC services and its

180   resultant effect on health seeking behaviour.[17, 29, 33, 34] These studies did not provide

181   consistent results on how the use of mobile phones influences the uptake of ANC and PNC

182   services. For instance, Lefevre et al. [35] showed the importance of the MomConnect

183   programme in MCH, but contextual factors such as why some women used the services more

184   than others were not explored. In addition, the mechanisms through which the use of mobile

185   phones influences health seeking behaviour have not been clearly explained. Towards this end,

6

186 a realist evaluation is proposed to understand how, why, for whom and under what health

187 systems conditions the MomConnect intervention achieves its goal of improving the uptake of

188 MCH services.

189

Study setting

191 The study will be conducted in the Gauteng (GT) and Free State (FS) provinces of South Africa

192 (Figure 1). These provinces were selected based on the highest (GT) and lowest (FS) rates of

193 MomConnect registration from September 2014 to June 2017. GT accounted for 299,417

194 (22.2%) and FS for 64,416 (4.8%) of the total number of national registrations of 1,337,889

195 for this period.[35] The GT and FS provinces differ from each other in terms of socio-economic

196 and demographic characteristics of their inhabitants.[1] The use of mobile phones in GT and

197 FS as at 2016 were 98.2% and 94.9% respectively.[36] Table 1 presents information on

198 socioeconomic and demographics characteristics of the populations living in GT and FS.

199 Western Rand and Johannesburg city districts were identified as study settings located in the

200 best resourced province (GT), while in FS (less resourced province) two districts, Xhariep and

201 Fezile Dabi were selected. Xhariep is the largest district in FS, has an economic quintile of

202 three, and is among the best resourced' districts in provinces.

203 **Table 1 Socioeconomic and demographic factors**

	Gauteng	Free state
	1.Western Rand district	*1. Xhariep district*
Population	884 031	135,036
Sub-districts	Sub-districts:4 1.Randfontein 2. Westonaria 3. Merafong City 4. Mogale City	Sub-districts:4 1. Kopanong 2. Naledi 3. Mohokare 4. Letsemeng
Houses headed by female	31.75%	37.6%
formal dwelling	76.3%	89.1%
Unemployment rate	26.3%	26.8%
	2. Johannesburg city district	*2. Fezile Dabi district*
Population	5,006,517	507,525
Sub-districts	Sub-districts:7 1. Johannesburg Sub-district A 2. Johannesburg Sub-district B 3. Johannesburg Sub-district C 4. Johannesburg Sub-district D 5Johannesburg Sub-district E 6. Johannesburg Sub-district F 7. Johannesburg Sub-district J	Sub-districts: 4 1. Mafube 2. Moqhaka 3. Ngwathe 4. Metsimaholo

7

Houses headed by female	37.7%	37.5%
Formal dwelling	81.3%	85.6%
Unemployment rate	61.5%	33.9%.

204 **Sources:** DHB 1016/1017

205 In terms of MCH indicators, the district health barometer (DHB) 2016/2017 reported 71.2% of
206 PNC visits within six days in GT, which is lower than the national target of 75% and FS
207 (85.9%). ANC first visits before 20 weeks was 58.4% less than the national target of 62.1 in
208 GT while FS had 65.8% of ANC first visits in the same period.[1]

209 *Figure 1: Map of South Africa and study settings (Setting 1: Gauteng and Setting 2: Free State)*

210

211 **Methods**

212 The study will be guided by a realist evaluation approach, which was introduced through the
213 seminal work of Pawson and Tilley [37] to address the question: 'What works, for whom, why,
214 in what situation, and how?' with regards to intervention, programmes and policies. The
215 philosophical ontology of realist evaluation is realism and its epistemological foundation lies
216 in scientific realism.[37] Realist evaluation belongs to the family of theory-driven approaches
217 of evaluation. In this light, the approach aims to develop and refine hypotheses of generative
218 causality explicating why and how intervention inputs bring about changes in key
219 outcomes.[38] The proposed study will be developed following three different phases, as
220 described in Figure 2 and reported following the guidelines for reporting realist evaluation
221 studies.[38]

222 *Figure 2: Study design showing Phases 1 to 3 adapted from* [39, 40] *(source: study author).*

223

224 **Phase 1: Gleaning the initial programme theory**

225 Phase 1 will address the first objective of the study, namely, to formulate the initial programme
226 theory (IPT) of how the MomConnect programme was expected to work for different actors
227 (designers, health workers and MCH clients). A multi-method elicitation study will be
228 conducted using data collected from the following sources: document review, key informant
229 interviews and a scoping review [41]:

230   -   Document review will explore documents such as the action plan, staff meeting reports
231   and other minutes; any literature on MomConnect; and the national monitoring as well
232   as evaluation report. Permission will be requested from the MomConnect monitoring

and evaluation team to access these documents and explore how MomConnect was developed, who participated and with what intended objectives.

- In-depth interviews (IDI) with 5-10 key informants, including programme designers (those who assisted in program conceptualisation) and managers (those who assisted in programme implementation and coordination) will be conducted to explore their expectations on how MomConnect was supposed to work. Key informants will be selected using convenient sampling and a face-to-face interview organised using an interview guide with exploratory questions. The in-depth interviews with key informants will be audio-recorded and transcribed verbatim

- The scoping review of research conducted on mHealth and MCH will be performed by searching the following databases: Academic research complete, Medline, Pubmed, Scopus, Health System Evidence and Google scholar.

Document analysis [42] as a methodological process for review and evaluation will be used to examine and interpret MomConnect documents, including capturing the meaning, gaining understanding, and developing empirical knowledge on how the intervention was developed and implemented.[42] The Intervention-Context-Actors-Mechanism-Outcomes (ICAMO) heuristic tool will be used to guide a content analysis approach.

An exploratory qualitative analysis of programme managers and designers' assumptions and perspectives will be undertaken. The in-depth interviews with key informants will be audio-recorded and transcribed verbatim. Summary sheets and field notes will be written up for each interview at the end of the day. Thematic analysis based on the generic inductive approach [43] will be conducted using Atlas.ti software version 8.0. For the scoping review a thematic analysis [44] will be used to explore the possible generative mechanisms reported in other studies conducted on mHealth interventions and MCH. The ICAMO framework will be used to retrieve the information.

A configurational mapping approach [45] guided by the ICAMO heuristic tool will be used to synthesise the information gleaned from document review, key informant and scoping review, to formulate the (IPT) that will be tested in phase two.[45] The theory formulated will be informed by various forms of inference making: deductive, inductive, and retroductive reasoning.

9

Phase 2: Testing the initial programme theory

The initial programme theory formulated in phase I will be tested in the selected cases using a multi-method study design. Quantitative assessment will be performed using a cross-sectional design, whereby a survey will be used to explore how socio-economic characteristic influence the uptake of MCH and determine for whom the intervention works. In contrast, qualitative approaches will focus on determining the mechanism by which the outcomes are generated. To assess the reliability of data collection, a pilot study will be conducted in two healthcare facilities selected for convenience in the sub-district with the highest and lowest rates of ANC first visits before 20 weeks in GT and FS, respectively. The pilot will include health care providers (HCP), pregnant women and mothers.

Sampling and data collection

OpenEpi software and MS Excel will be used to randomly select four facilities in each sub-district (see Table 3). The sample size in each facility will be calculated [46], assuming 50% prevalence of MCH services agreement per facility, a precision (d) of 0.10 and a 95% confidence interval. The monthly estimated number of MCH visits for each facility and the proportion of ANC first visits before 20 weeks will be used to calculate the sample size using an online calculator (Table 3).[46] In cases where the ratio of the sample size (n) to the population size (N) is greater than 5%, finite population correction (FPC) will be used.[47] The number of users found in all four facilities will be multiplied by a design effect (DE) of 1.5 to get the total number of participants (Table 3).

Table 2 Selected sample by districts, sub-districts, facilities and participants

District	Gauteng (District with highest rate)	Gauteng (District with lowest rate)	Free State (District with highest rate)	Free Sate (District with lowest rate)
Sub-District	Randfontein sub-district (8 facilities)	Johannesburg A (14 facilities)	Naledi (4 facilities)	Moqhaka (9 facilities)
Facility	Kocksoord Clinic ANC 1 visit < 20 weeks = 82.0%	Mayibuye Clinic ANC 1 visit, < 20 weeks = 49.0%	Vanstadensrus Clinic ANC 1 visit < 20 weeks = 75.0%	Thusanong (Kroon) clinic ANC 1 visit < 20 weeks = 69.0%
Sample per facility*	Number of participants = 53 x1.5 = 80	Number of participants = 85x1.5 = 127	Number of participants = 66 x1.5 = 99	Number of participants = 74 x 1.5 = 111

*Estimated number of participants (based on proportional sampling)

The study participants will include all pregnant women and mothers of infants registered under the MomConnect programme, who are 18 years of age or older, irrespective of parity (including

10

292   stillbirths/miscarriages), and socio-economic status. They will be identified through the

293   MomConnect registration registers at facility level. Health care providers (HCP) services will

294   include clinical staff in charge of ANC and PNC at facility level and will be selected based on

295   their prior experience with the MomConnect programme.

296   For administration of the study questionnaire, an appointment will be made with each

297   participant, using the contact details captured in the MomConnect database, to invite them to

298   the facility to participate in the study. The survey tools will also be administered telephonically

299   to those participants who are unable to visit the facility during the study period. Furthermore,

300   a facility assessment questionnaire will be administered to HCPs to explore the structural and

301   contextual attributes that may influence the uptake of ANC and PNC services.

302   Qualitative assessments will include in-depth interviews and focus group discussion (FGDs).

303   An estimated 10 to 20 in-depth interviews will be conducted with HCPs at facility level to

304   explore their perceptions (resources, implementation processes and programme uptake) of the

305   MomConnect programme. Four FGD (one per facility) consisting of between 10 and 15

306   participants will be conducted to ascertain their perceptions regarding the uptake of ANC

307   services and expectations of the MomConnect programme. IDIs and FGDs will be audio-

308   recorded and transcribed verbatim. The interview guide and survey questionnaire are designed

309   in English but will be translated into the local language used in the different study settings

310   (Afrikaans, Setswana, Sesotho, Zulu, Xhosa) and back-translated in English. Data gathered

311   from the above sources will be translated and transcribed in preparation for analysis.

312   In each case, a theory refining research approach underpinned by the hypothetico-deduction

313   analytic model will be used.[40, 48]

314

Data analysis

315

316   Inferential and descriptive analyses of the quantitative data including proportions and

317   frequencies will be performed using Stata version 15. Socio-economic and demographic data

318   will be used as independent variables while the uptake of MCH will be used as the dependent

319   variable, which will allow us to determine for whom the intervention works. For bivariate

320   analysis, categorical data will be analysed using Chi-squared test. Logistic regression models

321   will be constructed to assess the effects of independent variables as predictors of dependent

322   outcomes of interest. The power of each dependent variable will be tested before the variable

323   is include in the model and only the variable with positive outcomes will be maintained. A p-

324   value of <0.05 will be used to indicate statistical significance along with a 95% corresponding

325   confidence interval (CI).

11

326 For qualitative data, IDI and FGDs will be analysed separately using a thematic content
327 analysis approach to identify and make explicit the mechanism by which observed outcomes
328 are generated using the ICAMO framework. FGDs and IDI transcripts will be uploaded onto
329 Atlas.ti 8.0 for analysis and will follow five steps: 1) development of a coding framework, 2)
330 testing code reliability, 3) identifying initial themes emerging from the data, 4) using the code
331 manual to apply codes to the entire script, and 5) connecting codes into themes through an
332 interpretation process.

333 **Modifying the programme theory**

334 In-case analysis [37] will be conducted using retroductive reasoning [49] to modify the ICAMO
335 elements through configuration mapping based on the data obtained from each case to modify
336 the initial programme theory. In other words, ICAMO configurations will be modified into
337 case-based programme theories (for each of the four facilities). Each case-based modified
338 theory will be tested to check their explanatory power through the process of counterfactual
339 thinking towards a functional theory.[50] ICAMO matrices will be used to present data for
340 each higher-level outcome of concern.

341

342 **Phase 3: Refining the modified programme theory**

343 A refined programme theory is a clear explanatory theory that can be used to give details of
344 programme elements. In this phase the analysis will be realised through five means:

345   a) A cross case analysis of the four case studies will be conducted following retroductive
346   reasoning to construct ICAMO matrices (ICAMO configuration obtained from each of
347   the four case studies) across the cases to obtain a refined programme theory.

348   b) A counterfactual and trans-factual thinking process [50] will be carried out to compare
349   the conjectured ICAMO from the cases with the initial programme theory, and their
350   explanatory power across the cases examined.

351   c) For each generative mechanism linked to a positive outcome in one case, other cases
352   with the same outcome will be assessed to identify additional components. Similarly,
353   ICAMOs associated with failed outcomes will be categorized together.

354   d) A systems thinking approach [51] will be applied using a cross-case analysis to allow
355   critical reflection of how the intervention works.

356   e) The original transcripts will be referred to, in order to check for consistency of the final
357   ICAMO and will be validated through FGD with relevant stakeholders.

358

Quality control

Quality control and credibility will be assured through data familiarisation by all the investigators and corresponding discussion.

Ethics and dissemination

Ethics approval has been granted by the Health Research Ethics Committee (HREC) of the Stellenbosch University (Ref No: S18/09/189). An approval to conduct the study in the selected facilities is currently being processed by the relevant provincial Department of Health. Consent forms will be used to obtain permission from study participants before data collection. Personal information will be protected by not disclosing names during data analysis or reporting. Different papers will be published from the study, and the results will be presented in academic open day, national and international conferences.

DISCUSSION

Despite the relevance of mHealth in improving MCH being increasingly recognised [52], an empirical investigation to understand how the outcomes are generated is still lacking. This protocol specifies the research plan to investigate how and why the MomConnect programme works or achieves its goal of improving MCH services in South Africa. Study investigators will also seek to understand MomConnect as part of an mHealth programme that uses mobile phone by focusing on how the contextual factors affects the use of MCH services.

The proposed study draws on a theory-driven evaluation (TDE) approach, which describes a process under which components are hypothesised to affect outcomes, and considers the specific conditions under which such processes operate.[39] TDE is commonly used in the social sciences to investigate how programmes cause intended or observed outcomes [53], as well as address issues around internal and external validity, which is of potential relevance to both researchers and policymakers.[39, 54, 55] The proposed study will use a realist evaluation approach, which is a type of TDE.[38] Pawson and Tilley [37] developed the realist evaluation to address the question: What works, for whom, why, in what situation and how?. TDE will be used in this study to access in particular how the use of mobile phones influences the uptake of MCH services.

The protocol is an important quality tool as it allows for follow-up by anticipating the challenges and barriers that may occur during the study.[56, 57] This study protocol also assists in thinking through how to generate the internal consistency and external validity of results and

13

to explain how the interventions works in a given context to produce the observed outcome. The lack of such protocol can lead to some issues, such as lack of explanation of the change at or between individual, institutional or contextual levels because these was not documented from the start.[58] Moreover, writing a detailed research protocol is important in helping other researchers to replicate relevant study findings for contribution towards the broader research community. Constructing a comprehensive protocol including clear aims, rationale, analysis plans and expectations lends additional credibility to research across study fields.[58]

Acknowledgments

Not applicable

Contributors

The study was conceived by EMK and PD. The first manuscript was written by EMK. FCM and EN provided methodological support. FCM, PD, EN provided critical conceptualisation and contribution towards developing and refining the manuscript. All authors read and approved the final manuscript.

Competing interest:

None declared

Funding

None declared

Ethics approval

Stellenbosch University Human research ethics committee (Ref No S18/09/189).

References

[1]   Massyn N, Padarath A, Peer N, et al. *District Health Barometer*. 2017.

[2]   Symon A, Pringle J, Cheyne H, et al. Midwifery-led antenatal care models : mapping a systematic review to an evidence-based quality framework to identify key components and characteristics of care. *BMC Pregnancy Childbirth* 2016; 16: 168.

14

423 [3] Ram F, Singh A. Is antenatal care effective in improving maternal health in rural Uttar
424   Pradesh? Evidence from a district level household survey. *J.biosocSci* 2006; 38: 433–448.

425 [4] Massyn N, Peer N, Padarath A, et al. *District Health Barometer*. 2016.

426 [5] Moodley J, Chb MB, Fawcus S, et al. Improvements in maternal mortality in South Africa.
427   *SAML Res* 2018; 108: 4–8.

428 [6] Sachs JD. From millennium development goals to sustainable development goals. *Lancet
429   (London, England)* 2012; 379: 2206–11.

430 [7] Le Blanc D. Towards Integration at Last? The Sustainable Development Goals as a Network
431   of Targets. *Sustain Dev* 2015; 23: 176–187.

432 [8] Aranda-Jan CB, Mohutsiwa-Dibe N, Loukanova S. Systematic review on what works, what
433   does not work and why of implementation of mobile health (mHealth) projects in Africa. *BMC
434   Public Health* 2014; 14: 188–203.

435 [9] Kaplan W. Can the Ubiquitous power of mobile phones be used to improve health outcomes in
436   developing countries? *Global Health* 2006; 14.

437 [10] SANOU B. ICT Facts & Figures. The world in 2015. *Itu 150 Años (1865 - 2015)* 2015; 1–6.

438 [11] Premji S. Mobile health in maternal and newborn care: Fuzzy logic. *International Journal of
439   Environmental Research and Public Health* 2014; 6494–6503.

440 [12] Oyeyemi SO, Wynn R. The use of cell phones and radio communication systems to reduce
441   delays in getting help for pregnant women in low- and middle-income countries: a scoping
442   review. *Glob Health Action* 2015; 8: 28887–28895.

443 [13] World Bank. World Development Report 2016: Digital Dividends,
444   http://www.worldbank.org/en/publication/wdr2016 (2016, accessed 25 January 2018).

445 [14] Services P. South Africa Profile (Latest data available : 2017). 2017; 1–3.

446 [15] Watterson JL, Walsh J, Madeka I. Using mHealth to Improve Usage of Antenatal Care,
447   Postnatal Care, and Immunization: A Systematic Review of the Literature. *BioMed Research
448   International*. Epub ahead of print 2015. DOI: 10.1155/2015/153402.

449 [16] Poorman E, Gazmararian J, Parker RM, et al. Use of Text Messaging for Maternal and Infant
450   Health: A Systematic Review of the Literature. *Matern Child Heal* 2015; 19: 969–989.

451 [17] Feroz A, Perveen S, Aftab W. Role of mHealth applications for improving antenatal and
452   postnatal care in low and middle income countries: A systematic review. *BMC Health Serv
453   Res* 2017; 17: 1–12.

454 [18] Wambugu S, Villella C. mHealth for Health Information Systems in Low- and Middle-Income

15

455   Countries: Challenges and Opportunities in Data Quality, Privacy, and Security. 2016; 1–19.

456   [19]   Parker RM, Dmitrieva E, Frolov S, et al. Text4baby in the United States and Russia: An

457   Opportunity for Understanding How mHealth Affects Maternal and Child Health. *J Health*

458   *Commun* 2012; 17: 30–36.

459   [20]   USAIDS. Mobile Alliance for Maternal Action (MAMA). *mHealth knowledge*,

460   http://www.mhealthknowledge.org/search/site/MAMA (2015).

461   [21]   Ausen-anifrani S, Burman MK, Pastick K. SMS Maama. *United Nation Found* 2016; 1–14.

462   [22]   Peter JE, Barron P, Pillay Y. Using mobile technology to improve maternal, child and youth

463   health and treatment of HIV patients. *South African Med J* 2016; 106: 3.

464   [23]   Seebregts C, Dane P, Parsons AN, et al. Designing for scale : optimising the health

465   information system architecture for mobile maternal health messaging in South Africa (

466   MomConnect). *BMJ Glob* 2018; 2: 1–7.

467   [24]   Mehl GL, Tamrat T, Bhardwaj S, et al. Digital health vision : could MomConnect provide a

468   pragmatic starting point for achieving universal health coverage in South Africa and

469   elsewhere ? *BMJ Glob Heal* 2018; 3: 1–5.

470   [25]   Barron P, Peter J, Lefevre AE, et al. Mobile health messaging service and helpdesk for South

471   African mothers (MomConnect): history , successes and challenges. *BMJ Glob Heal* 2018; 3:

472   1–6.

473   [26]   Xiong K, Kamunyori J, Sebidi J. The MomConnect helpdesk : how an interactive mobile

474   messaging programme is used by mothers in South Africa. *BMJ Glob Heal* 2018; 3: 000578.

475   [27]   Engelhard M, Copley C, Watson J, et al. Optimising mHealth helpdesk responsiveness in

476   South Africa : towards automated message triage. *BMJ Glob Heal* 2018; 3: 1–9.

477   [28]   Pillay Y, Motsoaledi PA. Digital health in South Africa : innovating to improve health. *BMJ*

478   *Glob Heal* 2018; 4–6.

479   [29]   Skinner D, Delobelle P, Pappin M, et al. User assessments and the use of information from

480   MomConnect , a mobile phone text-based information service , by pregnant women and new

481   mothers in South Africa. *BMJ Glob Heal* 2018; 3: 1–6.

482   [30]   Barron P, Peter J, Lefevre AE, et al. Mobile health messaging service and helpdesk for South

483   African mothers (MomConnect): history , successes and challenges. *BMJ Glob Heal* 2018; 3:

484   000559-6.

485   [31]   Heekes A, Tiffin N, Dane P, et al. Self-enrolment antenatal health promotion data as an

486   adjunct to maternal clinical information systems in the Western Cape Province of South

487   Africa. 2018; 1–9.

488   [32]   Peter J, Benjamin P, Lefevre AE, et al. Taking digital health innovation to scale in South
489   Africa : ten lessons from MomConnect. *BMJ Glob Heal* 2018; 3: 1–4.

490   [33]   Free C, Phillips G, Watson L, et al. The Effectiveness of Mobile-Health Technologies to
491   Improve Health Care Service Delivery Processes: A Systematic Review and Meta-Analysis.
492   *PLoS Med*. Epub ahead of print 2013. DOI: 10.1371/journal.pmed.1001363.

493   [34]   Agarwal S, Perry HB, Long L-A, et al. Evidence on feasibility and effective use of mHealth
494   strategies by frontline health workers in developing countries: systematic review. *Trop Med Int*
495   *Heal* 2015; 20: 1003–1014.

496   [35]   Lefevre AE, Dane P, Copley CJ, et al. Unpacking the performance of a mobile health
497   information messaging program for mothers (MomConnect) in South Africa : evidence on
498   program reach and messaging exposure. *BMJ Glob Heal* 2018; 3: 1–12.

499   [36]   Statistics South Africa c. *General Household Survey 2016*. 2018.

500   [37]   Pawson R, Tilley N. *Realistic evaluation*. Sage, 1997.

501   [38]   Wong G, Westhorp G, Manzano A, et al. RAMESES II reporting standards for realist
502   evaluations. *BMC Med* 2016; 14: 96–114.

503   [39]   Van Belle SB, Marchal B, Dubourg D, et al. How to develop a theory-driven evaluation
504   design? Lessons learned from an adolescent sexual and reproductive health programme in
505   West Africa. *BMC Public Health* 2010; 10: 141–151.

506   [40]   Mukumbang FC, Marchal B, Belle S Van, et al. Unearthing how, why, for whom and under
507   what health system conditions the antiretroviral treatment adherence club intervention in South
508   Africa works: A realist theory refining approach. *BMJ Glob* 2018; 18: 1–15.

509   [41]   Ã DSD, Hausenblas HA. Elicitation studies and the theory of planned behavior : a systematic
510   review of exercise beliefs. *Pschology Sport Exerc* 2005; 6: 1–31.

511   [42]   Bowen GA. Document analysis as a qualitative research method. *Qualtative Res J* 2009; 9:
512   27–40.

513   [43]   Thomas DR. A General Inductive Approach for Analyzing Qualitative Evaluation Data. *Am J*
514   *Eval* 2006; 27: 237–246.

515   [44]   Ritchie J, Spencer L. Qualitative Data Analysis for Applied Policy Reasearch. *The qualitative*
516   *researcher's companion* 2002; 305–329.

517   [45]   Mukumbang FC, Marchal B, Belle S Van, et al. A realist approach to eliciting the initial
518   programme theory of the antiretroviral treatment adherence club intervention in the Western

17

519   Cape Province , South Africa. 2018; 1–16.

520   [46]   Naing L, Winn T, Rusli BN. Practical Issues in Calculating the Sample Size for Prevalence
521   Studies. *Arch Orofac Sci* 2006; 1: 9–14.

522   [47]   Burstein H. Finite Population Correction for Binomial ConFidence Limits. *Taylor Fr Gr* 1975;
523   70: 67–69.

524   [48]   Eastwood JG, Jalaludin BB, Kemp LA. Realist explanatory theory building method for social
525   epidemiology : a protocol for a mixed method multilevel study of neighbourhood context and
526   postnatal depression. *Springer Plus* 2014; 3: 1–12.

527   [49]   Zoltan D. Plenary Speech Researching complex dynamic systems : ' Retrodictive qualitative
528   modelling ' in the language classroom. *Cambridge Univ Pree* 2011; 47: 80–91.

529   [50]   Roese NJ. Counterfactual Thinking. *Am Psychol Assoc* 1997; 121: 133–148.

530   [51]   Savigny, Don de and Adam T. *Systems Thinking for Health Systems Strengthening - World*
531   *Health Organization - Google Books*,
532   https://books.google.co.za/books?hl=en&lr=&id=dyydaVwf4WkC&oi=fnd&pg=PA7&dq=Sa
533   vigny+and+Adam,+2009+system+thinking&ots=MaLpjjj9Z4&sig=7yHxOE5mtDT_3eiLQ54
534   BkiIMm9U#v=onepage&q=Savigny and Adam%2C 2009 system thinking&f=false (2009,
535   accessed 7 August 2017).

536   [52]   Lee H.S., ulugbek B. N., Bright I N, Mome M, lLiz Grant CP. H8. *Glob Heal* 2016; 6: 1–17.

537   [53]   Coryn CLS, Noakes LA, Westine CD, et al. A systematic review of theory-driven evaluation
538   practice from 1990 to 2009. *Am J Eval* 2011; 32: 199–226.

539   [54]   Chen HT. The conceptual framework of the theory-driven perspective. *Eval Program Plann*
540   1989; 12: 391–396.

541   [55]   Chen H-T, Rossi H. Issues in the Theory-Driven. *Eval Progr Planning, Vol* 1989; 12: 299–
542   306.

543   [56]   Chen L, Wang W, Du X, et al. Effectiveness of a smart phone app on improving immunization
544   of children in rural Sichuan Province, China: study protocol for a paired cluster randomized
545   controlled trial. *BMC Public Health*; 14. Epub ahead of print 2014. DOI: 10.1186/1471-2458-
546   14-262.

547   [57]   Mukumbang FC, Van Belle S, Marchal B, et al. Realist evaluation of the antiretroviral
548   treatment adherence club programme in selected primary healthcare facilities in the
549   metropolitan area of Western Cape Province, South Africa: a study protocol. *BMJ Open* 2016;
550   6: e009977-88.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

551 [58] Prashanth NS, Marchal B, Hoeree T, et al. How does capacity building of health managers

552   work? A realist evaluation study protocol. DOI: 10.1136/bmjopen-2012-000882.

553

19

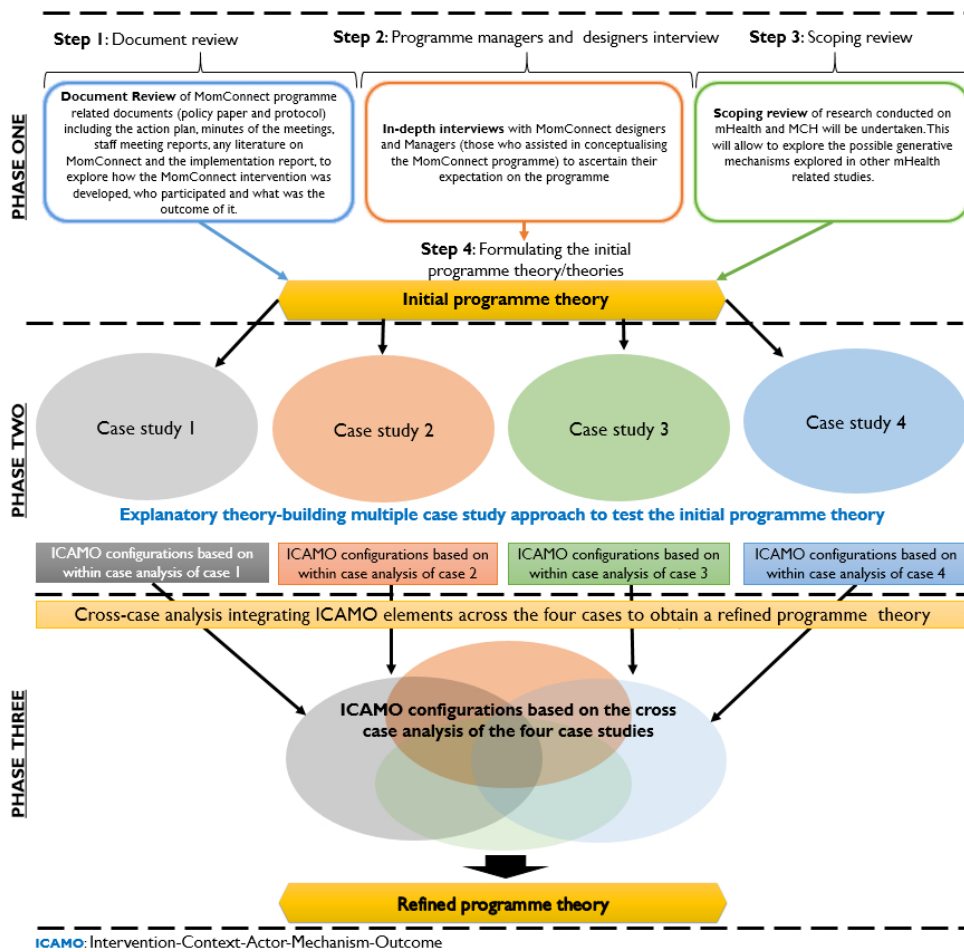Figure 1: Map of South Africa and study settings

194x145mm (96 x 96 DPI)

Figure 2: Study design showing Phases 1 to 3

237x225mm (96 x 96 DPI)

BMJ Open

Understanding the influence of the MomConnect programme on antenatal and postnatal care service utilisation in two South African Provinces: A Realist Evaluation Protocol

SCHOLARONE™
Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1 **Understanding the influence of the MomConnect programme on antenatal**

2 **and postnatal care service utilisation in two South African Provinces: A**

3 **Realist Evaluation Protocol**

4

5 Eveline M. Kabongo[1]*, Ferdinand C. Mukumbang[2], Peter Delobelle[2], Edward Nicol[1,3],

6

7 *[1] Division of Health Systems and Public Health, Stellenbosch University, Cape Town, South Africa,*

8 *[2] School of Public Health, University of the Western Cape, South Africa,*

9 *[3] South African Medical Research Council (SA MRC) Cape Town, South Africa*

10

11

12 *Corresponding author

13 Ferdinand C. Mukumbang: *mukumbang@gmail.com*

14

15 Eveline M. Kabongo: https://orcid.org/0000-0002-6651-9097

16 Ferdinand C. Mukumbang: https://orcid.org/0000-0003-1441-2172

17 Peter Delobelle: https://orcid.org/0000-0002-9016-7458

18 **Edward Nicol:** https://orcid.org/0000-0001-6019-9259

19

20

21

22

23

24

25

26

27

1

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

28 # ABSTRACT

29 **Introduction:** Timely antenatal care (ANC) and postnatal care (PNC) attendance decrease

30 maternal and child mortality by improving maternal and child health (MCH) outcomes. Mobile

31 health or mHealth has been identified as an effective way of improving the uptake of MCH

32 services. The MomConnect programme is an mHealth initiative launched by the National

33 Department of Health of South Africa in August 2014 to support MCH. Although widely used,

34 there is a limited understanding of how, why, for whom and under which health system

35 conditions, the implementation of MomConnect improves the health-seeking behaviour of

36 pregnant women and mothers of infants in ANC and PNC facilities. This paper describes the

37 protocol for a realist evaluation of the MomConnect programme, to provide a theory-based

38 understanding of how, why and under what healthcare conditions the MomConnect programme

39 works or not.

40 **Method and analysis:** The study will use the realist evaluation approach through its research

41 cycle conducted in three phases. In phase one, a multi-method elicitation study design will be

42 used, including a document review, key informant interviews and a scoping review to formulate

43 an initial programme theory of the MomConnect intervention. Content and thematic analytic

44 approaches will be used to analyse the data that will be fitted into a realist framework to

45 formulate the initial programme theory. In phase two, a multi-case study design will be applied

46 using a multimethod approach in two South African provinces. In each case, a theory-testing

47 approach underpinned by the hypothetico-deduction analytic model will be used to test the

48 initial programme theory. Surveys, interviews and focus group discussions will be conducted

49 with various programme actors and analysed using appropriate methods. Phase three will entail

50 refining the tested/modified programme theory through cross-case analysis.

51 **Expected outcomes:** An improved understanding of how and why the MomConnect

52 intervention improves the health seeking behaviour of pregnant women and mothers of infants,

53 and the health system conditions that influence its implementation.

54 **Ethics and dissemination:** Ethics approval was granted by the Stellenbosch University ethics

55 committee (S18/09/189). The protocol has been designed and the study will be conducted in

56 line with the principles of the Declaration of Helsinki (1964).

57

58

59

60

Strength and limitation of the study

- The study provides a blueprint on how, why and for whom the MomConnect programme works (or not) within the South African context.

- The proposed study will use a multi-case study design applying a mixed-methods approach, which allows for valid theories to be elicited, tested and refined.

- Although cross-case analysis and abstraction allows for theory refining, the cross-case analysis of four or more cases can be very challenging.

- The identification of what constitute a mechanism and context in some cases can be confusing.

Key words: mHealth, maternal health services, antenatal care, postnatal care, realist evaluation, MomConnect programme

INTRODUCTION

In recent decades, there has been greater use of antenatal (ANC) and postnatal care (PNC) services in South Africa, with higher rates of delivery assisted by professional healthcare providers.[1] ANC facilitates timely follow-up of pregnant women, to prevent complications such as premature delivery and pre-eclampsia, as well as predict the type of delivery, thereby reducing pregnancy-related morbidity and mortality.[2–4] Early PNC is important for the wellbeing of both mothers and new-borns, since it allows clinicians to screen for psychological and physical changes in the first days following birth.[4] Despite increasing utilisation in the country as a whole, access to early ANC and PNC services remains limited in certain provinces.[1]

In South Africa the maternal mortality ratio declined from 2014 to 2017, [5] with an institutional maternal mortality rate (iMMR) of 134/100 000 live births reported in 2016. The case fatality rate (CFRs) for excessive bleeding associated with caesarean delivery (BLDACD) dropped from 33.1 (2011 - 2013) to 31 (2014 - 2016) deaths per 100 000 caesarean deliveries.[5] In total, almost all (98%) of these cases occurred at tertiary hospitals in the public sector, where the majority of caesarean deliveries were performed, and attributable to referral from district hospitals after caesarean delivery with unresolved bleeding.[5] Complications of hypertension in pregnancy and obstetric haemorrhaging are hence still major causes of maternal mortality which can be prevented through early uptake of ANC and PNC services.[5]

92 In order to achieve the health outcomes enshrined under the Sustainable Development Goals

93 (SDGs), which include addressing the challenges faced by maternal and child health (MCH)

94 service delivery,[4, 6, 7] South Africa developed a strategic plan to reduce maternal and child

95 mortality by improving the uptake of ANC and PNC services. The plan included integrating

96 mobile health technology (mHealth) into the healthcare system as a strategy to overcome

97 barriers to universal health coverage.[7] The MomConnect programme is an example of the

98 application of this mHealth technology. The present paper presents a protocol for evaluating

99 the MomConnect programme in depth.

100 Towards this end, a realist evaluation is proposed to understand how, why, for whom and under

101 what health systems conditions the MomConnect intervention achieves its goal of improving

102 the uptake of MCH services.

103

BACKGROUND

105 mHealth is an element of electronic health (eHealth) used for the provision of healthcare

106 services using information and communication technology (ICT).[8] mHealth places specific

107 focus on the use of mobile phone technology based on text messages, regarded as a quick and

108 cost-effective form of communication.[9] Since mobile phone broadband coverage reaches an

109 estimated 69 % of the global population, the growing accessibility of mobile phones has

110 supported the use of mHealth in public health.[10] Even people living in rural areas in low and

111 middle-income countries (LMICs) have access to smart phones with internet connectivity [11,

112 12] and about eight out of every ten people living in LMICs own a mobile phone.[13] In 2017,

113 South Africa reached a mobile-cellular subscription rate of 162%.[14]

114 There is interest in the use of mHealth in MCH, since health facilities in LMICs are sometimes

115 difficult to access due to long distances. The use of mHealth in LMICs may support MCH [12]

116 by promoting healthier lifestyle habits, enhancing medication adherence, and enforcing regular

117 attendance of follow-up visits, thereby helping to prevent perinatal complications.[15–17] In

118 addition, the use of mHealth facilitates improves the communication between health care

119 service providers and users [18], and promote the uptake of MCH services. Furthermore, a

120 study by Feroz et al. [17] confirmed the relevance of mHealth initiatives in MCH as a tool for

121 promoting health education and behavioural change, in turn leading to improved uptake of

122 MCH services.[17] For example, the "Text4 Baby" intervention in the USA and Russia

123 examined preparedness among new mothers towards improved MCH.[19] Mothers who

4

124 received the Text4 Baby messages were three times more likely to feel ready and prepared to

125 be a mother compared to the control group.

126 In South Africa, there has been specific interest in the Cell-Life Mobile Alliance for Maternal

127 Action (MAMA) SMS application as a tool for improving MCH outcomes. This service targets

128 pregnant women and mothers with babies up to three months' old and focuses on HIV

129 prevention as well as the prevention, particular mother-to-child transmission of HIV (PMTCT).

130 The use of the MAMA application improved health-seeking behaviour in the target population,

131 and increased the rates of exclusive breastfeeding, delivery in health facilities, use of skilled

132 birth attendants for delivery, and adherence to recommended ANC and PNC visits.[20, 21]

133

The MomConnect intervention or initiative

135 The MomConnect intervention is a prototype for mHealth in South Africa.[22]. MomConnect

136 is a flagship programme of the South African National Department of Health launched in

137 August 2014. The programme uses mobile phone technology to provide pregnant and

138 postpartum women with twice-weekly health information text messages, and access to a

139 helpdesk for patient queries and feedback. [23] [24] The ultimate goal of the MomConnect

140 programme is to register all pregnant women on a national database and provide users with

141 important information on health promotion via a platform for feedback, free of charge.[25]

142 By dialling *120*550#, on a mobile phone, users subscribe to the MomConnect service and

143 receive messages which encourage them to register at the nearest clinic offering ANC services.

144 Once registered at a clinic, the user gains access to a two-way interactive system through

145 unstructured supplementary service data (USSD)-based surveys and help desk assistance.[23,

146 26] The help desk service is mostly used to obtain information on maternal health rather than

147 discussing the services received at a clinic.[26] Engelhard et al. [27] demonstrated the

148 feasibility and efficacy of the helpdesk in improving quality of care, but also emphasised the

149 need to benchmark its performance and explore opportunities for improvement elsewhere.[27]

150 By August 2017, the MomConnect programme had registered over 1.7 million pregnant

151 women at over 95% of public health facilities, representing 63% of all women attending their

152 first antenatal care appointment and suggesting that the programme is meeting its target of

153 identifying and responding to users' needs.[28] An evaluation of the MomConnect programme

154 in 2016 showed that participants reported that the intervention empowered them to better

155 manage their health during pregnancy and that of their babies, and that mothers developed a

156 particular connection with, and trusted the source of the messages.[29]

5

157 The MomConnect programme has seen a rapid scaling-up through strong government support

158 and partnerships between key stakeholders. Because of its expanding coverage, MomConnect

159 represents a powerful platform for real-time data collection and linkage to additional services

160 to improve patient care.[23] The MomConnect initiative has contributed to the integration of

161 information systems to support MCH clinical services [30], and represents an important

162 starting point to link other health services and databases.[31] The challenges experienced

163 during the use of the MomConnect intervention in most clinics was related to poor network

164 coverage.[29] The need for improvement in areas such as registration and language has also

165 been highlighted.[29]

166 Studies to date have largely focused on the effectiveness of mHealth programmes such as the

167 use of SMS services to remind patients of the timely use of ANC and PNC services and its

168 resultant effect on health seeking behaviour.[17, 29, 32, 33] These studies did not provide

169 consistent results on how the use of mobile phones influences the uptake of ANC and PNC

170 services. For instance, Lefevre et al. [34] showed the importance of the MomConnect

171 programme in MCH, but other elements such as why some women used the services more than

172 others were not explored. In addition, the mechanisms through which the use of mobile phones

173 influences health seeking behaviour have not been clearly explained. Towards this end, a realist

174 evaluation is proposed to understand how, why, for whom and under what health systems

175 conditions the MomConnect programme improves the health-seeking behaviour of pregnant

176 women and mothers of infants in the uptake of MCH services.

177

Study setting

179 The study will be conducted in the Gauteng (GT) and Free State (FS) provinces of South Africa

180 (Figure 1). These provinces were selected based on the highest (GT) and lowest (FS) rates of

181 MomConnect registration from September 2014 to June 2017. GT accounted for 299,417

182 (22.2%) and FS for 64,416 (4.8%) of the total number of national registrations of 1,337,889

183 for this period.[34] The district health barometer (DHB) 2016/2017 reported 71.2% of PNC

184 visits within six days in GT which is higher than the national average of 75% and also lower

185 than that of FS (85.9%), which is higher than the national average. ANC first visit before 20

186 weeks was 58.4% in GT far less than the national average in the same period (1). However, our

187 selection of study participating provinces is based on the highest and lowest rates of

188 MomConnect registration and not on ANC/PNC attendance rates. GT and FS provinces differ

189 from each other in terms of socio-economic and demographic characteristics of their

190 inhabitants.[1] The use of mobile phones in GT and FS in 2016 were 98.2% and 94.9%

6

191 respectively.[35] Table 1 presents information on the socioeconomic and demographics

192 characteristics of the populations living in GT and FS. Western Rand and Johannesburg city

193 districts were identified as study settings located in the best resourced province (GT), while in

194 FS (less resourced province) two districts, Xhariep and Fezile Dabi were selected. Xhariep is

195 the largest district in FS and is among the best resourced' districts in provinces. The selected

196 sub-districts in which the study facilities will be chosen included Randfontein and

197 Johannesburg Sub-district A in GT and FS Naledi and Moqhaka see table 1. The DHIS data

198 2016 was used to select the district and sub-districts included in the study. The details on how

199 districts and sub-districts was selected is provided in the sampling section.

200

201 **Table 1 Socioeconomic and demographic factors**

	Gauteng	Free state
	1.Western Rand district	*1. Xhariep district*
Population	884 031	135,036
Sub-districts	Sub-districts:4 1.Randfontein 2. Westonaria 3. Merafong City 4. Mogale City	Sub-districts:4 1. Kopanong 2. Naledi3. Mohokare 4. Letsemeng
Houses headed by female	31.75%	37.6%
formal dwelling	76.3%	89.1%
Unemployment rate	26.3%	26.8%
	2. Johannesburg city district	*2. Fezile Dabi district*
Population	5,006,517	507,525
Sub-districts	Sub-districts:7 1. Johannesburg Sub-district A 2. Johannesburg Sub-district B 3. Johannesburg Sub-district C 4. Johannesburg Sub-district D 5Johannesburg Sub-district E 6. Johannesburg Sub-district F 7. Johannesburg Sub-district J	Sub-districts: 4 1. Mafube 2. Moqhaka 3. Ngwathe 4. Metsimaholo
Houses headed by female	37.7%	37.5%
Formal dwelling	81.3%	85.6%
Unemployment rate	61.5%	33.9%.

202 **Sources:** DHB 1016/1017 and DHIS data 2016

203 The district health barometer (DHB) 2016/2017 reported 71.2% of PNC visits within six days

204 in GT, which is lower than the national target of 75% and FS (85.9%). ANC first visits before

205 20 weeks was 58.4% less than the national target of 62.1 in GT while FS had 65.8% of ANC

7

206 first visits in the same period.[1] However our selection of provinces is based om highest and
207 lowest rate of the MomConnect registration as mentioned above in this section and not on
208 ANC/PNC.

209 *Figure 1: Map of South Africa and study settings (Setting 1: Gauteng and Setting 2: Free State)*

210

Methods

212 The study will be guided by the realist evaluation approach, which was introduced through the
213 seminal work of Pawson and Tilley [36] to address the question: 'What works, for whom, why,
214 in what situation, and how?' with regards to intervention, programmes and policies. The
215 philosophical ontology of realist evaluation is realism and its epistemological foundation lies
216 in scientific realism.[36] Realist evaluation belongs to the family of theory-driven approaches
217 of evaluation. In this light, the approach aims to develop and refine hypotheses of generative
218 causality explicating why and how intervention inputs bring about changes in key
219 outcomes.[37] The proposed study will be developed following three different phases, as
220 described in Figure 2 and reported following the guidelines for reporting realist evaluation
221 studies.[37]

222 *Figure 2: Study design showing Phases 1 to 3 adapted from* [38, 39] *(source: study author).*

223

Phase 1: Gleaning the initial programme theory (12-18 months)

225 Phase 1 will address the first objective of the study re-formulating the initial programme theory
226 (IPT) of how the MomConnect programme was expected to work for different actors
227 (designers, health workers and MCH clients). A multi-method elicitation study will be
228 conducted using data collected from the following sources: document review, exploratory
229 study with key informant interviews and a scoping review [40]. Since Phase one of the study
230 require many sub-studies it is estimated to take between 12 to 18 months depending on funding
231 availability.

Document review

233 The document review will explore documents such as the action plans, staff meeting reports
234 and other minutes; any literature on MomConnect; and the national monitoring and evaluation
235 report. Permission will be requested from the MomConnect monitoring and evaluation team to
236 access these documents and explore how MomConnect was developed, who participated and
237 with what intended objectives.

8

238   Document analysis [41] as a methodological process for review and evaluation will be used to
239   examine and interpret MomConnect documents, including capturing the meaning, gaining
240   understanding, and developing empirical knowledge on how the intervention was developed
241   and implemented.[41] The Intervention-Context-Actors-Mechanism-Outcomes (ICAMO)
242   heuristic tool [42] will be used to guide a content analysis approach.

243   **Exploratory qualitative study**

244   An exploratory qualitative analysis of programme managers and designers' assumptions and
245   perspectives will be undertaken simultaneously [43]. In-depth interviews (IDIs) with 5-10 key
246   informants, including programme designers (those who assisted in programme
247   conceptualisation) and managers (those who assisted in programme implementation and
248   coordination) will be conducted to explore their expectations on how MomConnect was
249   supposed to work. Key informants will be selected using purposive sampling and face-to-face
250   interviews will be conducted using an interview guide with each key informant.

251   The IDIs with key informants will be audio-recorded and transcribed verbatim. Summary
252   sheets and field notes will be written up for each interview at the end of the day. Thematic
253   analysis based on the generic inductive approach [43] will be conducted using Atlas.ti software
254   version 8.0.

255   **Scoping Review**

256   The scoping review of research conducted on mHealth and MCH will be performed by
257   searching the following databases: Academic research complete, Medline, Pubmed, Scopus,
258   Health System Evidence and Google scholar using MeSH terms. The following MeSH terms
259   combinations (Boolean phrases) will be used to search the identified databases: ["mHealth"
260   AND "maternal health"], ["mobile phone" AND "maternal health" AND "child health"],
261   ["mHealth AND "maternal health services"], [mHealth PRE/15 maternal] and [mHealth
262   PRE/15 maternal AND child AND health].

263   A thematic analysis [44] will be used to explore the various modalities of mHealth, relevant
264   context conditions, possible generative mechanisms and important outcomes reported in other
265   studies conducted on mHealth interventions and MCH. Using abductive reasoning, we will
266   conduct configurational mapping informed by the ICAMO heuristic tool to formulate tentative
267   models of how and why mHealth programmes work in general.

268

269

9

Formulating the initial programme theory (IPT)

A configurational mapping approach [42] guided by the ICAMO heuristic tool will be used to synthesise the information gleaned from the document review, qualitative exploration study with key informants and scoping review, to formulate the IPT that will be tested in phase two.[42] The theory formulated will be informed by various abductive reasoning through deductive, inductive, and retroductive reasoning forms of inferences making.

Phase 2: Testing the initial programme theory (12 -18 months)

The IPT formulated in phase I will be tested in the selected cases using a multi-method study design. In each case, a theory refining research approach will be used, underpinned by the hypothetico-deduction analytic model informed by data from both quantitative and qualitative methods.[39, 45] Quantitative assessments will be performed using a cross-sectional design, whereby a survey will be used to explore how socio-economic characteristics influence the uptake of MCH to determine for whom the intervention works. The cross-sectional study could also point to possible mechanism to allow to identify possible regularity and demi-regularity. The qualitative approaches will help us explore the different mechanisms and various context conditions by which the outcomes are generated.

Sampling and data collection

A representative sampling frame from the district health information system (DHIS) was used to obtain the sampling for this study focusing on ANC first visits before 20 weeks for June 2016. This period was the latest month in the master frame data of DHIS used to calculate the sample. All the districts in each province were drawn to identify districts with the highest and lowest ANC first visits before 20 weeks. In GT, West Rand and Johannesburg District have the highest District with (69.0%) and lowest (57.3%) rates respectively. Randfontein Sub-district in West Rand District, Randfontein was identified as the best sub-district with the highest rate of ANC first visits before 20 weeks (80.3%), while Johannesburg A was the sub-district with the lowest rate in the Johannesburg district (50.6%). Similarly, in the FS Province the districts with the highest (73.4%) and lowest (69.1%) rates are Xhariep and Fezile Dabi districts respectively. Naledi Sub-district (Xhariep District) was identified as the sub-district with the highest rate (80.4%) while Moqhaka Sub-district (Fezile Dabi District), the sub-district with the lowest rate (55.0%).

OpenEpi software and MS Excel was used to randomly select four facilities in each sub-district (see Table 2). The sample size in each facility was calculated [46], assuming 50% prevalence

10

302   of MCH services agreement per facility, a precision (d) of 0.10 and a 95% confidence interval.

303   The monthly estimated number of MCH visits for each facility and the proportion of ANC first

304   visits before 20 weeks was used to calculate the sample size using an online calculator.[46] In

305   cases where the ratio of the sample size (n) to the population size (N) is greater than 5%, finite

306   population correction (FPC) was used.[47] The number of users found in all four facilities will

307   be multiplied by a design effect (DE) of 1.5 to get the total number of participants (Table 2).

308

309   **Table 2** Selected sample by districts, sub-districts, facilities and participants

District	Gauteng (District with highest rate)	Gauteng (District with lowest rate)	Free State (District with highest rate)	Free Sate (District with lowest rate)
Sub-District	Randfontein sub-district (8 facilities)	Johannesburg A (14 facilities)	Naledi (4 facilities)	Moqhaka (9 facilities)
Facility	Kocksoord Clinic ANC 1 visit < 20 weeks = 82.0%	Mayibuye Clinic ANC 1 visit, < 20 weeks = 49.0%	Vanstadensrus Clinic ANC 1 visit < 20 weeks = 75.0%	Thusanong (Kroon) clinic ANC 1 visit < 20 weeks = 69.0%
Sample per facility*	Number of participants = 53 x1.5 = 80	Number of participants = 85x1.5 = 127	Number of participants = 66 x1.5 = 99	Number of participants = 74 x 1.5 = 111

310   *Estimated number of participants (based on proportional sampling)

311   The study participants will include all pregnant women and mothers of infants registered under

312   the MomConnect programme, who are 18 years of age or older, irrespective of parity (including

313   stillbirths/miscarriages), and socio-economic status. They will be identified through the

314   MomConnect registration registers at facility level. Health care providers (HCP) will include

315   clinical staff in charge of ANC and PNC at facility level and will be selected based on their

316   prior experience with the MomConnect programme.

317   A structured questionnaire survey tool has been developed (**Additional file 1**) to collect

318   quantitative data from pregnant women and mothers of infants registered with the

319   MomConnect programme. This tool will assess their understanding of how psychological

320   determinants, socio-cultural context and structural context influence their uptake of MCH

321   services. An appointment will be made with each participant, using the contact details captured

322   in the MomConnect database, to invite them to the facility to participate in the study. In

323   addition, the survey instruments will be administered telephonically to those participants who

324   are unable to visit the facility during the study period.

325   Furthermore, a facility assessment questionnaire (**Additional file 2**) will be administered to

326   HCPs at facility level to explore the structural and contextual attributes that may influence the

327   uptake of ANC and PNC services. Furthermore, a facility assessment questionnaire will be

11

administered to HCPs to explore the structural and contextual attributes that may influence the uptake of ANC and PNC services.

Qualitative assessments will include in-depth interviews (IDIs) and focus group discussion (FGDs). An estimated 10 to 20 IDI will be conducted with HCPs at facility level to explore their perceptions (resources, implementation processes and programme uptake) of the MomConnect programme (See **Additional Files 3, 4 and 5** for interview and FGD guidelines with patients and healthcare providers). Four FGDs (one per facility) consisting of between 10 and 15 participants will be conducted by the field workers and the principal researcher to ascertain participants perceptions regarding the uptake of MCH services and expectations of the MomConnect programme. Daily activities in selected ANC and PNC facilities will be observed as well. IDIs and FGDs will be audio-recorded and transcribed verbatim to be analysed using Atlas ti 8.0. The interview guide and survey questionnaire are designed in English but will be translated into the local language used in the different study settings (Afrikaans, Setswana, Sesotho, Zulu, Xhosa) and back translated in English. Data gathered from the above sources will be transcribed, translated and back translated in preparation for analysis.

In each case, a theory refining research approach underpinned by the hypothetico-deduction analytic model will be used for both quantitative and qualitative study.[39, 45] The hypothetico-deduction approach is most appropriate when testing an existing theory or a theory formulated *a priori*. This approach allows for various aspects and the entire hypothesis or initial theory to be examined in light of the new evidence that is emerging in the various cases.

Data analysis

Inferential and descriptive analyses of the quantitative data including proportions and frequencies will be performed using Stata version 15. Socio-economic and demographic data will be used as independent variables while the uptake of MCH will be used as the dependent variable, which will allow us to determine for whom the intervention works. For bivariate analysis, categorical data will be analysed using Chi-squared test. Logistic regression models will be constructed to assess the effects of independent variables as predictors of dependent outcomes of interest. The power of each dependent variable will be tested before the variable is included in the model and only the variable with positive outcomes will be maintained. A p-value of <0.05 will be used to indicate statistical significance along with a 95% corresponding confidence interval (CI).

360 For qualitative data, IDI and FGDs will be analysed separately using a thematic content

361 analysis approach to identify and make explicit the mechanism by which observed outcomes

362 are generated using the ICAMO framework. FGDs and IDI transcripts will be uploaded onto

363 Atlas.ti 8.0 for analysis. The qualitative data analysis will comprise two main activities:

364 For the qualitative data deductive and inductive thematic analyses will be applied to analyse

365 the data collected through observation, IDIs and FGDs following these seven steps: (1)

366 Familiarising with the data set; (2) development of a coding framework, (3) coding a portion

367 of the dataset for each case study (4) testing code reliability, (5) identifying initial themes

368 emerging from the data, (6) using the code manual to apply codes to the entire script, and (7)

369 connecting codes into themes through an interpretation process.

370 **Modifying the initial programme theory**

371 In-case analysis [36] will be conducted using retroductive reasoning [48] to modify the ICAMO

372 elements through configuration mapping based on the data obtained from each case to modify

373 the IPT. In other words, ICAMO configurations will be modified into case-based programme

374 theories (for each of the four facilities). Each case-based modified theory will be tested to check

375 their explanatory power through the process of counterfactual thinking towards a functional

376 theory.[49] ICAMO matrices will be used to present data for each higher-level outcome of

377 concern.

Phase 3: Refining the modified programme theory (6-12 months)

379

380 A cross case analysis of the four case studies will be conducted using *retroductive* reasoning

381 to construct ICAMO matrices (ICAMO configuration obtained from each of the four case

382 studies) to obtain a refined programme theory or model. The cross-case analysis will allow us

383 to obtain a more refined programme theory to the IPT and the case-specific theories. A refined

384 theory is a clear or functional explanation theory that can be used to give details of the

385 programme elements and their roles in orchestrating the observed outcomes in certain context

386 conditions for the different actors involved. This refined theory although obtained through

387 abstraction, remains close enough to the observed data, yet provides explanations that are

388 sufficiently general to explain outcomes across settings and social activities.[36]

389

Quality control

391 The RAMESIS II guideline for conducting and reporting realist evaluation [37] will be used to
392 ensure quality control in the study.

393 First, to elicit the IPT, all the above steps will be followed to ensure the trustworthiness of data
394 collected from various sources, thus capturing a wide range of intended and unintended
395 outcomes, context-mechanism interactions and relevant actors.

396 In phase 2, to assess the reliability of data collection, a pilot study will be conducted in two
397 healthcare facilities selected for convenience in the sub-district with the highest and lowest
398 rates of ANC first visits before 20 weeks in GT and FS, respectively. The pilot will include
399 health care providers (HCPs), pregnant women and mothers.

400 At all levels of the study, quality control and credibility will be assured through data
401 familiarisation by all the investigators and discursive interactions.

402

Ethics and dissemination

404 Ethics approval has been granted by the Health Research Ethics Committee (HREC) of the
405 Stellenbosch University (Ref No: S18/09/189). An approval to conduct the study in the selected
406 facilities is currently being processed by the relevant provincial Department of Health. Consent
407 forms will be used to obtain permission from study participants before data collection. Personal
408 information will be protected by not disclosing names during data analysis or reporting.
409 Different papers will be published from the study, and the results will be presented in academic
410 open day, national and international conferences.

411

DISCUSSION

413 Despite the relevance of mHealth in improving MCH being increasingly recognised [50], an
414 empirical investigation to understand how the outcomes are generated is still lacking. This
415 protocol specifies the research plan to investigate how and why the MomConnect programme
416 works or achieves its goal of improving MCH services in South Africa. Study investigators
417 will also seek to understand MomConnect as part of an mHealth programme that uses mobile
418 phones by focusing on how contextual factors affect the use of MCH services.

419 The proposed study draws on a theory-driven evaluation (TDE) approach, which describes a
420 process under which components are hypothesised to affect outcomes, and considers the
421 specific conditions under which such processes operate.[38] TDE is commonly used in the
422 social sciences to investigate how programmes cause intended or observed outcomes [51], as

14

423 well as address issues around internal and external validity, which is of potential relevance to

424 both researchers and policymakers.[38, 52, 53] The proposed study will use a realist evaluation

425 approach, which is a type of TDE.[37] Pawson and Tilley [36] developed the realist evaluation

426 to address the question: 'What works, for whom, why, in what situation and how?' TDE will

427 be used in this study to assess in particular how the use of mobile phones influences the uptake

428 of MCH services. The protocol is an important quality tool as it allows for follow-up by

429 anticipating the challenges and barriers that may occur during the study.[54, 55] This study

430 protocol also assists in thinking through how to generate the internal consistency and external

431 validity of results and to explain how the interventions works in a given context to produce the

432 observed outcome. The lack of such protocol can lead to some issues, such as lack of

433 explanation of the change at or between individual, institutional or contextual levels because

434 these were not documented from the start.[56] Moreover, writing a detailed research protocol

435 is important in helping other researchers to replicate relevant study findings for contribution

436 towards the broader research community. Constructing a comprehensive protocol including

437 clear aims, rationale, analysis plans and expectations lends additional credibility to research

438 across study fields. [56]

439 It is expected that this study will improve our understanding of how and why the MomConnect

440 intervention impacts the health seeking behaviours of pregnant women and mothers of infants.

441 This study is also expected to provide a detailed description of the health system conditions

442 that influence the implementation of the MomConnect programme to improve the uptake of

443 ANC and PNC services. Finally, the study will provide some recommendations to improve the

444 rollout and implementation of MomConnect elsewhere.

445 **Contributors:** The study was conceived by EMK and PD. The first manuscript was written by

446 EMK. FCM and EN provided methodological support. FCM, PD, EN provided critical and

447 contribution towards developing and refining the manuscript. All authors read and approved the

448 final manuscript.

450 **Competing interest**: The authors declared no potential competing interest with respect to the

451 research, authorship, and/or publication of this article.

452 **Ethics approval**: Stellenbosch University Human research ethics committee (Ref No

453 S18/09/189).

454 **Patient and public involvement:** No patient involved

15

455 **References**

456 [1] Massyn N, Padarath A, Peer N, et al. *District Health Barometer*. 2017.

457 www.hst.org.za/.../District-Health-Barometer-201617.aspx

458 [2] Symon A, Pringle J, Cheyne H, et al. Midwifery-led antenatal care models : mapping a

459 systematic review to an evidence-based quality framework to identify key components and

460 characteristics of care. *BMC Pregnancy Childbirth* 2016;16(1):168.

461 [3] Ram F, Singh A. Is antenatal care effective in improving maternal health in rural Uttar

462 Pradesh? Evidence from a district level household survey. *Journal ofbiosocial Science* 2006;

463 38: 433–448.

464 [4] Massyn N, Peer N, Padarath A, et al. *District Health Barometer*. 2016. www.hst.org.za/.../-

465 District-Health-Barometer-201516.aspx

466 [5] Moodley J, Chb MB, Fawcus S, et al. Improvements in maternal mortality in South Africa.

467 *South African Medical Research* 2018;108(3):4–8..

468 [6] Sachs JD. From millennium development goals to sustainable development goals. *Lancet

469 (London, England)* 2012; 379(9832):2206–11

470 [7] Le Blanc D. Towards Integration at Last? The Sustainable Development Goals as a Network

471 of Targets. *Sustainable Development* 2015;23(3):176–87

472 [8] Aranda-Jan CB, Mohutsiwa-Dibe N, Loukanova S. Systematic review on what works, what

473 does not work and why of implementation of mobile health (mHealth) projects in Africa. *BMC

474 Public Health* 2014;14(1):188–203

475 [9] Kaplan W. Can the Ubiquitous power of mobile phones be used to improve health outcomes in

476 developing countries? *Global Health* 2006;2(1):9.

477 [10] SANOU B. ICT Facts & Figures. The world in 2015. *Itu 150 Años (1865 - 2015)* 2015; 1–6.

478 Available from: http://www.itu.int/en/ITU-

479 D/Statistics/Documents/facts/ICTFactsFigures2015.pdf

480 [11] Premji S. Mobile health in maternal and newborn care: Fuzzy logic. *International Journal of

481 Environmental Research Public Health* 2014;11(6):6494–503.

482 [12] Oyeyemi SO, Wynn R. The use of cell phones and radio communication systems to reduce

483 delays in getting help for pregnant women in low- and middle-income countries: a scoping

484 review. *Global Health Action* 2015 Dec 10;8(1):28887–95.

485 [13] World Bank. World Development Report 2016: Digital Dividends,

486 http://www.worldbank.org/en/publication/wdr2016 (2016, accessed 25 January 2018).

16

487   [14]   Services P. South Africa Profile (Latest data available : 2017). 2017; 1–3.

488   [15]   Watterson JL, Walsh J, Madeka I. Using mHealth to Improve Usage of Antenatal Care,

489   Postnatal Care, and Immunization: A Systematic Review of the Literature. *BioMed Research*

490   *International*. Epub ahead of print 2015. DOI: 10.1155/2015/153402.

491   [16]   Poorman E, Gazmararian J, Parker RM, et al. Use of Text Messaging for Maternal and Infant

492   Health: A Systematic Review of the Literature. *Matern Child Heal* 2015;19(5):969–89.

493   [17]   Feroz A, Perveen S, Aftab W. Role of mHealth applications for improving antenatal and

494   postnatal care in low and middle income countries: A systematic review. *BMC Health Service*

495   *Research* 2017;17(1):704.

496   [18]   Wambugu S, Villella C. mHealth for Health Information Systems in Low- and Middle-Income

497   Countries: Challenges and Opportunities in Data Quality, Privacy, and Security. *mHealth*

498   *Information System* 2016; 1–19.

499   [19]   Parker RM, Dmitrieva E, Frolov S, et al. Text4baby in the United States and Russia: An

500   Opportunity for Understanding How mHealth Affects Maternal and Child Health. *Journal of*

501   *Health Commun* 2012;17(1):30–6.

502   [20]   USAIDS. Mobile Alliance for Maternal Action (MAMA). *mHealth knowledge*,

503   http://www.mhealthknowledge.org/search/site/MAMA (2015).

504   [21]   Ausen-anifrani S, Burman MK, Pastick K. SMS Maama. *United Nation Found* 2016; 1–14.

505   Available from: http://www.askmama.co.za/.

506   [22]   Peter JE, Barron P, Pillay Y. Using mobile technology to improve maternal, child and youth

507   health and treatment of HIV patients. *South African Mededical Journal* 2016;106(1):3

508   [23]   Barron P, Peter J, LeFevre AE, et al. Mobile health messaging service and helpdesk for South

509   African mothers (MomConnect): history, successes and challenges. *BMJ Global Heal*th

510   2018;3(2):e000559

511   [24]   Seebregts C, Dane P, Parsons AN, et al. Designing for scale : optimising the health

512   information system architecture for mobile maternal health messaging in South Africa (

513   MomConnect). *BMJ Global Health* 2018;2(3):1–7.

514   [25]   Mehl GL, Tamrat T, Bhardwaj S, et al. Digital health vision : could MomConnect provide a

515   pragmatic starting point for achieving universal health coverage in South Africa and

516   elsewhere ? *BMJ Global Health* 2018;3(2):1–5.

517   [26]   Xiong K, Kamunyori J, Sebidi J. The MomConnect helpdesk : how an interactive mobile

518   messaging programme is used by mothers in South Africa. *BMJ Global Health*

519   *2018;3(2):000578.*

17

520   [27]   Engelhard M, Copley C, Watson J, et al. Optimising mHealth helpdesk responsiveness in
521   South Africa : towards automated message triage. *BMJ Global Health* 2018;3(2):1–9.

522   [28]   Pillay Y, Motsoaledi PA. Digital health in South Africa : innovating to improve health. *BMJ*
523   *Glob Heal* 2018; 4–6.

524   [29]   Skinner D, Delobelle P, Pappin M, et al. User assessments and the use of information from
525   MomConnect , a mobile phone text-based information service , by pregnant women and new
526   mothers in South Africa. *BMJ Gloalb Heathl* 2018;3(2):e000561.

527   [30]   Heekes A, Tiffin N, Dane P, et al. Self-enrolment antenatal health promotion data as an
528   adjunct to maternal clinical information systems in the Western Cape Province of South
529   Africa. *BMJ Glob Health* 2018;3(2):e000565.

530   [31]   Peter J, Benjamin P, Lefevre AE, et al. Taking digital health innovation to scale in South
531   Africa : ten lessons from MomConnect. *BMJ Gloalb Health* 2018;3(2):1–4.

532   [32]   Free C, Phillips G, Watson L, et al. The Effectiveness of Mobile-Health Technologies to
533   Improve Health Care Service Delivery Processes: A Systematic Review and Meta-Analysis.
534   *PLoS Medecine* 2013;10(1):e1001363.

535   [33]   Agarwal S, Perry HB, Long L-A, et al. Evidence on feasibility and effective use of mHealth
536   strategies by frontline health workers in developing countries: systematic review. *Tropical*
537   *Medecine International Health* 2015 Aug;20(8):1003–14.

538   [34]   Lefevre AE, Dane P, Copley CJ, et al. Unpacking the performance of a mobile health
539   information messaging program for mothers (MomConnect) in South Africa : evidence on
540   program reach and messaging exposure. *BMJ Global Health* 2018;3(2):e000553.

541   [35]   Statistics South Africa c. *General Household Survey 2016*. 2018.
542   http://microdata.worldbank.org/index.php/catalog/2879/

543   [36]   Pawson R, Tilley N. *Realistic evaluation*. Sage, 1997.
544   https://journals.sagepub.com/doi/pdf/10.1177/109821409902000221

545   [37]   Wong G, Westhorp G, Manzano A, et al. RAMESES II reporting standards for realist
546   evaluations. *BMC Medecine* 2016;14(1):96–114.

547   [38]   Van Belle SB, Marchal B, Dubourg D, et al. How to develop a theory-driven evaluation
548   design? Lessons learned from an adolescent sexual and reproductive health programme in
549   West Africa. *BMC Public Health* 2010;10(1):141–51.

550   [39]   Mukumbang FC, Marchal B, Belle S Van, et al. Unearthing how , why , for whom and under
551   what health system conditions the antiretroviral treatment adherence club intervention in South
552   Africa works : A realist theory refining approach. *BMJ Global. BMC Health Services*

18

553   *Research; 2018;18(1):343.*

554   [40]   Downs DS, and Hausenblas HA. Elicitation studies and the theory of planned behavior : a

555   systematic review of exercise beliefs. *Pschology of Sport and Exercise* 2005;6(1):1–31.

556   [41]   Bowen GA. Document analysis as a qualitative research method. *Qualtative Research Journal*

557   2009;9(no.2):27–40.

558   [42]   Mukumbang FC, Marchal B, Belle S Van, et al. A realist approach to eliciting the initial

559   programme theory of the antiretroviral treatment adherence club intervention in the Western

560   Cape Province , South Africa. *BMC Medical Reearchs Methodology* 2018;18(1):47.

561   [43]   Thomas DR. A General Inductive Approach for Analyzing Qualitative Evaluation Data.

562   *American Journal of Evaluation* 2006;27(2):237–46.

563   [44]   Ritchie J, Spencer L. Qualitative Data Analysis for Applied Policy Reasearch. *The qualitative*

564   *researcher's companion* 2002; 305–329.

565   [45]   Eastwood JG, Jalaludin BB, Kemp LA. Realist explanatory theory building method for social

566   epidemiology : a protocol for a mixed method multilevel study of neighbourhood context and

567   postnatal depression. *Springer Plus* 2014;3(1):12.

568   [46]   Naing L, Winn T, Rusli BN. Practical Issues in Calculating the Sample Size for Prevalence

569   Studies. *Arch Orofac Sci* 2006; 1: 9–14.

570   [47]   Burstein H. Finite Population Correction for Binomial ConFidence Limits. J*ournal of the*

571   *American Statistical Association.* 1975;70(349):67–9.

572   [48]   Zoltan D. Plenary Speech Researching complex dynamic systems : ' Retrodictive qualitative

573   modelling ' in the language classroom. *Cambridge University Pree* 2011;47(1):80–91.

574   [49]   Roese NJ. Counterfactual Thinking. *American Psychological Association* 1997;121(1):133–48.

575   [50]   Lee H.S., ulugbek B. N., Bright I N, Mome M, lLiz Grant CP. Effextiveness of mHealth

576   intervention for maternal, newborn and child health in low-and middle-income countries:

577   Systematic review and meta-analysis. *Glob Health* 2016;6(1):1–17.

578   [51]   Coryn CLS, Noakes LA, Westine CD, et al. A systematic review of theory-driven evaluation

579   practice from 1990 to 2009. *American Journal of Evaluation.* 2011;32(2):199–226.

580   [52]   Chen HT. The conceptual framework of the theory-driven perspective. *Evaluation Program*

581   *Planning.* 1989;12(4):391–6.

582   [53]   Chen H-T, Rossi H. Issues in the Theory-Driven. *Evaluation Program Planning*, Vol.

583   1989;12(4):299–306.

584   [54]   Chen L, Wang W, Du X, et al. Effectiveness of a smart phone app on improving immunization

19

585 of children in rural Sichuan Province, China: study protocol for a paired cluster randomized

586 controlled trial. *BMC Public Health* 2014;14(1):262.

587 [55] Mukumbang FC, Van Belle S, Marchal B, et al. Realist evaluation of the antiretroviral

588 treatment adherence club programme in selected primary healthcare facilities in the

589 metropolitan area of Western Cape Province, South Africa: a study protocol. *BMJ Open* 2017

590 Jul 21];6(4):e009977-88.

591 [56] Pashanth N. et al. How does capacity building of health managers work? A realist evaluation

592 study protocol. *BMJ* 2012;2(2):e000882.

593

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

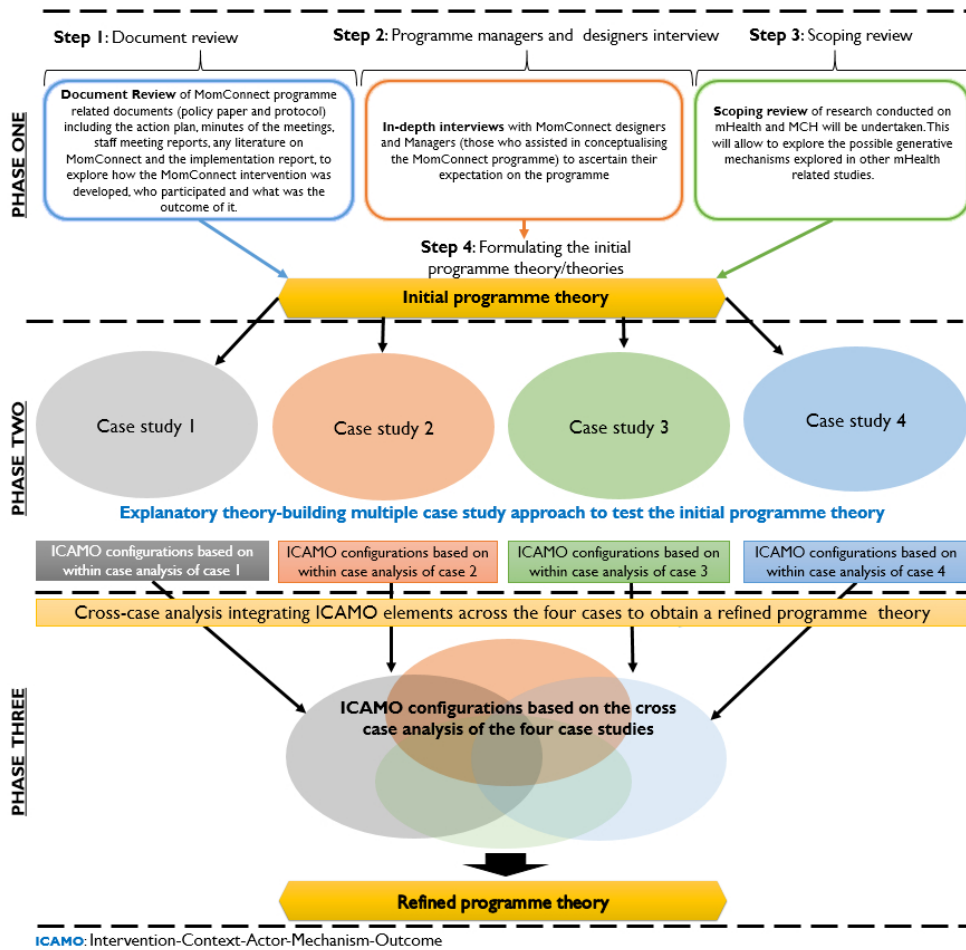Figure 1: Map of South Africa and study settings

194x145mm (96 x 96 DPI)

Figure 2: Study design showing Phases 1 to 3

237x225mm (96 x 96 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Additional File 1 – Data collection form/Survey questionnaire

This form will be presented to the respondents. The investigator will ask the participant each question and select the appropriate answer for each question.

1. Socio- demographics characteristics	
1.1Month & Year of birth	---
1.2 Age	---
1.3 Race	White/Colored/Indian/Black/ Other…
1.4 Marital status	Single / married / living together / divorced / separated / widowed
1.5 Highest level of schooling	Less than primary / primary / secondary / diploma / degree
1.6 Partner level of education	Less than primary / primary / secondary / diploma / degree
1.7 Occupation	Unemployed/Employed/student/refuse to answer
1.8 Partner Occupation	Unemployed/Employed/student/refuse to answer
1.9 What is your source of income?	Permanent Employment / Part-time Employment / Seasonal Employment / Grant / Other (please specify).
1.10Parity	Primiparous/Multiparous
1.11 Wanted last child	Last child wanted, wanted child but later, wanted no more child
1.12 How many children do you have?	(indicate numerical value) or Refuse to answer
1.13 What is your home languishing?	English/seseko/ Afrikance, sewana Xhosa, other

2. Mobile phone usage for MomConnect	
2.1 Mobile phone usage	
2.1.1 Do you have your own cellphone or do you use a SIM card in someone else's phone? *(If not, do you have access to a cellphone?)*	Own phone/Only SIM card/No phone Yes / No/DK/RA
2.1.2 Do you share your cellphone? *(If yes, with whom do you share your phone?)*	Yes / No Partner / Family Member / Friend / Other
2.1.3 Do you have problems in receiving messages in your phone?	Yes/ No/ DK/RA
2.1.4 What do you like the most about the MomConnect information received in your phone	1.The reminders about ANC and PNC booking/ 2 information about the development of my baby/ 3. Information about danger signs/ 4. Other

3 Health seeking behaviours		
3.1.1 Did you receive health check-ups (ANC) during your last pregnancy at least once?	1. Yes /2 No	If no go to question 3.1.3
3.1.1.a. If yes when was your first ANC visit?	1. within 1 to 3 months/ 2. 4-6 months / 3. 7-9 months	If 2 or 3 ask question 3.1.3
3.1.1.b. How many times did you visit for ANC during pregnancy?	1. 4 times/ 2. more	
3.1.2 Why did you visit the clinic today?	1. Pregnancy visit /2. 6-week post birth follows up / 3. Immunization /4. I am sick/ /5. Advised by my family members/6. To start a regular check- up/ 7. Other….	
3.1.3 Why didn't you attend ANC check-up during your three first months of pregnancy?	1. I was healthy/2. I thought it was unnecessary/3. Expenses of Check-up was unaffordable/ 4. Clinic is too far away from home/5. Family members disapproved/6. Poor transportation facility to the health facility/7. I was scared/8. If any other reason, please specify	
3.2.5 Did you go for PNC check-up after delivery?	1. Yes/2. No	
3.2.5.a If yes When did you receive your PNC check-up and that of your baby?	1. Within 6 days, 2. After 6 days	
31.5. b. If after 6 days why?	1. I was healthy/2. I thought it was unnecessary/ 3. Expenses of health care/ 4. Clinic is too far away from home/ 5. Family members disapproved/5. Poor transportation facility to the health facility/6. I was scared/7. If any other reason, please specify	
3.1.6. Why did you come to this health institution for check-up? (more than 1 answer can be marked)	1. Close to my house/ 2. Close to where I work /3. Inexpensive/4. Behaviour of staff is good/5. Convenient timing/ 6. Good quality service/Others…	
3.1.7 How long do you have to travel to the nearest clinic	1. 1 to 2 km to / 2. 3 to 4 km/ 3>4 km	
3.2 Cultural belief (Please provide your answer to the following statement by selecting one answer)		
3.2. Do you need to ask a permission to go the clinic for your ANC/PNC?	1. Yes/ 2. No	
3.2.3 To whom do you ask that permission for going to the clinic for ANC/PNC?	1. My husband/ 2. Family/3. My mother in low/4. My own decision/5. others…	
3.2.3 Who is looking after your children if you have to go to the clinic	1. Grandparent/ 2 Husband/ 3. Friends/ 4. No one	

Thank you for your cooperation!

Additional File 2 - Facility Assessment

2 Facility assessment (manager interview)	
2.1. Do your clients access the facility easily? Yes/ No / Don't know / If not why?	
2.2. a. If no what are the possible barriers you may think of? …..	
2.1 Do you train all your clients on how to use MomConnect? Yes / No / Don't Know	
2.1.a. If yes is this training continually? Yes / No / Don't Know	
2.2. How many days do you have ANC per week? Once a week / Twice a week	
2.3. How many days do you provide PNC per week? One day / Two days	
2.4. Is MomConnect programme education or training being given in each of your ANC and PNC session? Yes/ No / If no, why?	
2.5. Are you using the MomConnect materiel during all your ANC session? Yes / No / If no, why?	
2.6. Do you use the MomConnect during your PNC session? Yes / No / If no, why?	

THANK YOU FOR YOUR COOPERATION!

Additional File 3

Interview and Discussion Topic Guides for MomConnect key informants

My name is Eveline Kabongo. I'm from Stellenbosch University. My study is part of the MomConnect programme which you have designed. To begin I would like to thank you for your time and for being interviewed.

Question 1: I am interested in understanding how the MomConnect program works? The first thing that I want to know is what you see as the purpose of the MomConnect programme?

Question 2: Why did you think the MomConnect intervention is important to improve MCH health?

Question 3: What does the intervention consist of or what are the various components of the MomConnect programme?

Question 4: How did you expect the MomConnect programme to increase the utilisation of MCH care services such as ANC and PNC services?

Question 5: Who are the individuals involved in running the MomConnect programme?

Question 6: As a MomConnect designer and manager, how do you expect the MomConnect programme to improve ANC and PNC services in rural and urban areas? How do you think the messages that are sent to expectant mothers may improve ANC/PNC? Are there some of the enablers you can think of, i.e. things that can help the program succeed?

Question 7: During your planning what were the factors that you thought could act as barriers to the implementation of the MomConnect programme?

a. Do you think that the user's level of education may have an impact on their use of MCH services? Do you think that users from poor households will have difficulty in using healthcare services even though they receive all the supporting messages encouraging them to go to the clinic and use health facilities through the MomConnect programme?

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Question 8: Which other conditions do you think could prohibit women from using ANC and PNC services?

Thank you for your time and contribution!

Additional File 4 - Interview and Discussion Topic Guide for Healthcare Providers

My name is Eveline Kabongo. I am from Stellenbosch University. As a healthcare provider, you are a target in this study as you are one of those who are implementing the MomConnect programme at the facility level.

Question 1: What is the purpose of the MomConnect programme?

Question 2: In your opinion how well do you think this programme is working? Is it achieving its goals or not? If not why?

Question 3: What exactly is it about MomConnect that makes ANC/PNC client use MCH services?

Question 4: Have you experienced for yourself that sending clients the messages on their mobile phone helps them to use MCH services? How exactly do you think this helps them?

Question 5: Why else do you think that pregnant women and mothers registered on MomConnect will use the MCH services as instructed by the messages and continue with their clinic appointments?

Question 6: In what ways do you think these clients become empowered to self-manage their uptake of MCH through the MomConnect messages?

Question 7: How were your services before the development of the MomConnect programme? Do you think it affects the way your services are being run?

Thank you for your time and contribution

Additional File 5 - Focus group discussion guideline with pregnant women and mothers of infants registered to MomConnect

I am Ms Eveline Kabongo. I am from Stellenbosch University. My study seeks to examine how the MomConnect programme influences health-seeking behaviour among pregnant women and mothers of infants aged from zero to one year, to improve maternal and child health. Your collaboration will be of much help as it will allow us to understand the rationale behind the MomConnect programme.

Question 1:How long have you been registered with the MomConnect programme? Does it help you better use your MCH and attend your clinic appointments?

Do you think that being registered on the MomConnect programme makes your utilisation of ANC/or PNC a) Easy? b) Difficult? c) Did not change anything at all?

Question 2: When receiving the message from MomConnect how do you feel?
In what ways do you think that being registered on the MomConnect programme helps you to use ANC/PNC services and attend your clinic appointments?

Question 3: How does being registered to the MomConnect programme influence your healthcare service utilisation in terms of empowering or encouraging you to use ANC and PNC services as early as possible?

Question 4: What makes you use ANC/PNC at the time that you are supposed to use it? What affects your use of ANC and PNC services as an individual?

Question 5: Do you give feedback about the message and services received? How does interaction and feedback help you to use ANC/PNC services?

Question 6: What do you think about the messages and education that you receive from MomConnect? Does it really help you to use ANC/PNC services? If so, how?

Question 7: Did your husband or family member accept your use of ANC/PNC when needed?

Thank you for your time and contribution!