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Design Paper 1

Upstream interventions aiming to encourage adolescents' use of contraception in low- and middle-income countries: A rationale and protocol for a mixed-methods synthesis to develop a mid-range theory

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About this design paper

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**Upstream interventions aiming to encourage adolescents' use of
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A rationale and protocol for a mixed-methods synthesis
to develop a mid-range theory**

Abstract

This paper sets out the rationale and protocol for a novel mixed methods evidence synthesis. Reducing adolescent childbearing is a priority in many low- and middle-income settings; increased use of contraception can help address this. However there is a lack of, and recognised need for, synthesised findings exploring interventions that aim to address upstream determinants of adolescent contraceptive demand. Upstream determinants include gender inequalities, fertility norms, economic empowerment and participation in education, which affect individuals' knowledge, attitudes and behaviours. This project has two aims: firstly, to develop a mid-range theory to explain how upstream interventions can encourage adolescents' use of contraception in low- and middle- income countries. Within this, we aim to explore what types of interventions have been evaluated; what intervention characteristics may facilitate or hinder their effectiveness; and what mid-range theory could explain how these interventions achieve effectiveness. The second aim of the project is to reflect on how best to build a mid-range theory using novel methods within an evidence synthesis. Specifically, we will aim to explore how useful the methods and different evidence sources are for building theory.

We will build on a comprehensive, systematic search conducted for a 3ie evidence gap map to identify what types of interventions have been evaluated. We will then focus on a subset of these to explore what factors (e.g. intervention content, implementation, context or other characteristics) may facilitate or hinder effectiveness. We will conduct an Intervention Component Analysis and a qualitative views synthesis to achieve this. We will use these findings to develop a preliminary theory, which we will then test and refine using Qualitative Comparative Analysis. Two stakeholder advisory groups, one with international, national and sub-national professionals and one with adolescents, will be convened to feed into, reflect on and shape the synthesis at three specific time points. We will reflect on the methods and evidence sources used, as well as the use of stakeholder advisory groups, to shape and develop the mid-range theory.

Introduction

Reducing adolescent childbearing is a global priority and use of contraception is one means of achieving this (Chandra-Mouli, Ferguson et al. 2019). There exists a large body of (synthesised) evidence on the effectiveness of interventions to encourage adolescent contraceptive use (Mwaikambo, Speizer et al. 2011, McQueston, Silverman et al. 2013, Denno, Hoopes et al. 2015, Phiri, King et al. 2015, Belaid, Dumont et al. 2016, Mason-Jones, Sinclair et al. 2016, Oringanje, Meremikwu et al. 2016). However interventions typically focus on the supply of contraceptives and services, and/or individual-level demand-side factors. There has been less attention paid to synthesising evidence on the effectiveness of interventions that target upstream factors, such as gender inequalities, fertility norms, economic empowerment and participation in education, which influence individual attitudes and behaviours.

The evidence synthesis proposed in this paper sets out to develop a mid-range theory to explain how upstream interventions aiming to encourage adolescents' use of contraception could have an effect on demand or use. Identifying the mechanisms through which upstream interventions are intended to have an effect will allow us to present a framework that sets out the key elements (e.g. characteristics of the intervention content, context or implementation) that should be incorporated into interventions and their implementation. This framework could then be used to develop interventions that suit a particular population or setting, whilst ensuring they address the key mechanisms required in order to be effective.

This paper starts by (i) outlining the policy rationale for focusing on upstream interventions, before (ii) describing some of the methodological innovative strategies we will adopt, and then (iii) the specific details and plan of how the work will be undertaken to develop a mid-range theory for developing upstream interventions to encourage adolescents' use of contraception.

Policy relevance of understanding how upstream interventions can encourage adolescents' use of contraception

Reducing adolescent childbearing is a priority in many low- and middle-income settings and adolescent birth rate is an indicator for Sustainable Development Goal 3 (Ensure healthy lives and promote well-being for all at all ages) (United Nations 2017). Encouraging contraceptive use is one means of addressing this issue.

The factors shaping adolescents' use of contraception are numerous, interacting and complex. Factors are typically delineated into those relating to the supply of, or access to, contraceptives and contraceptive services, and those relating to demand for contraception. Contraceptive demand has been conceptualised as having three key parts: 1/ a desire to avoid, delay, space or

limit childbearing, 2/ a desire to use contraception and 3/ having the agency to use family planning (i.e. “the ability to act on their desires and make decisions regarding their reproduction” (p10) (ICRW 2014). These desires and agency are influenced by an individual’s knowledge, beliefs, attitudes and skills, which in turn are influenced by peers, family members and partners as well as upstream factors which affect the extent to which the wider environment supports or enables contraceptive use (ICRW 2014). Although the importance of upstream factors has been recognised (Mutumba, Wekesa et al. 2018, Slaymaker, Scott et al. 2020), much research has focused on evaluating interventions targeting adolescents’ knowledge, beliefs, attitudes, and skills rather than these wider determinants (ICRW 2014, Rankin, Heard et al. 2016). An evidence gap map of adolescent reproductive and sexual health impact evaluations and systematic reviews found that the most frequently evaluated intervention type was sexual health education (Rankin, Jarvis-Thiébault et al. 2016). Fewer evaluations and syntheses have been conducted on upstream interventions aiming to encourage adolescents’ use of contraception.

Upstream factors include legal, political, social and cultural factors that shape contraceptive use (Svanemyr, Amin et al. 2015). Upstream interventions could include: economic empowerment of girls (e.g. microfinance schemes), encouraging school enrolment and retention (e.g. cash transfers); helping to shape gender, sexual behaviour and fertility norms (e.g. peer-led, community mobilisation or mass media) or to reduce gender and other inequalities (promoting laws, policies or their implementation to create greater gender equality). 3ie’s evidence gap map reviewed existing systematic reviews and impact evaluations (Rankin, Jarvis-Thiébault et al. 2016). The authors recommended that future syntheses should explore the theories of change underpinning cash transfer and income generation and savings interventions. Therefore we propose to focus on upstream interventions aiming to encourage adolescents’ use of contraception in low- and middle-income countries.

The broad range of upstream interventions available creates challenges for policy-makers and practitioners: it can be difficult to judge which intervention would be most feasible and effective in their specific context. Previous syntheses have also noted a lack of theory underpinning interventions, or the need to document why interventions work (ICRW 2014, Rankin, Heard et al. 2016). Mid-range theory could help these decisions. Therefore we aim to develop and test a mid-range theory to explain how upstream interventions work to encourage adolescent contraceptive use. The mid-range theory developed and refined in this study should help to inform policymakers, evaluators and implementers in the development and implementation of upstream interventions. We will use novel methods and evidence sources to do this and so will also aim to explore how to use, and the value of using,

these novel methods and evidence sources develop mid-range theory. This methodological innovation should be of use to future researchers.

Innovation: the use of novel methods to develop mid-range theory

Mid-range theories sit between an individual intervention's theory of change and grand social science theory explaining universals of a phenomenon. They aim to consolidate existing theory and empirical research and, when applied to interventions, set out the principles and mechanisms through which a category of interventions can achieve outcomes for a particular issue. These principles and mechanisms can then be used to develop specific effective interventions that are appropriate for particular populations and settings.

This project aims to use novel methods (Intervention Component Analysis and Qualitative Comparative Analysis) to develop an empirically-based mid-range theory about how upstream interventions can encourage adolescents' contraceptive use in low- and middle-income countries. By developing a mid-range theory, we will provide a framework that sets out the key elements (e.g. characteristics of the intervention content, context or implementation) that should be incorporated into interventions and their implementation. This could then be used to develop specific interventions that suit a particular population or context, whilst ensuring they address the key mechanisms required in order to be effective.

The methodological contribution of this research include:

- 1) Use of Intervention Component Analysis (ICA) to incorporate novel evidence sources into Qualitative Comparative Analysis (QCA)
- 2) Use of QCA in a development evidence synthesis
- 3) Exploration of the value of ICA and QCA as tools for developing mid-range theory
- 4) Exploration of how stakeholder involvement can be used to shape the development of mid-range theory

1. Use of Intervention Component Analysis to incorporate novel evidence sources into a Qualitative Comparative Analysis

Intervention Component Analysis (ICA) (Sutcliffe, Thomas et al. 2015) is an inductive approach developed in response to the poor reporting of intervention processes that is common across the literature (Hoffmann, Glasziou et al. 2014). It involves (a) inductively describing and coding intervention features and (b) using trialists' informally-reported experience-based evidence (e.g. information located in introduction and discussion sections) (Sutcliffe, Thomas et al. 2015). This approach ensures a thorough consideration of insights into

the development (including theories underpinning interventions), processes and content of interventions. Such insights will then be used, in conjunction with insights from a qualitative synthesis of views about interventions, to develop a preliminary theoretical framework that will be tested and refined in the QCA. Whilst syntheses of theories have been conducted previously (Bonell, Jamal et al. 2013, Bonell, Hinds et al. 2016), it has been noted that many intervention evaluations do not explicitly state the theories underpinning them (Rankin, Heard et al. 2016). By using ICA, we will be able to capture both explicit, name theories used to develop interventions, but also theories implicit in the development of interventions, and/or in explanations of their results. We will be able to explore the value of these novel evidence sources. While QCA may help to reveal the components that are associated with effective interventions, it should have a theoretical basis to avoid data dredging or nonsensical outputs. The ICA and qualitative synthesis will develop the theory upon which QCA can build and refine its mid-range theory.

2. Use of QCA in a development evidence synthesis

Initially developed in policy science, Qualitative Comparative Analysis (QCA) is a relatively new method within the fields of social and health care and has yet to have been adopted widely within the development field (Kneale, Thomas et al. 2018, Pattyn, Molenveld et al. 2019). QCA blends a deep, holistic understanding of interventions and their underlying theory with Boolean logic to examine data patterns. The approach tests and refines a preliminary theory using empirical data from case studies (Kneale, Sutcliffe et al. 2019). However its contribution to developing mid-range theory has yet to be adequately evaluated.

QCA was developed as a solution to the challenge of analysing data containing a small number of cases, each with an extensive array of factors that may trigger an outcome of interest (Ragin 2009). This ‘small N-many variables’ challenge is similar to that often faced by systematic reviewers. The utility of QCA in evidence synthesis was first explored by Thomas and colleagues to understand configurations of intervention components that were aligned with “successful” interventions (Thomas, O'Mara-Eves et al. 2014).

The first step in conducting any QCA is to select a set of cases (in this case, evaluated interventions) to examine. To undertake the QCA, these interventions are then categorised as effective or ineffective (or harmful). The characteristics of these two sets of interventions are explored, drawing on Boolean minimisation to identify which combinations of characteristics are associated with effective interventions and which are associated with ineffective interventions. The goal of QCA is to identify the simplest expression of characteristics/processes that are associated with effective or ineffective interventions (Thomas, O'Mara-Eves et al. 2014, Kneale, Sutcliffe

et al. 2019). For example, a solution generated from using QCA may identify that interventions involving activities to increase girls' economic autonomy, interactive conversations with young mothers, and have adolescents involved in the design of the intervention, may be those that are most effective. This solution may only partially explain the outcome, suggesting that other pathways also exist to an effective intervention. QCA allows us to recognise that there may be different pathways to effective or ineffective interventions, although the implications of this for generating mid-range theory have not been fully evaluated. A key step within QCA is the interpretation stage, where the salience and logic of the solution is checked against the evidence from individual studies. However the risk of treating all cases as equal, regardless of quality or study design, and the risk that causality is mistakenly attributed to associations, has not been addressed in the approach to theory building. Furthermore in many ways the interpretation is relatively restricted, and the way in which this solution can be used to generate or refine mid-range theory has not been considered in the literature up to this point.

3. Exploration of the value of ICA and QCA as tools for developing mid-range theory

The capacity of QCA to be used as a potential route for understanding the generalisability of interventions across different groups and different settings has been touted in methodological papers (Kneale, Thomas et al. 2018, Burchett, Kneale et al. 2020), although few empirical investigations have been conducted to date to examine how QCA can be used to develop mid-range theory. The use of ICA in combination with QCA has also been recommended, but not previously attempted (Sutcliffe, Thomas et al. 2015).

QCA may be particularly useful for generating mid-range theory as it allows an exploration of some of the complex causal relationships that take place in the natural world but that can otherwise be challenging to identify and measure. QCA allows us to consider conjunctural causation, referring to circumstances where a particular intervention component or contextual or participant characteristic triggers an outcome only in the presence of another component(s). For example, activities to increase girls' economic autonomy alone may not be enough to change contraceptive use without another component that supports behaviour change. QCA allows us to examine necessary or sufficient causal relationships. Necessary relationships signify that an outcome cannot be triggered in the absence of a condition or set of characteristics i.e. all studies in the outcome set will share a particular characteristic or set of characteristics but this along may not be enough to trigger an outcome. Sufficient causal relationships signify a (successful) outcome is triggered in the presence of a sufficient condition or sufficient condition set, although other pathways to achieving the outcome may also

exist. These forms of sufficient causal relationships are usually the target of systematic reviews (Kneale, Thomas et al. 2018). Finally, one of the most complex forms of relationship that can be explored through QCA are INUS causal relationships (insufficient but non-redundant parts of a condition which is itself unnecessary but sufficient for the occurrence of the outcome). INUS conditions are an extension of the logic of sufficient and necessary conditions above (Kneale, Thomas et al. 2018). A well known example of an INUS condition is the role of a short circuit in starting a house fire (Mackie 1965). In this example, a short circuit could only have triggered a fire in the presence of flammable materials nearby. A short-circuit alone is therefore not sufficient for a house to catch fire but in the presence of other components including flammable material (conjunctural causation), does become part of a set of conditions sufficient for causing a fire. However, this set of conditions is itself not necessary to start a house fire, as there are many other routes through which homes catch fire. This is relevant to the current evidence synthesis, since upstream contraceptive interventions are varied, complex and context sensitive. Different interventions, or the same interventions implemented in different contexts or with different populations, could have a number of different pathways to effectiveness.

As we have stated above, up to this point there has been little exploration of how ICA and QCA can be used to develop, test and refine mid-range theory in a mixed methods synthesis. This project is expected to make a methodological advance in this respect.

4. Exploration of how stakeholder involvement can be used to shape the development of mid-range theory

A final element of innovation in this proposal will be the use of stakeholder engagement to shape the development of the mid-range theory. Stakeholder engagement as critical in order to develop theories that are salient to decision-makers and intervention recipients (Kneale, Thomas et al. 2015). However, there are few documented examples of how the involvement of stakeholders changes the contents of the theory. Some exceptions do exist (De Buck, Hannes et al. 2018), although there is much left to be understood around how the involvement of stakeholders can clarify the concepts represented, whether additional adverse impacts are accounted for with the input of stakeholders, how the involvement should be managed, and what happens when there are divergent views between the stakeholders and the evidence.

Study protocol

Aim: to explore the use of novel methods to build a mid-range theory of how upstream interventions encourage adolescents' use of contraception in low- and middle-income countries.

Objective 1: to develop a mid-range theory to explain how upstream interventions encourage adolescents' use of contraception in low- and middle-income countries.

Research questions:

1. What types of upstream interventions have been evaluated that aim to encourage adolescents' use of contraception in low- and middle-income countries?
2. What characteristics of these interventions, their underlying theory, implementation, population and settings may facilitate or hinder their effectiveness?
3. What mid-range theory could explain how upstream interventions encourage adolescents' use of contraception?

Objective 2: To reflect on how best to build a mid-range theory using novel methods within an evidence synthesis

Research questions:

4. How useful are the Intervention Component Analysis (ICA) and Qualitative Comparative Analysis (QCA) methods for building mid-range theory?
5. What evidence sources are most helpful for this theory-building process?

Stakeholder engagement

We will convene two advisory groups: one with professional stakeholders (policy-makers, NGO staff, and academics) at the international, national and sub-national level and one with adolescents (aged 16-19 years) in Mozambique. We will seek their input at three specific points. First, to advise on which set of studies to focus on for research questions (RQs) 2 and 3. Second, to refine the preliminary theory developed for RQ2 and third, reflect on the coherence of the mid-range theory proposed based on the findings for RQ3.

Production of the systematic review and evidence synthesis

Identification of studies

The evidence gap map by 3ie involved a comprehensive search for literature on adolescent sexual and reproductive health interventions in 2016 (Rankin, Jarvis-Thiébault et al. 2016). Rather than duplicate their searches and screening, we will screen the impact evaluations included in this map. We will also search for papers published since their search was conducted in 2016. A draft search strategy has been compiled in the OvidSP Medline database by a professional librarian with experience in systematic review searching and reviewed by the project team (see appendix 1). The search strategy includes terms covering three core concepts: adolescents (aged 10-19); contraception; and low and middle-income countries (as defined by the World Bank, June 2019). Publication dates are limited from 2016 to current and language is limited to English or Portuguese. No limits are added for study methodology. The draft search strategy will be used to search the following bibliographic databases: OvidSP Medline, OvidSP Embase, OvidSP Global Health, Ebsco CINAHL Plus, Ebsco Africa-Wide Information, ProQuest ERIC, WHO Global Index Medicus, Web of Science Social Sciences Citation Index Expanded. Search syntax and terms will be modified as appropriate for each database.

Studies from grey literature will be sought by searching websites of organisations that provide, fund or evaluate adolescent contraceptive services, such as Advocates for Youth, Family Health International, Guttmacher Institute, Interagency Youth Working Group, International Center for Research on Women, International Planned Parenthood Federation, Joint United Nations Program on HIV and AIDS, Marie Stopes International, Pathfinder International, Population Council, United Nations Population Fund, United Nations Children's Fund, and World Health Organization (WHO). We will also screen reference lists from included studies and consult experts in the field.

Selection of studies

Search results will be downloaded into Endnote and duplicates removed before being uploaded into Eppi-Reviewer for screening.

Each reference will be screened for potential inclusion on the basis of title and abstract, using pre-specified exclusion criteria to ensure relevance (see table 1).

Table 1: Exclusion criteria

1. Year published	Exclude if published before 2005
2. Language	Exclude if not written in English or Portuguese
3. Intervention aim	Exclude if intervention's primary aim is not encouraging contraceptive use
4. Participants	Exclude if not focused on adolescents aged 10-19 years (the intervention either targeted 10-19 year olds, or at least 50% of study sample were aged 10-19 years, or results were presented separately for this age group)
5. Country	Exclude if the intervention was NOT conducted in low- and middle-income countries, as defined by the World Bank in 2019.
6. Study design	Exclude if not an outcome or process evaluation, presenting empirical findings
7. Outcomes	Exclude if not reporting at least one of the following outcomes: <ul style="list-style-type: none"> - uptake or use of modern contraception¹ - intention/readiness to use contraception - desire to avoid, delay, space or limit childbearing, - desire to use contraception.
8. Intervention focus	Exclude if intervention does not focus on upstream interventions (girls' economic or other empowerment, school enrolment and retention, shaping norms around gender, sexual behaviour or fertility through peer-led, community mobilisation or mass media interventions, advocacy and other interventions to reduce gender and other inequalities).

We will limit included papers to those published in 2005 or later, since it was then that interest in contraceptive use grew (Deitch and Stark 2019). We will use the WHO's definition of adolescence, i.e. 10-19 years (World Health Organization (WHO) 2020) and the World Bank's definition of low- or middle-income country (The World Bank 2020). Due to resource constraints, we will

¹ Evaluations only reporting measures of condom use will only be included if the intervention clearly stated a goal of pregnancy prevention and condoms were used for contraceptive purposes or for dual protection.

only include papers written in English and Portuguese, as these are the languages in which at least two members of the study team are fluent.

All reviewers participating in screening will pilot these exclusion criteria using a sample of studies. Pilot screening results will be discussed to ensure consistency of understanding; the criteria's wording and guidance on criteria will be refined as necessary. The exclusion criteria will initially be applied to titles and abstracts. Full reports will be obtained and screened for those studies that appear to meet the criteria or where there is insufficient information to be sure. Screening will initially be conducted by two reviewers, one from LSHTM and one from ICRHM, until at least 80% consistency in screening has been achieved. Following this, the remaining references will be screened by individual reviewers. If a reviewer cannot reach a decision regarding inclusion of a specific paper at full text, they will refer to a second and, if necessary, third reviewer in order to reach a decision.

Where findings from an intervention evaluation have been published in multiple papers, these will be identified and one paper designated the 'key' paper, with the remaining papers designated as 'link' papers.

RQ1: What types of upstream interventions have been evaluated that aim to encourage adolescents' use of contraception in low- and middle-income countries?

Coding of studies

All included papers will initially be coded according to standardised classification systems developed for this review. Multiple dimensions of the research will be captured by the coding system, including:-

- Study design (e.g. RCT, process evaluation, qualitative study)
- Country
- Language
- Participant characteristics (e.g. age, marital status)
- Intervention characteristics (such as aim and activities, e.g. conditional cash transfer to encourage school attendance; microfinance to empower girls)
- Outcomes reported

At this point, we will be able to address our first research question, about what types of interventions have been evaluated. The number of interventions evaluated for each type of intervention will be calculated, as well as details of how populations, settings and other factors vary between the types of

interventions that have been evaluated.

RQ2: What characteristics of these interventions, their underlying theory, implementation, population and settings may facilitate or hinder their effectiveness?

We will then select a set of studies to be included in the analysis for the second and third research questions. We will consult our advisory groups regarding which to focus on, as well as considering whether there are sufficient studies for this analysis. However it may be that we use one or more of the following criteria for selection:

- Population: e.g. interventions targeting married or unmarried adolescents; interventions targeting very young adolescents
- Intervention aim: e.g. interventions focused on school attendance
- Study design: e.g. only RCTs
- Outcomes: evaluations that report certain outcome measures e.g. use of modern contraceptive method

Once criteria have been selected, intervention evaluations will be quality appraised. The nature of the evidence base will determine whether we exclude low quality studies or weight evidence according to quality.

In addition to these criteria, we may further limit the analysis to those interventions that were most and least effective. This is a method that has previously been used in QCA and enables a focus on the differences between these two groups, avoiding the 'noise' from those achieving a moderate effect (Melendez-Torres, Sutcliffe et al. 2019). This is important since heterogeneity is of critical importance in QCA, in order to identify which combinations of characteristics are sufficient to explain the outcomes (Thomas, O'Mara-Eves et al. 2014). In this case, before selecting the most and least effective interventions, we would exclude those of a low quality rating and small sample size, to avoid the risk of including those whose large effect size may be due to their small sample size or poor methods.

In order to identify which intervention characteristics may facilitate or hinder effectiveness, we will use ICA and a qualitative synthesis of views about the included interventions.

Intervention Component Analysis (ICA)

ICA involves inductive line-by-line coding of the introduction, methods, discussion and conclusion sections of intervention evaluation papers. This provides a means of gathering evidence on interventions' features, process, development, implementation and strengths and weaknesses of intervention features (Sutcliffe, Thomas et al. 2015). We will expand this to capture authors' explanations of why they believe interventions had the effect they did.

These codes will then be reviewed and refined, with codes merged or split into sub-codes as necessary. This coding framework will then be applied to all included studies. The codes and coded findings will then be used to identify higher-order analytic themes.

Sutcliffe et al. recommend using QCA as a subsequent step, to validate the preliminary theory identified in the ICA (Sutcliffe, Thomas et al. 2015). Therefore the second stage of ICA – identifying which intervention features appear to be important for effectiveness – will be conducted using the QCA method.

Qualitative synthesis

To explore how intervention experiences may be associated with interventions' effectiveness (or lack of effect/harm), we will conduct a thematic synthesis of qualitative studies of adolescent, provider and other stakeholder views and experiences of included interventions. We will explore what mechanisms are perceived to lead to increased contraceptive use, or a lack of increased use. We will also examine whether views differ according to characteristics such as age, gender, marital status, or between adolescents, their partners, family members and providers.

We will use thematic analysis to code the qualitative findings inductively (Thomas and Harden 2008). First we will read a sample of the included papers and apply line-by-line coding to capture descriptive themes emerging from the data. These codes will then be reviewed and refined, with codes merged or split into sub-codes as necessary. This coding framework will then be applied to all included studies. The codes and coded findings will then be used to identify higher-order analytic themes. The relative importance of the different characteristics will be examined through the frequency and strength of feeling of participants or study authors mentioning them, as well as the consistency of opinion about that characteristic.

The findings from the ICA and qualitative synthesis will be brought together into a preliminary theory setting out which aspects of the interventions' content, implementation and/or context appear to be important in terms of the effectiveness, or lack of effect, of the interventions.

We will present the findings from the ICA and qualitative synthesis, as well as the preliminary theory, to our advisory groups and discuss whether they resonate with them and if we have missed any particular considerations.

RQ3: What mid-range theory could explain how upstream interventions encourage adolescents' use of contraception?

Qualitative Comparative Analysis

We will use qualitative comparative analysis (QCA) to test and refine the preliminary theory to explain how upstream interventions can encourage adolescents' use of contraception. We will explore whether there are characteristics central to the theory of change that are associated with greater effectiveness and whether there are particular configurations of intervention and implementation characteristics that are more effective for particular participants or in particular contexts. There are six stages to QCA (Thomas, O'Mara-Eves et al. 2014).

1. Build a data table

First we will construct a table, where each included intervention is one row and each characteristic identified (in the preliminary theory developed from the ICA and qualitative synthesis) is recorded in one column. For each characteristic, each intervention will be coded with either a 1, if the reviewers determine it to be present in the intervention, or a 0, if the reviewers determine that it is absent in the intervention. The team will reach agreement about what threshold to set to determine whether a non-binary characteristic is considered present or absent. We will also consider whether fuzzy-set coding is needed, which allows values between zero and one.

2. Construct a truth table

In constructing a truth table, instead of each row relating to an individual intervention, each row relates to a configuration, or combination, of characteristics. The number of 'most effective' and 'least effective' studies that are members of each configuration is also presented. It is then possible to identify four possible results for each configuration: positive cases (all studies included are 'most effective'), negative cases (no studies included are 'most effective'), contradictions (some but not all 'most effective' studies are included) and remainders (no studies are included). This will then be repeated with the least effective studies.

3. Resolving contradictory configurations

Sets of studies with identical configurations but where some are 'most effective' whilst others are 'least effective' are known as contradictory

configurations. The dataset will be checked for these and any identified contradictions will be resolved, such as by either adding or replacing characteristics, or using other known techniques (Thomas, O'Mara-Eves et al. 2014).

4. Boolean minimisation

Algorithms will be used within QCA software (Dusa 2019) to identify the most logically simple expression of a Boolean algorithms.

5. Consideration of logical remainders

At this point, those configurations that are not supported by cases, known as logical remainders, will be considered. Accounting for logical remainders can help to simplify the solution and involves theorising the likely outcome should a configuration have been observed in the data and using this information in the minimisation of the solution.

6. Interpretation

In the final stage, the findings will be interpreted based on the reviewers' understanding of the interventions and their evaluations. In addition robustness checks will be conducted. We will present initial findings to our stakeholders during this interpretation stage, to elicit their thoughts on whether the theory resonates them. The involvement of stakeholders should ensure that the theory is represented in a manner that is easily interpreted across audiences. Normative group techniques may be used to agree which further adaptations may be needed to implement interventions in specific contexts, including Mozambique, or for different population groups.

The QCA will follow good practice laid out elsewhere (Kneale, Sutcliffe et al. 2019).

RQs 4 & 5: How useful are the Intervention Component Analysis (ICA) and Qualitative Comparative Analysis (QCA) methods for building mid-range theory? What evidence sources are most helpful for this theory-building process?

Methodological reflections

Finally, to answer the final two research questions, reviewers will keep a shared reflective journal throughout the project, to note key thoughts and observations regarding the use of ICA and QCA. Towards the end of the project, we will discuss our perceptions of using the methods and its potential for theory building. Team members will also reflect on the insights gained from the types of evidence that were incorporated into the synthesis.

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Appendix 1: Draft search strategy for OvidSP Medline

1. adolescent/ or child/
2. puberty/ or menarche/
3. homeless youth/
4. minors/
5. disabled children/
6. students/
7. child*.ti,ab.
8. (girl or girls or boy or boys).ti,ab.
9. (paediatric* or pediatric*).ti,ab.
10. (schoolage* or (school adj1 age*)).ti,ab.
11. minor*.ti,ab.
12. ((school or college) adj3 (pupil* or student*)).ti,ab.
13. prepubescen*.ti,ab.
14. puberty.ti,ab.
15. pubescent*.ti,ab.
16. adolescen*.ti,ab.
17. juvenil*.ti,ab.
18. underage*.ti,ab.
19. (preteen* or pre-teen*).ti,ab.
20. (teen or teens or teenager).ti,ab.
21. teenage*.ti,ab.
22. (youth or youths).ti,ab.
23. young people*.ti,ab.
24. young person*.ti,ab.
25. young wom#n.ti,ab.
26. (young man or young men).ti,ab.
27. (highschool or (high adj1 school*)).ti,ab.
28. sophomore*.ti,ab.
29. (university adj3 student*).ti,ab.
30. (transition adj4 adult*).ti,ab.
31. emerging adult*.ti,ab.
32. young adult*.ti,ab.
33. early adult*.ti,ab.
34. freshm?n.ti,ab.
35. (("10" or "11" or "12" or "13" or "14" or "15" or "16" or "17" or "18" or "19") adj (year* old or year* of age)).ti,ab.
36. ((ten or eleven or twelve or thirteen or fourteen or fifteen or sixteen or seventeen or eighteen or nineteen) adj (year* old or year* of age)).ti,ab.
37. (age* adj ("10" or "11" or "12" or "13" or "14" or "15" or "16" or "17" or "18" or "19") adj year*).ti,ab.
38. (age* adj (ten or eleven or twelve or thirteen or fourteen or fifteen or sixteen or seventeen or eighteen or nineteen) adj year*).ti,ab.
39. or/1-38
40. exp Contraception/
41. Family Planning Services/
42. exp Contraceptive Devices/

43. Contraception Behavior/
44. family planning.ti,ab.
45. contracept*.ti,ab.
46. ((childbear* or pregnan*) adj2 (avoid* or delay* or prevent* or limit* or space or spacing or timing)).ti,ab.
47. or/40-46
48. Developing Countries/
49. ((developing or less* developed or under developed or underdeveloped or middle income or low* income) adj (economy or economies)).ti,ab.
50. ((developing or less* developed or under developed or underdeveloped or middle income or low* income or underserved or under served or deprived or poor*) adj (countr* or nation? or population? or world)).ti,ab.
51. (low* adj (gdp or gnp or gross domestic or gross national)).ti,ab.
52. (low adj3 middle adj3 countr*).ti,ab.
53. (Imic or Imics or third world or lami countr*).ti,ab.
54. transitional countr*.ti,ab.
55. global south.ti,ab.
56. "Democratic People's Republic of Korea"/
57. (North Korea or (Democratic People* Republic adj2 Korea)).ti,ab.
58. Cambodia/
59. Cambodia.ti,ab.
60. Indonesia/
61. (Indonesia or Dutch East Indies).ti,ab.
62. (Kiribati or Gilbert Islands or Phoenix Islands or Line Islands).ti,ab.
63. Laos/
64. (Laos or (Lao adj1 Democratic Republic)).ti,ab.
65. Micronesia/
66. Micronesia.ti,ab.
67. Mongolia/
68. Mongolia.ti,ab.
69. Myanmar/
70. (Myanmar or Burma).ti,ab.
71. Papua New Guinea/
72. (Papua New Guinea or German New Guinea or British New Guinea or Territory of Papua).ti,ab.
73. Philippines/
74. (Philippines or Philippine Islands).ti,ab.
75. Solomon Islands.ti,ab.
76. Timor-Leste/
77. (Timor-Leste or East Timor or Portuguese Timor).ti,ab.
78. Vanuatu/
79. (Vanuatu or New Hebrides).ti,ab.
80. Vietnam/
81. (Viet Nam or Vietnam or French Indochina).ti,ab.
82. American Samoa/
83. American Samoa.ti,ab.
84. exp China/
85. China.ti,ab.
86. Fiji/
87. Fiji.ti,ab.

88. Malaysia/
89. (Malaysia or Malayan Union or Malaya).ti,ab.
90. Marshall Islands.ti,ab.
91. Nauru.ti,ab.
92. "Independent State of Samoa"/
93. ((Samoa not American Samoa) or Western Samoa or Navigator Islands or Samoan Islands).ti,ab.
94. Thailand/
95. (Thailand or Siam).ti,ab.
96. Tonga/
97. Tonga.ti,ab.
98. (Tuvalu or Ellice Islands).ti,ab.
99. Melanesia/
100. Melanesia.ti,ab.
101. Polynesia/
102. Polynesia.ti,ab.
103. Kyrgyzstan/
104. (Kyrgyzstan or Kyrgyz Republic or Kirghizia or Kirghiz).ti,ab.
105. Moldova/
106. Moldova.ti,ab.
107. Ukraine/
108. Ukraine.ti,ab.
109. Uzbekistan/
110. Uzbekistan.ti,ab.
111. Albania/
112. Albania.ti,ab.
113. Armenia/
114. Armenia.ti,ab.
115. Azerbaijan/
116. Azerbaijan.ti,ab.
117. "Republic of Belarus"/
118. (Belarus or Byelarus or Byelorussia or Belorussia).ti,ab.
119. Bosnia-Herzegovina/
120. (Bosnia or Herzegovina).ti,ab.
121. Bulgaria/
122. Bulgaria.ti,ab.
123. "Georgia (Republic)"/
124. Georgia.ti,ab. not Georgia/
125. Kazakhstan/
126. (Kazakhstan or Kazakh).ti,ab.
127. Kosovo/
128. Kosovo.ti,ab.
129. Montenegro/
130. Montenegro.ti,ab.
131. "Republic of North Macedonia"/
132. North Macedonia.ti,ab.
133. Romania/
134. Romania.ti,ab.
135. exp Russia/
136. "Russia (Pre-1917)"/

137. USSR/
138. (Russia or Russian Federation or USSR or Union of Soviet Socialist Republics or Soviet Union).ti,ab.
139. Serbia/
140. Serbia/
141. Turkey/
142. (Turkey.ti,ab. not animal/) or (Anatolia or Asia Minor).ti,ab.
143. Turkmenistan/
144. Turkmenistan.ti,ab.
145. Tajikistan/
146. Tajikistan.ti,ab.
147. Asia, Central/
148. Asia, Northern/
149. Central Asia.ti,ab.
150. Haiti/
151. (Haiti or Hayti).ti,ab.
152. Bolivia/
153. Bolivia.ti,ab.
154. El Salvador/
155. El Salvador.ti,ab.
156. Honduras/
157. Honduras.ti,ab.
158. Nicaragua/
159. Nicaragua.ti,ab.
160. Argentina/
161. (Argentina or Argentine Republic).ti,ab.
162. Belize/
163. (Belize or British Honduras).ti,ab.
164. Brazil/
165. Brazil.ti,ab.
166. Colombia/
167. Colombia.ti,ab.
168. Costa Rica/
169. Costa Rica.ti,ab.
170. Cuba/
171. Cuba.ti,ab.
172. Dominica/
173. Dominica.ti,ab.
174. Dominican Republic/
175. Dominican Republic.ti,ab.
176. Ecuador/
177. Ecuador.ti,ab.
178. Grenada/
179. Grenada.ti,ab.
180. Guatemala/
181. Guatemala.ti,ab.
182. Guyana/
183. (Guyana or British Guiana).ti,ab.
184. Jamaica/
185. Jamaica.ti,ab.

186. Mexico/
187. (Mexico or United Mexican States).ti,ab.
188. Paraguay/
189. Paraguay.mp.
190. Peru/
191. Peru.ti,ab.
192. Saint Lucia/
193. (St Lucia or Saint Lucia or Lyonala or Hewanorra).ti,ab.
194. "Saint Vincent and the Grenadines"/
195. (Saint Vincent or St Vincent or Grenadines).ti,ab.
196. Suriname/
197. (Suriname or Dutch Guiana).ti,ab.
198. Venezuela/
199. Venezuela.ti,ab.
200. Djibouti/
201. (Djibouti or French Somaliland).ti,ab.
202. Egypt/
203. Egypt.ti,ab.
204. Morocco/
205. Morocco.ti,ab.
206. Tunisia/
207. Tunisia.mp.
208. (Gaza or West Bank or Palestine).ti,ab.
209. Algeria/
210. Algeria.ti,ab.
211. Iran/
212. (Iran or Persia).ti,ab.
213. Iraq/
214. (Iraq or Mesopotamia).ti,ab.
215. Jordan/
216. Jordan.ti,ab.
217. Lebanon/
218. (Lebanon or Lebanese Republic).ti,ab.
219. Libya/
220. Libya.ti,ab.
221. Syria/
222. (Syria or Syrian Arab Republic).ti,ab.
223. Yemen/
224. Yemen.ti,ab.
225. Afghanistan/
226. Afghanistan.ti,ab.
227. Nepal/
228. Nepal.ti,ab.
229. Bangladesh/
230. Bangladesh.ti,ab.
231. Bhutan/
232. Bhutan.ti,ab.
233. exp India/
234. India.ti,ab.
235. Pakistan/

236. Pakistan.ti,ab.
237. Maldives.ti,ab.
238. Sri Lanka/
239. (Sri Lanka or Ceylon).ti,ab.
240. Angola/
241. Angola.ti,ab.
242. Cameroon/
243. (Cameroon or Kamerun or Cameroun).ti,ab.
244. Cape Verde/
245. (Cape Verde or Cabo Verde).ti,ab.
246. Comoros/
247. (Comoros or Glorioso Islands or Mayotte).ti,ab.
248. Congo/
249. (Congo not ((Democratic Republic adj3 Congo) or congo red or crimean-congo)).ti,ab.
250. Cote d'Ivoire/
251. (Cote d'Ivoire or Cote dlvoire or Ivory Coast).ti,ab.
252. Eswatini/
253. (eSwatini or Swaziland).ti,ab.
254. Ghana/
255. (Ghana or Gold Coast).ti,ab.
256. Kenya/
257. (Kenya or East Africa Protectorate).ti,ab.
258. Lesotho/
259. (Lesotho or Basutoland).ti,ab.
260. Mauritania/
261. Mauritania.ti,ab.
262. Nigeria/
263. Nigeria.ti,ab.
264. (Sao Tome adj2 Principe).ti,ab.
265. Senegal/
266. Senegal.ti,ab.
267. Sudan/
268. (Sudan not South Sudan).ti,ab.
269. Zambia/
270. (Zambia or Northern Rhodesia).ti,ab.
271. Zimbabwe/
272. (Zimbabwe or Southern Rhodesia).ti,ab.
273. Botswana/
274. (Botswana or Bechuanaland or Kalahari).ti,ab.
275. Equatorial Guinea/
276. (Equatorial Guinea or Spanish Guinea).ti,ab.
277. Gabon/
278. (Gabon or Gabonese Republic).ti,ab.
279. Mauritius/
280. (Mauritius or Agalega Islands).ti,ab.
281. Namibia/
282. (Namibia or German South West Africa).ti,ab.
283. South Africa/

284. (South Africa or Cape Colony or British Bechuanaland or Boer Republics or Zululand or Transvaal or Natalia Republic or Orange Free State).ti,ab.
285. Benin/
286. (Benin or Dahomey).ti,ab.
287. Burkina Faso/
288. (Burkina Faso or Burkina Fasso or Upper Volta).ti,ab.
289. Burundi/
290. (Burundi or Ruanda-Urundi).ti,ab.
291. Central African Republic/
292. (Central African Republic or Ubangi-Shari).ti,ab.
293. Chad/
294. Chad.ti,ab.
295. "Democratic Republic of the Congo"/
296. (((Democratic Republic or DR) adj2 Congo) or Congo-Kinshasa or Belgian Congo or Zaire or Congo Free State).ti,ab.
297. Eritrea/
298. Eritrea.ti,ab.
299. Ethiopia/
300. (Ethiopia or Abyssinia).ti,ab.
301. Gambia/
302. Gambia.ti,ab.
303. Guinea/
304. (Guinea not (New Guinea or Guinea Pig* or Guinea Fowl or Guinea-Bissau or Portuguese Guinea or Equatorial Guinea)).ti,ab.
305. Guinea-Bissau/
306. (Guinea-Bissau or Portuguese Guinea).ti,ab.
307. Liberia/
308. Liberia.ti,ab.
309. Madagascar/
310. (Madagascar or Malagasy Republic).ti,ab.
311. Malawi/
312. (Malawi or Nyasaland).ti,ab.
313. Mali/
314. Mali.ti,ab.
315. Mozambique/
316. (Mozambique or Mocambique or Portuguese East Africa).ti,ab.
317. Niger/
318. (Niger not (Aspergillus or Peptococcus or Schizothorax or Cruciferae or Gobius or Lasius or Agelastes or Melanosuchus or radish or Parastromateus or Orius or Apeargillus or Parastromateus or Stomoxys)).ti,ab.
319. Rwanda/
320. (Rwanda or Ruanda).ti,ab.
321. Sierra Leone/
322. (Sierra Leone or Salone).ti,ab.
323. Somalia/
324. (Somalia or Somaliland).ti,ab.
325. South Sudan/
326. South Sudan.ti,ab.
327. Tanzania/

- 328. (Tanzania or Tanganyika or Zanzibar).ti,ab.
- 329. Togo/
- 330. (Togo or Togolese Republic or Togoland).ti,ab.
- 331. Uganda/
- 332. Uganda.ti,ab.
- 333. "africa south of the sahara"/
- 334. africa, central/
- 335. africa, eastern/
- 336. africa, southern/
- 337. africa, western/
- 338. ("Africa South of the Sahara" or sub-Saharan Africa or subSaharan Africa).ti,ab.
- 339. Central Africa.ti,ab.
- 340. Eastern Africa.ti,ab.
- 341. Southern Africa.ti,ab.
- 342. Western Africa.ti,ab.
- 343. or/48-342 [ALL LOW AND MIDDLE-INCOME COUNTRIES]
- 344. 39 and 47 and 343
- 345. limit 344 to yr="2016 -Current"
- 346. limit 345 to (english or portuguese)



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