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Evaluating the impact of an intervention to increase uptake of modern contraceptives among adolescent girls (15–19 years) in Nigeria, Ethiopia and Tanzania: the Adolescents 360 quasi-experimental study protocol

Christina Joanne Atchison,1 Emma Mulhern,2 Saidi Kapiga,3,4 Mussa Kelvin Nsanya,4 Emily E Crawford,5 Mohammed Mussa,6 Christian Bottomley,1 James R Hargreaves,7 Aoife Margaret Doyle1


ABSTRACT

Introduction Nigeria, Ethiopia and Tanzania have some of the highest teenage pregnancy rates and lowest rates of modern contraceptive use among adolescents. The transdisciplinary Adolescents 360 (A360) initiative being rolled out across these three countries uses human-centred design to create context-specific multicomponent interventions with the aim of increasing voluntary modern contraceptive use among girls aged 15–19 years.

Methods The primary objective of the outcome evaluation is to assess the impact of A360 on the modern contraceptive prevalence rate (mCPR) among sexually active girls aged 15–19 years. A360 targets different subpopulations of adolescent girls in the three countries. In Northern Nigeria and Ethiopia, the study population is married girls aged 15–19 years. In Southern Nigeria, the study population is unmarried girls aged 15–19 years. In Tanzania, both married and unmarried girls aged 15–19 years will be included in the study. In all settings, we will use a prepopulation and postpopulation-based cross-sectional survey design. In Nigeria, the study design will also include a comparison group. A one-stage sampling design will be used in Nigeria and Ethiopia. A two-stage sampling design will be used in Tanzania. Questionnaires will be administered face-to-face by female interviewers aged between 18 and 26 years. Study outcomes will be assessed before the start of A360 implementation in late 2017 and approximately 24 months after implementation in late 2019.

Ethics and dissemination Findings of this study will be widely disseminated through workshops, conference presentations, reports, briefings, factsheets and academic publications.

INTRODUCTION

In 2012, the global community launched the Family Planning 2020 (FP2020) initiative to reach 120 million new contraceptive users in developing countries by 2020.1 Specifically, it calls for meeting all women’s needs for modern contraception to prevent unintended pregnancies and reducing the high adolescent birth rates in the world’s poorest countries. Helping adolescent girls avoid unintended pregnancies can have far-reaching benefits for them, their children and societies as a whole.2 Complications of pregnancy and childbirth are the leading cause of death among girls aged 15–19 years,3 4 and babies born to adolescent mothers face greater health risks than those born to older women.5 Moreover, adolescent childbearing is associated with lower educational attainment, and it can perpetuate a cycle of poverty from one generation to the next.3

Strengths and limitations of this study

► This study is part of an independent multicomponent impact evaluation of a multicountry adolescent sexual and reproductive health intervention, and we will collect comparable data before and after intervention implementation in four different settings in three countries.

► In Nigeria, the randomisation of intervention allocation was not possible; therefore, in this quasi-experimental design, conclusions about causality are less definitive than a cluster-randomised design.

► Triangulation with dose–response and trends analyses will strengthen the inference possible from the study findings.

► Due to resource constraints, we focused resources on selected geographical areas, and we acknowledge that this will restrict the generalisability of our findings.
From 1990 to 2010, adolescent fertility rates declined in most countries. However, adolescent fertility rates remain high in many lower-income countries. In some countries, fertility rates are declining more slowly in adolescents than in older women. Nigeria, Ethiopia and Tanzania have among the highest rates of adolescent fertility globally, with 109, 57 and 118 births per 1000 girls aged 15–19 per year, respectively. Equally, these countries also have some of the lowest rates of use of modern contraception in adolescents. In Nigeria, 98.8% of married adolescent girls and 50.3% of unmarried sexually active adolescent girls do not use a modern contraceptive method. The equivalent figures are 68.2% and 42.5% in Ethiopia and 86.7% and 66.9% in Tanzania. Preventing pregnancy among adolescents is a global priority and new interventions are needed, particularly in countries like Nigeria, Ethiopia and Tanzania where adolescent fertility rates remain high.

Despite having clear needs, both married and unmarried adolescent girls in many low-income and middle-income countries lack access to reliable contraception. In addition, rates of contraceptive failure are higher in adolescents than in older women, with younger women more likely to abandon contraception despite ongoing need. Reasons include poor understanding of pregnancy risks, concerns about the effect of contraceptives on health or fertility and opposition from partners. Lack of knowledge of services, cost, shyness and community stigma about sexual activity and disapproving attitudes from providers are further barriers. Adolescent sexual and reproductive health is affected by a country’s cultural, religious, legal, political and economic contexts. In responding, health actions are needed at each level, from structural, through to community settings including schools and health services. The most effective programmes are typically multicomponent and target one or more of these settings. There is a range of effective and scalable interventions including comprehensive sexuality education and provision of youth-friendly sexual and reproductive health services. Yet the evidence base for action remains relatively weak. The overwhelming majority of intervention studies derive from high-income countries.

Adolescents 360 (A360) is an initiative in the field of adolescent sexual and reproductive health programming, with the intention of being implemented at scale in Nigeria, Ethiopia and Tanzania. The final package of interventions is country-specific and includes a combination of community-based sexual and reproductive health education, counselling and improved contraceptive provision through ‘adolescent friendly’ services. The external evaluation of the A360 intervention comprises an outcome evaluation, a process evaluation and a cost effectiveness study. We present here the study protocol for the outcome evaluation of A360.

**METHODS AND ANALYSIS**

**Study objective**

The primary objective of the outcome evaluation is to evaluate the effectiveness of the A360 programme in increasing the uptake of voluntary modern contraception among sexually active girls aged 15–19 years.

**Study settings**

In Nigeria, A360 is being implemented by the Society for Family Health (SFH) in three states in the north (Federal Capital Territory, Nasarawa, Kaduna) and in seven states in the south (Lagos, Osun, Ogun, Oyo, Edo, Delta and Akwa Ibom) of the country. The A360 programme will be implemented in approximately 60% of the local government areas (LGAs) in each selected state. We will conduct the outcome evaluation in four LGAs in Nasarawa State and two LGAs in Ogun State. Nasarawa State is a state in north central Nigeria with a total population of 1.9 million. Overall, 41.3% of the female household population have no education, and the median age at first marriage for women is 19.7 years. Current use of modern contraception among married women aged 15–49 years is 16.3%. Ogun State in south western Nigeria has a total population of 3.8 million. Overall, 24.1% of the female household population have no education, and the median age at first marriage for women is 20.5 years. Current use of modern contraception among married women aged 15–49 years is 21.5%.

In Ethiopia, A360 is being implemented by Population Services International (PSI) in two city administrations and five regional states (Addis Ababa, Amhara, Dire Dawa, Harari, Oromia, Southern Nations, Nationalities and People’s Region and Tigray). Within each of the selected regional states, A360 will be implemented in selected woredas (districts), and we will conduct the outcome evaluation study in four woredas in Oromia Region. Oromia Region has a total population of 27 million. Overall, 51.5% of the female household population have no education, and the median age at first marriage for women is 17.4 years. Current use of modern contraception among married women aged 15–49 years is 28.1%.

In Tanzania, A360 is being implemented by PSI in 10 regions (Kagera, Geita, Mwanza, Arusha, Tabora, Tanga, Dar es Salaam, Mbeya, Iringa and Morogoro). We will conduct the outcome evaluation in urban and semiurban wards of Ilemela District, Mwanza Region. Mwanza Region has a total population of 2.8 million. Overall, 24.2% of the female household population have no education, and the median age at first marriage for women is 18.9 years. Current use of modern contraception among married women aged 15–49 years is 18.4%.

**Interventions under study**

The A360 interventions are being designed using a human-centred design process which includes the following steps:

1. Inspiration: a period of formative research to understand adolescent girls’ sexual and reproductive health needs and their sociocultural environment.

2. Ideation: an iterative process of generating, testing and refining ideas and developing and testing prototypes in real-world settings.

3. Implementation: intervention rollout at scale in target regions across the three countries. Interventions are currently in the final round of prototyping (ideation phase). The most likely final package of interventions in each setting is described in table 1.

**Design of outcome evaluation**

A summary of the methods used can be found in table 2. Separate protocols were developed for each country to take into account the country-specific Adolescents 360 implementation strategies and study designs developed.

**Nigeria**

The intervention will be evaluated in Ogun (South Nigeria) and Nasarawa (North Nigeria) through population-based surveys conducted at baseline (late 2017) and approximately 24 months after the start of the implementation of the interventions.
<table>
<thead>
<tr>
<th>Country (Region)</th>
<th>A360 regions</th>
<th>Study design</th>
<th>Outcome evaluation study setting</th>
<th>Study population (sample size)</th>
<th>Sampling strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nigeria (South)</strong></td>
<td>Lagos, Osun, Ogun, Oyo, Edo, Delta, Akwa Ibom</td>
<td>Cross-sectional before-and-after study with comparison group</td>
<td>Ogun State: ▶ Ado-Odo Ota LGA (intervention) ▶ Shagamu LGA (comparison)</td>
<td>Unmarried girls aged 15–19 years (12,020) Cohabiting adults (250)</td>
<td>Single stage cluster design PSU: EA Simple random sample of EAs (approx. 710 in Ogun). All HHs visited in selected EAs. All eligible individuals to be recruited to participate.</td>
</tr>
<tr>
<td><strong>Nigeria (North)</strong></td>
<td>Federal Capital Territory, Kaduna, Nasarawa</td>
<td>Cross-sectional before-and-after study with comparison group</td>
<td>Nasarawa State: ▶ Doma LGA (intervention) ▶ Toto LGA (comparison) ▶ Karu LGA (intervention) ▶ Nasarawa LGA (comparison)</td>
<td>Married girls aged 15–19 years (4,555) Husband (250)</td>
<td>Single stage cluster design PSU: EA Simple random sample of EAs (approx. 1,150 in Nasarawa). All HHs visited in selected EAs. All eligible individuals to be recruited to participate.</td>
</tr>
<tr>
<td><strong>Ethiopia</strong></td>
<td>Addis Ababa, Amhara, Dire Dawa, Harari, Oromia, SNNP, Tigray</td>
<td>Cross-sectional before-and-after study</td>
<td>Oromia regional state: Wara Janso, Lome, Ada’a, Fentale woredas</td>
<td>Married girls aged 15–19 years (1,926) Husband (128)</td>
<td>Single stage cluster design PSU: Kebele Probability proportional to size sample of 45 kebele. All HHs visited in selected kebele. All eligible individuals to be recruited to participate.</td>
</tr>
<tr>
<td><strong>Tanzania</strong></td>
<td>Kagera, Geita, Mwanza, Arusha, Tabora, Tanga, Dar es Salaam, Mbeya, Iringa, Morogoro</td>
<td>Cross-sectional before-and-after study</td>
<td>Mwanza region: Ilemela district (urban and semiurban wards only)</td>
<td>Married and unmarried girls aged 15–19 years (4,980) Cohabiting adults (127)</td>
<td>Two stage cluster design PSU: Street Simple random sample of 30 streets. Simple random sample of 50 GPS points within each street. All HHs with front door within 20 m radius of GPS point visited. All eligible individuals recruited to participate.</td>
</tr>
</tbody>
</table>

A360, Adolescents 360; EA, enumerations area; GPS, Global Positioning System; HH, household; LGA, local government area; PSU, primary sampling unit; SNNP, Southern Nations, Nationalities and People’s Region.
intervention. In Nasarawa, four LGAs consisting of two similar pairs have been selected for evaluation. Two of these will receive the intervention (one in each pair) and two will not, that is, they will act as comparisons. In Ogun, the evaluation will be conducted in only two LGAs (one intervention and one comparison).

**Study unit inclusion criteria and selection**

Study states were selected by SFH. The selected states were chosen because of the absence of other large-scale adolescent focused sexual and reproductive health activities and because of SFH’s previous experience working in these states.

Study LGAs were selected by SFH in collaboration with the state Ministry of Health and local government officials. The LGAs were selected from among those where there were no security concerns, and comparison-intervention pairs were selected to be similar with respect to as many as possible of the following criteria:

- Population density.
- Estimated modern contraceptive prevalence rate (mCPR) among 15–49-year olds (DHIS2, 2016).  
- Number of health facilities.
- Presence of World Bank support for Maternal and Child Health activities.

**Allocation to intervention and comparison arms**

Within a pair, allocation of an LGA to the intervention or comparison arm of the outcome evaluation study was done by SFH in collaboration with the state Ministry of Health and local government officials.

**Ethiopia**

The intervention will be evaluated through two population-based cross-sectional surveys, one conducted before implementation (late 2017) and another approximately 24 months after the start of the intervention.

**Study unit inclusion criteria and selection**

The study region and woredas were selected by PSI. Oromia region was selected because of its relatively low mCPR as compared with other regions in the Ethiopia Demographic and Health Survey (DHS) 2011 (24.9%) and its standing as having the highest unmet need for contraception (29.9%) as compared with other regions.  

Criteria used by PSI for selecting woredas for inclusion in the study included:

- Good infrastructure and accessible all year round.
- Close proximity to PSI head office in Addis Ababa.
- Population of married adolescent girls anticipated to be large.

**Tanzania**

As in Ethiopia, the intervention will be evaluated through before-and-after population-based surveys that are scheduled to take place in late 2017 and approximately 24 months after the start of the intervention.

**Study unit inclusion criteria and selection**

Mwanza Region was selected by the evaluators in collaboration with PSI because of the high unmet need for modern contraception among girls aged 15–19 years relative to other A360 target regions, the absence of other large-scale sexual and reproductive health activities and because PSI has previous experience working in the region. The study will be restricted to urban and semiurban wards in Ilemela District, in part because PSI focuses efforts in more densely populated areas and in part because of resource constraints.

**Study population**

A360 targets different subpopulations of adolescent girls in the three countries (table 2).

**Inclusion criteria**

Adolescent girls aged 15–19 years:

- Unmarried (Tanzania and Southern Nigeria only).
- Married or living as married (Ethiopia, Tanzania and Northern Nigeria only).
- Living, at the time of the survey, in the study sites.
- Voluntarily provides informed consent.

**Exclusion criteria**

There were no specific exclusion criteria.

**Sampling strategy**

A one-stage cluster sampling design will be used in Nigeria and Ethiopia. A two-stage cluster sampling design will be used in Tanzania. In each country, we will use the smallest available administrative unit as the primary sampling unit. Specifically, we will use enumeration areas (EAs) from the 2006 census in Nigeria, kebele from the 2007 census in Ethiopia and streets in Tanzania.

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- Close proximity to PSI head office in Addis Ababa.
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the structured interview. In Nasarawa, in order to reach our target sample size of 250 husbands, we estimated that for every 17 sexually active married girls interviewed, one will be systematically selected and asked permission to interview her husband. In Ogun, due to the uncertainty in the proportion of unmarried girls who will report that they are sexually active, we propose that for every 7–14 sexually active unmarried girls surveyed, one will be systematically selected and asked permission to interview a cohabiting adult in order to reach our target sample size of 250 cohabiting adults. The exact sampling interval will be finalised following the pilot study.

Ethiopia
A sample of 45 kebeles will be selected from across the four study woredas with probability proportional to population size. Within the selected kebele, we will visit each household and all eligible married girls aged 15–19 years will be recruited to participate in the structured interview. In households that have more than one eligible married female aged 15–19 years, all consenting married adolescent girls will be interviewed. In order to reach our target sample size of 128 husbands, we estimated that for every 15 sexually active married adolescent girls aged 15–19 years interviewed, one will be systematically selected and asked permission to interview her husband.

Tanzania
A simple random sample of 30 ‘streets’ (neighbourhoods) will be selected from across the 15 urban and semiurban wards of Ilemela District. The boundaries of each selected street will be identified and mapped using Global Positioning System (GPS) devices, and within each street, we will randomly select 50 GPS coordinates using ArcGIS software V.9.3 (Esri, Redlands, USA). All households whose front doors are located within a radius of 20 m around the GPS point will be visited and all eligible consenting girls aged 15–19 years residing in these households invited to be interviewed. We aim to interview 166 girls per street. In order to reach our target sample size of 127 cohabiting adults, we estimated that for every 15 sexually active adolescent girls aged 15–19 years interviewed, one will be systematically selected and asked permission to interview her husband (married girls) or a cohabiting adult (unmarried girls).

Data collection
The questionnaires will be adapted from various research instruments that have been used and validated in the study countries, including DHS,7–9 and FP2020 surveys. They will be developed in English and then translated into the local languages of the study communities. Final modifications will be made to the questionnaires following an extensive pretesting exercise and after pilot surveys are conducted in communities outside of the selected study sites.

Questionnaires will be administered face-to-face by female interviewers aged between 18 and 26 years. For households with potentially eligible study participants who are not at home, we will attempt to revisit up to twice (three visits in total). Data will be collected and recorded electronically in the field via tablets. This allows improved data quality through real time data delivery, built-in logical checks and skip patterns.

Study outcomes
Our primary outcome, the mCPR among 15–19 year old girls will be defined as follows:

<table>
<thead>
<tr>
<th>Number of fecund sexually active 15–19 year old girls reporting use of modern contraceptives at the time of the survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fecund sexually active 15–19 year old girls</td>
</tr>
</tbody>
</table>


Sexually active girls: those who report having sexual intercourse in the last 12 months.

Fecund girls: those who have started menstruating, are not pregnant and do not report that they are infertile.

Secondary outcomes are outlined in table 3.

Data analysis
In Nigeria, our hypothesis is that sexually active girls aged 15–19 years living in areas where the A360 programme is implemented will have a greater increase in use of modern contraception compared with sexually active girls aged 15–19 years living in areas where the A360 programme has not been implemented. We will estimate the intervention effect separately for Ogun and each LGA-pair in Nasarawa. The effect estimates will be obtained by subtracting the baseline mCPR prevalence estimates from the prevalence estimates at follow-up and then calculating the difference between the comparison and intervention LGAs (the difference in difference method). If the two effect estimates for Nasarawa are similar, then we will combine them (eg, by weighting by the inverse of the variance) to produce a single summary estimate for the state. Similar analyses will be performed to look at the intervention effect on secondary outcomes (table 3). The difference in differences analysis assumes a common trend in the outcome in both the intervention and comparison area. Even if the two areas differ in a number of characteristics, the analysis is valid provided the common trend assumption is upheld. We will measure potential confounders at baseline and endline and adjust our analysis for any compositional changes over time in these confounders.

In Ethiopia and Tanzania, our hypothesis is that the prevalence of modern contraceptive use among sexually active girls aged 15–19 years living in areas where the A360 programme is implemented will increase between 2017 and 2019. The increase in mCPR will be greater
than what would have been expected to have occurred in the absence of the intervention. The primary analysis will compare the proportion of sexually active girls who report using modern contraception at baseline and endline. Similar analyses will be performed to look at the intervention effect on secondary outcomes (table 3). We will use logistic regression models to adjust for potential confounders, including age, educational attainment, parity and marital status (Tanzania only). In addition, we will conduct the following secondary analyses:

1. **Dose–response:** individual level of engagement with the A360 interventions will be measured at endline. We will use a series of questions to rank individuals by their level of engagement with the A360 interventions that are available in the place where they live. We will then use regression models to assess the strength of association between level of engagement with the A360 interventions and use of modern contraception. Our hypothesis will be that those who are more engaged will be more likely to use modern contraception. If the data are consistent with this hypothesis, this will provide additional evidence of the effectiveness of the intervention. Our analysis approach will try to capture exposure to the main components of the intervention and to capture overall exposure to the package of interventions. For example, if there are two main components of the intervention (A, B), then we may have three different exposure variables (A, B and a combination of A and B). There remains some uncertainty as to which intervention components will be implemented in each setting over the 2-year follow-up. A detailed analysis plan will be finalised prior to the endline data collection.

2. **Secular trends:** mCPR data available from other sources for the time period 2015–2019 will be examined to assess whether changes in mCPR in A360 communities between 2017 and 2019 reflect background changes in mCPR or whether mCPR appears to have increased more than would be expected during this time period. Detailed contraceptive use data among adolescents do not exist for the specific geographical areas in our study. Potential sources of data include DHS (Tanzania, Ethiopia), PMA2020 (Ethiopia) and demographic surveillance site data from areas near to our study sites (Kisesa in Mwanza; Kersa and Harar in Oromia). These data are unlikely to be directly comparable but we believe that they will give a broad indication as to whether mCPR is increasing, static or decreasing in the regions our study are situated in. Specifically, we will undertake a ‘modified’ difference in difference analysis. Prior to analysis of the endline data, from available existing data we will estimate the absolute increase in mCPR rates that we would expect in the study communities if secular trends from other sources were replicated. In the ‘modified’ difference in difference analysis, we will subtract this expected change from the difference between baseline and mCPR rate. When presenting this ‘modified’ difference in difference analysis, we will also present our assessment of the likely comparability, accuracy and completeness of these alternative data sources.

All analyses will be conducted in Stata V.15 and we will use weights and robust SEs to account for the cluster sampling design.

### Sample size

The baseline mCPR estimates and projected trends used in our sample size calculations were based on analysis which PSI conducted in September 2015 using available DHS data and our own review of historical DHS and PMA2020 data.

Effect estimates are based on an analysis (unpublished) conducted by one of our evaluation collaborators, Ms Michelle Weinberger (Avenir Health). She reviewed 25 studies published between 1993 and 2014, which had estimated the impact of family planning interventions on mCPR using a variety of study designs. Ms Weinberger extracted published ORs for effect size when available or calculated them using published results. She then calculated the median and maximum ORs to give a sense of...
the average and maximum increase in mCPR expected based on the existing evidence base.

**Nigeria**

In Ogun State, among sexually active unmarried girls aged 15–19 years, we assumed that between 2017 and 2019, mCPR will increase from 64.4% to 65.6% in the absence of A360 and from 64.4% to 72.6% in the presence of A360. Based on these assumptions and those in tables 4 and 5, our target sample size is 12,020 unmarried girls aged 15–19 years.

In Nasarawa State, among sexually active married 15–19 year olds, we have assumed that between 2017 and 2019, mCPR will increase from 3.0% to 3.1% in the absence of A360 and from 3.0% to 5.1% in the presence of A360. Thus, 4,555 married girls aged 15–19 years must be surveyed to achieve 90% power (table 5). In addition, a sample of 250 cohabiting adults (Ogun) and 250 husbands/male partners (Nasarawa) will be interviewed.

**Ethiopia**

In Oromia Region, among sexually active married girls aged 15–19 years, we have assumed that between 2017 and 2019, mCPR will increase from 44.0% to 50.8% in the presence of A360. Based on this assumption and those in table 4, 1,926 married girls aged 15–19 must be surveyed to achieve 90% power (table 5). In addition, a sample of 128 husbands/male partners will be interviewed.

**Tanzania**

In Ilemela District, Tanzania, among sexually active girls aged 15–19 years, we have assumed that between 2017 and 2019, mCPR will increase from 26.7% to 32.7% in the presence of A360. Thus, 4,980 girls aged 15–19 years (corresponding to 1,217 sexually active girls) must be surveyed to achieve 90% power (table 5). In addition, a sample of 127 cohabiting adults will be interviewed.

Based on discussions between the A360 funders, implementers and ourselves as independent evaluators of the programme, it was felt to be important to have an evaluation which was powered to detect small increases in mCPR in the study settings. These small effect sizes would be important in terms of the number of users of contraception gained and potential unplanned pregnancies averted among adolescent girls given the large scale of rollout of A360 across the three countries. In addition, it was felt that realistically, over only 2 years, achievable effect sizes were likely to be small but if detected might provide some reassurance that in the longer term we could expect greater increases.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ogun* (%)</th>
<th>Nasarawa* (%)</th>
<th>Oromia† (%)</th>
<th>Mwanza‡ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of 15–19-year-old girls who are married (or living together)</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Proportion of 15–19-year-old girls who are unmarried (not currently married)</td>
<td>90</td>
<td>85</td>
<td>80</td>
<td>78</td>
</tr>
<tr>
<td>Proportion of unmarried 15–19-year-old girls who report sexual activity in the past year</td>
<td>15</td>
<td>15</td>
<td>–</td>
<td>25</td>
</tr>
<tr>
<td>Proportion of married 15–19-year olds who report sexual activity in the past year</td>
<td>97</td>
<td>97</td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td>Proportion of sexually active girls who are married</td>
<td>42</td>
<td>53</td>
<td>–</td>
<td>52</td>
</tr>
<tr>
<td>Proportion of sexually active girls who are unmarried</td>
<td>58</td>
<td>47</td>
<td>–</td>
<td>48</td>
</tr>
<tr>
<td>Proportion of households with resident who is female aged 15–19 years</td>
<td>19</td>
<td>29</td>
<td>27</td>
<td>34</td>
</tr>
</tbody>
</table>

**Table 5** Sample size estimates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ogun</th>
<th>Nasarawa</th>
<th>Oromia</th>
<th>Mwanza</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target sample of sexually active 15–19-year olds*</td>
<td>1413</td>
<td>3586</td>
<td>1132</td>
<td>1217</td>
</tr>
<tr>
<td>Total sample of all 15–19-year olds*</td>
<td>10,362</td>
<td>4067</td>
<td>1284</td>
<td>3314</td>
</tr>
<tr>
<td>Design effect</td>
<td>1.16</td>
<td>1.12</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Sample size for survey†</td>
<td>12,020</td>
<td>4555</td>
<td>1926</td>
<td>4980</td>
</tr>
</tbody>
</table>

*Includes unmarried girls (Ogun); married girls (Nasarawa and Ethiopia); unmarried and married girls (Mwanza).
†Total sample of all 15–19-year olds × design effect.
Further details of the sample size calculations for the study, including sources of data used for assumptions, are available in the online supplementary file 1.

**Patient and public involvement**

There was no patient or public involvement in the design of this study. However, the intervention was designed using a human-centred design process which includes an iterative process of generating, testing and refining ideas and developing and testing prototypes with individuals from the target population through a series of structured workshops.16

**Strengths and limitations**

A strength of our outcome evaluation is the collection of comparable data before and after intervention implementation in four different settings in three countries. In two settings in Nigeria, we will also collect data from populations not exposed to the intervention and hence will have a quasi-experimental design.45 Triangulation with dose–response and trends analyses and implementer monitoring and evaluation data will strengthen the inference possible from the study findings. A process evaluation, conducted throughout the 2-year implementation period in the outcome evaluation areas, will provide information on the context and mechanism of the intervention and will complement the outcome data.

In Nigeria, where the intervention will be evaluated through a quasi-experimental design, the validity of the effect estimate depends on the time trend being the same in both intervention and comparison areas. The common trend assumption is untestable because we will not know what the trend in the intervention area would have been in the absence of the intervention. We have tried to select LGAs with similar key sociodemographic and reproductive health indicators as trends in mCPR are likely to be influenced by the characteristics of the population. In addition, our baseline survey will allow us to undertake a more accurate assessment as to how comparable our study sites are on a number of additional key indicators and we will be able to adjust for imbalances in potential confounders at the analysis stage.

In Tanzania and Ethiopia, the study design does not include a comparison group and observed changes in mCPR could be due to secular trends or other influences. As described above, we will examine historical and contemporaneous mCPR data from other sources so that our findings can be interpreted in the context of underlying trends. In addition, a dose–response analysis will be conducted at endpoint to look at the association between individual-level engagement with the A360 intervention and modern contraception use.

Due to resource constraints, we decided to focus on a limited number of geographical areas, which will affect the generalisability of our findings. However, our study is only one component of the overall A360 evaluation. The A360 programme implementers will also be collecting monitoring and evaluation data across all sites, and the process evaluation and a cost effectiveness analysis will be conducted over wider A360 areas. We anticipate incorporating this additional information into the overall evaluation.

It is important to note that this outcome evaluation is not evaluating human-centred design per se, but an intervention designed using human-centred design. A major challenge in designing the outcome evaluation for A360 was that when the outcome evaluation study protocols and data collection tools were being developed, the A360 project was in the mid-stages of intervention development. If the final intervention package is significantly different from earlier prototypes, then the study protocol and data collection tools for the baseline study may not be as well tailored to the intervention as if the final package of interventions was known in advance. If needed, changes to the baseline study protocol and data collection tools will be made to better capture the impact of the final A360 package of interventions.

**ETHICS AND DISSEMIFICATION**

**Informed consent**

Informed consent will be obtained from all study participants and the consent process will be documented. Written informed consent will be obtained from all participants in Tanzania. In Nigeria and Ethiopia, only verbal consent will be obtained as a waiver of written consent was granted because national surveys obtaining verbal responses to a questionnaire and involving similar sensitive questions on reproductive health issues are carried out using only verbal consent in these settings. In Nigeria, parental consent and adolescent girl assent are required for unmarried girls aged 15–17 years. In Tanzania, parental consent waiver was granted for this age group because of the sensitive nature of the topics discussed. Married adolescent girls under 18 years of age are considered emancipated in all three countries and do not require parental consent in addition to their own voluntary consent. Study participants will be informed of all risks and protections and will be able to withdraw from the study at any time for any reason.

**Benefits and risks**

There are no direct individual benefits for taking part in the study. Potential risks to participants are minimal. The most significant risk identified is a breach of confidentiality. There will be no identification of the respondent on the survey questionnaire. All study staff will be trained to ensure that they will protect the privacy and confidentiality of participants to the fullest extent possible. Interviews will be held at the household of the respondents out of hearing range of others. All data will be entered directly into tablets and sent to private secure servers on a daily basis through a private and secure internet connection. Data security will include data storage encryption and controlled password protected access for authorised users only. Data will be kept anonymised during the study and will be kept strictly confidential in storage for 10 years after completion of the study. All data based on this
research will be reported in aggregate form. Participants will not be identified by name in any report or publication resulting from the study data.

Compensation
There are no costs for being in the study. Therefore, participants will not receive compensation for taking part.

Dissemination of study findings
Our research findings dissemination plan includes peer-reviewed publications, stakeholder workshops, reports and briefings, social media and presentations at different forums. In compliance with the funder’s requirements, after a period of 6–12 months following the endline survey, the data will be made available via the London School of Hygiene and Tropical Medicine Data Repository after removing all direct and indirect identifiers from the data.

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Contributors
CJA, EM, SK, MKN, EEC, MM, CB, JRH and ADM were involved in conception and study design. CB provided statistical expertise. CJA, EM and ADM were involved in drafting of the manuscript. SK, MKN, EEC, MM, CB and JRH were involved in critical revision of the manuscript for important intellectual content. All the authors were involved in final approval of the manuscript and decision to submit the manuscript for publication.

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Competing interests
None declared.

Patient consent
Not required.

Ethics approval
National Health Research Ethics Committee of Nigeria (Ref: NHREC/01/01/2007-25/05/2017), National Health Research Ethics Review sub-Committee of Tanzania (Ref: NIMR/HG/R.8a/ Vol. IX/2594), Oromia Health Bureau Research Ethical Review Committee (Ref: BEFIHBTFH/1-8/2844) and the London School of Hygiene and Tropical Medicine Ethics Committee (Ref: 14145).

Provenance and peer review
Not commissioned; externally peer reviewed.

Data sharing statement
This is a study protocol paper. No data are yet available. Our research findings dissemination plan includes peer-reviewed publications, stakeholder workshops, reports and briefings, social media and presentations at different forums. In compliance with the funder’s requirements, after a period of 6–12 months following the endline survey, the data will be made available via the London School of Hygiene and Tropical Medicine Data Repository after removing all direct and indirect identifiers from the data.

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REFERENCES