BMJ Paediatrics Open

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Journal:	*BMJ Paediatrics Open*
Manuscript ID	bmjpo-2019-000510
Article Type:	Original article
Date Submitted by the Author:	17-Apr-2019
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Keywords:	Comm Child Health, Epidemiology, Growth, Health services research

Associations between maternal contraception and stunting in Guatemala: Secondary analysis of the 2014-2015 Demographic and Health Survey

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Abstract word count: 240

Main body text word count: 2,494

Number of references: 40

Number of tables: 5

Number of figures: 0

ABSTRACT

Background: There has been limited research on the relationship between maternal contraception and child growth in low- and middle-income countries (LMICs). This study examines the association between maternal contraception and child linear growth in Guatemala, a LMIC with a very high prevalence of child stunting. We hypothesize that access to maternal contraception is associated with better child linear growth and less stunting in Guatemala.

Methods: Using representative national data on 12,440 children 0-59 months of age from the 2014-2015 Demographic and Health Survey in Guatemala, we constructed multivariable linear and Poisson regression models to assess whether child linear growth and stunting were associated with maternal contraceptive variables. All models were adjusted for a comprehensive set of pre-specified confounding variables.

Results: In the multivariable regression analyses, maternal contraceptive use and unmet need for family planning were associated with modest, statistically significant greater height-for-age z-score. Similarly, current and prior use of a modern contraceptive method were associated with a statistically significant lower prevalence ratio of stunting and severe stunting. Unmet need for family planning was associated with a statistically significant lower prevalence ratio for severe stunting but not stunting.

Conclusions: Direct measures of maternal contraception were generally associated with better child linear growth and less child stunting in Guatemala. In addition to the human rights

imperative to expand contraceptive access and choice, family planning merits further study as a strategy to improve child growth in Guatemala and other countries with high prevalence of stunting.

What is known about the subject:

- There has been limited research on the relationship between maternal contraception and child growth in low- and middle-income countries like Guatemala.
- Prior studies have shown that indirect markers of family planning utilization such as maternal age, birth intervals, and family size are often associated with improved child growth.
- However, these proxy markers of maternal contraception are detached from real-world use and need.

What this study adds:

- Direct measures of maternal contraception were generally associated with modestly better child linear growth and less child stunting in Guatemala.
- This is the first study to assess the relationship between unmet need for family planning and child growth in a low- and middle-income country.
- This analysis adds to the evidence that family planning may have positive spillover effects on child growth.

INTRODUCTION

Approximately 200 million women in low- and middle-income countries (LMICs) wish to avoid pregnancy but do not use modern contraceptive methods.[1] Access to family planning averts maternal deaths[2] and is supported by rights-based frameworks.[3] Family planning also may have important spillover effects for child growth.[4]

This study examines the relationship between maternal contraception and child linear growth in Guatemala, an upper-middle income country in Central America. Guatemala has Latin America's highest prevalence of stunting,[5] and rural children in Guatemala are among the most stunted populations in the world.[6] Stunting confers significant short- and long-term health risks, and it is thus a critical child health issue in Guatemala and globally.

Understanding the relationship between maternal contraception and child growth is relevant to policymakers and program implementers in Guatemala and other similar contexts seeking to address high levels of child stunting. In the authors' own community nutrition programs in Guatemala,[7] we anecdotally have observed more rapid improvements in child growth in communities with higher utilization of maternal contraception. Evidence from the field of evolutionary anthropology also supports a trade-off between reproduction and offspring health.[8] Prior research in LMICs has demonstrated that pregnancy intention is variably associated with stunting[9-15] and that proxy markers of family planning utilization such as maternal age, birth intervals, and family size are associated with improved child linear growth.[4 16-19] However, retrospective assessments of pregnancy intention are subject to bias,[20 21] and indirect markers of

family planning utilization are detached from real-world contraceptive use and need. Few studies of child stunting have utilized direct measures of family planning such as modern contraceptive use or unmet need for family planning, which have emerged as critical metrics in the family planning movement.[22]

Within this background, we hypothesize that maternal contraception is associated with better child linear growth and less stunting in Guatemala.

METHODS

Study design and sample

To assess the association between maternal contraception and child growth in Guatemala, we conducted a secondary analysis of survey data from the 2014-2015 Demographic and Health Survey (DHS). Details on survey design can be found in the DHS report.[23] We used the Children's Recode file, which comprises 12,440 children ages 0-59 months.

Dependent variables

The dependent variables are related to child growth. Child length/height-for-age z-score (HAZ) was utilized as a continuous dependent variable, and the presence of stunting (HAZ ≤ -2.0) or severe stunting (HAZ ≤ -3.0) were utilized as binary dependent variables. HAZ was based on WHO reference standards.

Independent variables

The independent variables were selected around two core themes of (1) maternal contraceptive use and (2) maternal contraceptive need.

Variables relating to maternal contraception use included current use, prior use, and duration of current use (dichotomized to more or less than the median period of use of 15 months). We used DHS definitions of contraceptive type (modern method, traditional method, and no use) with the exception of classifying "folkloric methods" (0.1% of sample) as no use.

Variables relating to maternal contraceptive need included unmet need for family planning (hereafter "unmet need") and pregnancy intention. Unmet need is a dichotomous variable referring to "women who are not currently using a method of contraception and want to stop or delay childbearing."[24] Pregnancy intention refers to the mother's retrospective assessment of whether the child was wanted at the time of the pregnancy.

Confounding variables

Confounding variables were selected *a priori* for model inclusion based on a review of global stunting literature,[6 25] predictors of child stunting reported in previous research conducted in Guatemala,[26 27] and the authors' country-specific expertise.[28-30]

Continuous confounding variables included age of child in months, age of mother in years, and household wealth index. Given non-linearity between HAZ and these continuous variables, for each we pre-specified restricted cubic splines with five knots.

Categorical confounding variables included child sex, area of residence (urban, rural), maternal and partner education attainment (none, incomplete primary, primary, incomplete secondary, complete secondary, and higher), maternal literacy (not literate, semi-literate, literate), maternal marital status (never in union, partnered, or formerly partnered), region of country, ethnic group by self-identification, language spoken in the home, presence of diarrhea in the last two weeks, type of sanitation (improved and unshared, improved and shared, or unimproved), type of drinking water, birth order, and number of children under age 5 in the household.

Statistical analysis

We took into account survey weighting, clustering at the PSU level, and sampling design using Stata's *svyset* command and estimated variance using the Taylor linearization. We used Stata version 13 (College Station, TX) for all analyses and did not correct p-values for multiple testing. Eight percent of children were excluded in the bivariate and multivariate analysis due to missing data.

First, we generated population descriptive statistics and assessed the bivariate relationships between independent and dependent variables.

We then constructed two sets of multivariable linear regression models to test the hypothesis that maternal contraception is associated with HAZ. The same pre-specified confounding variables were included in all models. The first set of models utilized independent variables related to maternal contraceptive use: current contraceptive use (Model 1A); adding prior contraceptive use to Model 1A (Model 1B); and adding duration of current contraceptive use to Model 1B (Model 1C). The second set of models utilized independent variables relating to unmet need: unmet need (Model 2A) and adding pregnancy intention to Model 2A (Model 2B).

Next, in order to test whether maternal contraception was associated with the presence of stunting and severe stunting, we specified multivariable Poisson regressions with the same independent variables as Models 1C and 2B. We chose Poisson rather than logistic regression to facilitate the interpretation of results.[31] The same pre-specified confounding variables were included.

Finally, we carried out sensitivity analyses. First, we ran the models on a restricted sample of children with a birth order of 2 or greater for whom preceding birth interval data were available (n=8,434). Birth interval is a proxy for maternal contraception and has been associated with child growth in the literature.[4] Second, we added maternal height as a continuous variable to the models with listwise deletion of records with missing data (n=10,657). Third, we included meal frequency and dietary diversity as indicator variables and ran the models on applicable children ages 6-23 months (n=3,520).

Ethics

The use of survey data for this study was approved by DHS. We followed STROBE guidelines in reporting our research.

Patient and Public Involvement

As a secondary data set analysis, there was no patient or public involvement in the conduct of this research.

RESULTS

Sample characteristics and bivariate analyses

The characteristics of children included in the analyses are shown in Table 1 and bivariate relationships in Table 2.

Table 1: Survey-weighted characteristics of children in the sample

Characteristic	Number	Population estimate
Dependent variables		
HAZ, mean (SD)	11,674	-1.68 (1.14)
Stunted, % (95% CI)	11,674	39.1 (37.4 to 40.8)
Severely stunted, % (95% CI)	11,674	12.1 (11.0 to 13.4)
Independent variables		
Maternal current contraceptive use, % (95% CI)	12,440	
No use		44.3 (42.8 to 45.9)
Traditional method		10.9 (10.1 to 11.7)

Modern method, <15 months		22.9 (21.7 to 24.2)
Modern method, ≥15 months		21.9 (20.8 to 23.1)
Maternal prior contraceptive use, % (95% CI)	12,440	
No use		49.8 (48.3 to 51.4)
Traditional method		11.4 (10.5 to 12.4)
Modern method		38.8 (37.3 to 40.3)
Maternal unmet need for family planning, % (95% CI)	12,437	19.9 (18.8 to 21.2)
Pregnancy intention, % (95% CI)	12,437	
Wanted then		64.1 (62.9 to 65.4)
Wanted later		20.3 (19.4 to 21.3)
Not wanted		15.6 (14.6 to 16.6)
Confounding variables		
Child's age in months, median (IQR)	11,962	29 (14 to 44)
Mother age in years, mean (SD)	12,440	27.8 (6.7)
Wealth index, median (IQR)	12,440	-49,854 (-107,310 to 33,359)
Male sex, % (95% CI)	12,440	51.9 (50.9 to 52.9)
Rural area of residence, % (95% CI)	12,440	64.2 (62.2 to 66.2)
Maternal education, % (95% CI)	12,440	
None		18.9 (17.5 to 20.3)
Incomplete primary		35.2 (33.7 to 36.7)
Primary		17.3 (16.3 to 18.3)
Incomplete secondary		17.7 (16.6 to 18.9)
Complete secondary		7.4 (6.6 to 8.2)
Higher		3.6 (3.2 to 4.2)
Partner education, % (95% CI)	12,440	
No education		12.5 (11.5 to 13.7)

Incomplete primary		31.0 (29.7 to 32.4)
Primary		19.6 (18.6 to 20.7)
Incomplete secondary		19.3 (18.1 to 20.6)
Complete secondary		8.4 (7.7 to 9.2)
Higher		4.4 (3.9 to 5.0)
No partner or unknown		4.7 (4.2 to 5.2)
Maternal literacy, % (95% CI)	12,432	
Not literate		21.4 (19.8 to 23.0)
Semi-literate		12.9 (11.9 to 13.9)
Literate		65.8 (63.9 to 67.6)
Maternal marital status, % (95% CI)	12,440	
Never in union		4.5 (4.0 to 5.0)
Current partner		87.5 (86.7 to 88.3)
Former partner		8.0 (7.4 to 8.7)
Region of country, % (95% CI)	12,440	
Metropolitan Guatemala City		15.4 (13.8 to 17.2)
North		11.3 (10.0 to 12.8)
Northeast		9.1 (8.0 to 10.4)
Southeast		8.9 (8.0 to 9.9)
Central		10.7 (9.7 to 11.9)
Southwest		23.6 (22.2 to 25.1)
Northwest		16.9 (15.3 to 18.6)
Petén		4.0 (3.3 to 4.9)
Indigenous ethnicity, % (95% CI)	12,436	51.9 (49.4 to 54.4)
Mayan language spoken in home, % (95% CI)	12,440	30.5 (27.9 to 33.2)
Diarrhea last 2 weeks, % (95% CI)	12,038	19.2 (18.3 to 20.3)
Sanitation, % (95% CI)	12,250	

Improved and unshared		74.2 (72.6 to 75.8)
Improved and shared		16.9 (15.7 to 18.1)
Unimproved		8.9 (7.7 to 10.3)
Improved drinking water, % (95% CI)	12,257	62.1 (60.0 to 64.5)
Birth order number, median (IQR)	12,440	2 (1 to 4)
Children in household, median (IQR)	12,440	1 (1 to 2)

CI, confidence interval; HAZ, height-for-age z-score; IQR, interquartile range; SD, standard deviation. Estimates account for sampling design. Of note, estimates differ slightly from the DHS report, which uses the Household Member Recode in its calculations.

Table 2: Bivariate relationships between dependent and independent variables

	HAZ, mean (95% CI)	**Stunted, % (95% CI)**	**Severely stunted, % (95% CI)**
Maternal current contraceptive use			
No use	-1.86 (-1.92 to -1.80)	45.1 (42.8 to 47.6)	16.3 (14.5 to 18.2)
Traditional method	-1.72 (-1.81 to -1.63)	40.5 (36.8 to 44.4)	12.1 (9.8 to 15.0)
Modern method, <15 months	-1.53 (-1.60 to -1.47)	33.4 (30.6 to 36.3)	9.1 (7.6 to 10.8)
Modern method, ≥15 months	-1.47 (-1.53 to -1.41)	32.5 (30.2 to 34.8)	7.2 (6.0 to 8.5)
Maternal prior contraceptive use			
No use	-1.83 (-1.89 to -1.78)	44.5 (42.3 to 46.7)	15.4 (13.8 to 17.2)
Traditional method	-1.65 (-1.74 to -1.56)	36.7 (33.2 to 40.3)	9.9 (7.9 to 12.3)
Modern method	-1.50 (-1.55 to -1.45)	32.9 (30.8 to 35.0)	8.5 (7.3 to 9.8)
Maternal unmet need			
Unmet need	-1.62 (-1.66 to -1.58)	47.7 (44.6 to 50.7)	17.6 (15.2 to 20.2)
No unmet need	-1.93 (-2.01 to -1.85)	36.9 (35.2 to 38.7)	10.8 (9.7 to 11.9)
Pregnancy intention			

Wanted then	-1.66 (-1.71 to -1.61)	38.5 (36.5 to 40.4)	11.7 (10.5 to 13.1)
Wanted later	-1.68 (-1.74 to -1.62)	38.5 (36.1 to 41.1)	11.7 (10.2 to 13.5)
Not wanted	-1.78 (-1.86 to -1.70)	42.3 (39.2 to 45.4)	14.1 (11.8 to 16.8)

HAZ, height-for-age z-score; CI, confidence interval. Estimates account for sampling design.

Multivariable regression with dependent variable of HAZ

Table 3 shows the results of the multivariable linear regression Models 1A-1C focusing on maternal contraceptive use. Current and prior use of maternal contraception were statistically significant (overall p-value <0.001 for these categorical variables in all models). When duration of current modern use was included (Model 1C), use for ≥15 months was associated with a 0.19 (95% CI 0.12 to 0.25, p<0.001) increase in HAZ but modern use for <15 months was not statistically significant.

In the multivariable linear regression models focusing on maternal contraceptive need, unmet need was associated with a -0.07 (-0.13 to -0.01, p=0.02) change in HAZ (Model 2A). When pregnancy intention was included (Model 2B), unmet need similarly was associated with a -0.07 (-0.13 to -0.01, p=0.03) change in HAZ while pregnancy intention was not significant (overall p=0.08 for this categorical variable).

Table 3: Coefficient estimates and 95% CI from linear regression models relating to maternal contraceptive use and HAZ (n=11,501)

	Model 1A	**Model 1B**	**Model 1C**

Current contraceptive use	***	***	***
No use	(Reference)	(Reference)	(Reference)
Traditional	0.11** (0.03 to 0.18)	0.09* (0.02 to 0.17)	0.10** (0.03 to 0.18)
Modern, any duration	0.10*** (0.05 to 0.16)	0.10*** (0.05 to 0.16)	N/A
Modern, <15 months	N/A	N/A	0.03 (-0.03 to 0.10)
Modern, ≥15 months	N/A	N/A	0.19*** (0.12 to 0.25)
Prior contraceptive use		***	***
No use		(Reference)	(Reference)
Traditional		0.11** (0.04 to 0.19)	0.12** (0.05 to 0.20)
Modern		0.11*** (0.05 to 0.16)	0.12*** (0.07 to 0.18)

CI, confidence interval; N/A, not applicable. * p<0.05, ** p<0.01, *** p<0.001. Asterisks not associated with estimates reflect the overall p-value of the variable. The same pre-specified confounding variables were included in all models: age of child, age of mother, wealth index, child sex, area of residence, maternal and partner education attainment, maternal literacy, maternal marital status, region of country, ethnic group, language, presence of diarrhea in the last two weeks, type of sanitation, type of drinking water, birth order, and number of children under age 5 in the household. Estimates account for sampling design.

Multivariable regression with dependent variable of stunting and severe stunting

Table 4 shows the results of the multivariable Poisson regression models assessing stunting and severe stunting against maternal contraceptive use. The independent variables of current and prior use of maternal contraception both were statistically significant for the outcomes of stunting and severe stunting (overall p-value <0.05). Compared with no contraceptive use,

current use of a modern contraceptive method for ≥15 months was associated with a prevalence ratio of stunting of 0.90 (95% CI 0.84 to 0.97, p=0.005) and severe stunting of 0.65 (95% CI 0.54 to 0.78, p<0.001). Prior use of either traditional or modern contraceptive types was associated with statistically significantly lower prevalence of stunting and severe stunting.

Table 4: Prevalence ratios of stunting and severe stunting estimated from multivariable Poisson regression models using maternal contraceptive use

	Prevalence ratio of stunting (95% CI)	**Prevalence ratio of severe stunting (95% CI)**
Maternal current contraceptive use	*	***
No use	(Reference)	(Reference)
Traditional method	0.96 (0.88 to 1.04)	0.85 (0.69 to 1.04)
Modern method, <15 months	1.00 (0.92 to 1.08)	0.91 (0.77 to 1.06)
Modern method, ≥15 months	0.90** (0.84 to 0.97)	0.65*** (0.54 to 0.78)
Maternal prior contraceptive use	**	***
No use	(Reference)	(Reference)
Traditional method	0.88** (0.80 to 0.96)	0.73** (0.60 to 0.88)
Modern method	0.92* (0.87 to 0.98)	0.81** (0.70 to 0.93)

CI, confidence interval. * p<0.05, ** p<0.01, *** p<0.001. Asterisks not associated with estimates reflect the overall p-value of the variable. The same pre-specified confounding variables were included in all models: age of child, age of mother, wealth index, child sex, area of residence, maternal and partner education attainment, maternal literacy, maternal marital status, region of country, ethnic group, language, presence of diarrhea in the last two weeks, type

of sanitation, type of drinking water, birth order, and number of children under age 5 in the household. Estimates account for sampling design.

Table 5 shows the results of the multivariable Poisson regression models assessing stunting and severe stunting against maternal contraceptive need. In these models, the only association reaching statistical significance was that unmet need was associated with a severe stunting prevalence ratio of 1.14 (1.01 to 1.30, p=0.04).

Table 5: Prevalence ratios of stunting and severe stunting estimated from multivariable Poisson regression models using maternal contraceptive need

	Prevalence ratio of stunting (95% CI)	**Prevalence ratio of severe stunting (95% CI)**
Maternal unmet need		
Unmet need	1.04 (0.97 to 1.10)	1.14* (1.01 to 1.30)
No unmet need	(Reference)	(Reference)
Pregnancy intention		
Wanted then	(Reference)	(Reference)
Wanted later	1.05 (0.99 to 1.12)	1.11 (0.97 to 1.27)
Not wanted	0.99 (0.92 to 1.06)	1.02 (0.87 to 1.19)

CI, confidence interval. * p<0.05, ** p<0.01, *** p<0.001. The overall p-value for the variable pregnancy intention was not significant in either model. The same pre-specified confounding variables were included in all models: age of child, age of mother, wealth index, child sex, area of residence, maternal and partner education attainment, maternal literacy, maternal marital status, region of country, ethnic group, language, presence of diarrhea in the last two weeks, type of sanitation, type of drinking water, birth order, and number of children under age 5 in the household. Estimates account for sampling design.

Sensitivity analyses

Inclusion of antecedent birth intervals to the models yielded results that were generally consistent with the findings of the primary models. The results of the sensitivity analyses with maternal height and dietary covariates were also similar to the main analysis.

DISCUSSION

This study was a secondary analysis of maternal contraception and child growth using 2014-2015 Guatemala DHS data. In the multivariable linear regression models, maternal contraceptive use and need were associated with statistically significant changes in child linear growth as measured by HAZ. In the multivariable Poisson regression models, maternal contraceptive use was associated with statistically significant lower prevalence of stunting and severe stunting; for unmet need, the relationship was significantly higher for severe stunting but not stunting.

While the magnitude of the associations reported in this study is modest, these results should be viewed in the context of other strategies to improve child growth. A meta-analysis of evidence-based interventions for child nutrition reported the effect size of nutrition education in food-insecure populations of 0.25 HAZ and complementary food provision of 0.39 HAZ.[32] Trials of water, sanitation, and hygiene (WASH) interventions have not consistently found benefit.[33] A review of context-specific nutrition programs found a median reduction in child stunting of 3% per year [34]. These sobering figures reiterate that stunting arises from a complex political, economic, and social context that can only be partially attenuated via technical intervention.[25]

This research is, to our knowledge, the first to specifically investigate the association of unmet need on child linear growth, and it is one of the few studies assessing maternal modern contraception use on child growth. As discussed in the introduction, other researchers have explored the relationship between family planning and child growth principally by focusing on pregnancy intention or proxy metrics of contraception like birth intervals, maternal age, and family size. Such measures have generally been found to be associated with child growth, often using underlying DHS data.[4 16-19] The association with pregnancy intention has been less consistent in cross-sectional studies,[9-15] perhaps owing to challenges in retrospectively determining pregnancy intent.[20] Interestingly, unintended and/or mistimed pregnancies previously have been associated with poorer child growth in Bolivia and Peru, two Latin American countries with large indigenous populations demographically similar to Guatemala.[9 10]

Several findings that emerged from this work merit additional comment. First, an unexpected result was that use of traditional methods was generally associated with similar changes in child growth and stunting compared to use of modern methods. We caution that our study was not intended to test the ordering of contraceptive types on child growth, does not address contraceptive efficacy, and is subject to the definitional and methodological issues described below. For example, self-reporting of traditional contraceptive use might reflect residual confounders such as maternal autonomy, which was not incorporated in this analysis but has been associated with stunting in other settings.[35] Second, the association between maternal contraception and child growth persisted even in the sensitivity analysis that controlled for antecedent birth intervals. This finding suggests that the association of contraception on improved child growth may not be solely mediated through birth spacing and family size; other

mechanisms are speculative but might include comparatively increased household resources directed to children of mothers with access to contraception. Third, the relationship between current modern contraceptive use and HAZ seemed to be "dose-dependent," as current use of modern methods for 15 or more months was associated with statistically significant improvements in child HAZ and stunting, while users of less than 15 months had no significant difference in child growth compared to those not using contraception.

One important methodological consideration in this study is definitional. We used DHS-aligned definitions of contraceptive type (modern or traditional) and unmet demand in all analyses.[24] However, the distinction between modern versus traditional methods has been debated.[36] For example, DHS defines women who use a traditional method to have no unmet need for family planning,[24] but other researchers classify traditional users as having an unmet need for modern methods.[1] We justify the definitions utilized in this study as appropriate given that it is the classification scheme currently recommended by DHS.

The strengths of this study include use of a recently released, representative DHS survey that permitted current population-level estimates of change in HAZ and stunting in Guatemala. Additionally, our prior ethnographic and programmatic experience in Guatemala assisted in selection of a comprehensive set of covariates tailored to the setting. In response to critiques of DHS studies arising from the economics literature, we also carefully specified non-linear relationships between continuous covariates and HAZ.[37] A final study strength is that we conducted thorough sensitivity analyses, which were generally consistent with the main analysis.

This research has some limitations and weaknesses. First, this study used data from a single survey in Guatemala, which limits generalizability to other countries. At the same time, an advantage of using single-country data is that it allowed us to carefully select confounders of interest based on stunting risk factors in a single context. Second, use of secondary survey data does not permit us to infer causality and raises the possibility of residual confounding. Potential examples include dimensions of wealth not captured in asset-based indices,[38] maternal autonomy,[35] or paternal anthropometry.[39] Third, we are unsure of the accuracy of self-reported contraceptive data in large surveys in Guatemala. In our own ethnographic and programmatic experience, family planning can be a delicate topic in Guatemalan households.

Our study suggests multiple directions for future research on the relationship between maternal contraception and child growth. Multi-country studies would be useful to further evaluate the association between unmet need and child growth. Aggregating data across countries would also facilitate analysis of the association between child growth and maternal use of long-acting reversible contraceptives, which are increasingly emphasized in the global reproductive health literature. Structural equation modeling could help characterize the pathways and mediators between family planning and stunting. Given the difficulty in designing an ethically rigorous randomized trial examining the impact of a maternal contraception intervention on child growth, alternative methodological and statistical approaches to infer causality may be helpful. Such strategies could also help better understand the dynamic process of contraceptive discontinuation and its impact on child growth.[40]

In conclusion, using secondary survey data in Guatemala, this study found an association between direct measures of maternal contraception and better child growth outcomes that was modest in magnitude yet significant from a public health perspective. In addition to the human rights imperative to expand contraceptive access and choice, family planning merits further research and policy consideration as a strategy to improve child growth in Guatemala and similar countries with high prevalence of stunting.

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Acknowledgments: The authors thank colleagues and program beneficiaries at Wuqu' Kawoq in Guatemala.

Sources of funding: This research was supported by the National Institutes of Health's National Center for Advancing Translational Sciences, grant UL1TR002494. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health's National Center for Advancing Translational Sciences.

Conflict of interest statement: The authors declare no conflicts of interest.

Contributor statements: DF conceptualized the study, conducted the statistical analysis, wrote the initial manuscript draft, and revised the manuscript. AP conducted the statistical analysis and revised the manuscript. BM, AC, and KA assisted in the interpretation of the statistical models, and revised the manuscript. PR conceptualized the study, assisted in designing and interpreting the statistical models, and revised the manuscript All authors reviewed and approved the final manuscript.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	See title
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4	See abstract text
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7	The introductory text describes the scientific background and builds the study rationale
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 7	"Within this background, we hypothesize that maternal contraception is associated with better child linear growth and less stunting in Guatemala."
Methods				
Study design	4	Present key elements of study design early in the paper	Page 7	See text under "Study design and sample"
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 7	See text under "Study design and sample"
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 7	"…we conducted a secondary analysis of survey data from the 2014-2015 Demographic and Health Survey (DHS). Details on survey design can be found in the DHS report.23 We used the Children's Recode file, which comprises 12,440 children ages 0-59 months."
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and		

		unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9	In the text on these pages, we extensively define and discuss all variables.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7	This study is a secondary analysis of DHS data, so we cite the DHS report which has further details on survey collection and data processing
Bias	9	Describe any efforts to address potential sources of bias	8-9	We imply that we protected against bias by using pre-specified confounding variables, and we state that we do not correct for multiple hypothesis testing.
Study size	10	Explain how the study size was arrived at	7	We state we that we use the nationally representative sample of children available in the original DHS survey.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10	We extensively discuss our quantitative dependent variable (HAZ) and confounding variables.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-10	See text under "statistical analysis"
		(*b*) Describe any methods used to examine subgroups and interactions	N/A	Subgroup analysis was not performed
		(*c*) Explain how missing data were addressed	9	Eight percent of children were excluded due to missing data when fitting these models.
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	10	See extensive discussion of sensitivity analyses
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13	In the Results section beginning on page 11, we specify the number of records available for each variable. We also discuss on page 9 how missing records were handled in the regression analyses.
		(b) Give reasons for non-participation at each stage	N/A	Given use of secondary survey data, this is not applicable
		(c) Consider use of a flow diagram	N/A	Given use of secondary survey data, we chose not to use a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-13	See section under "Sample characteristics and bivariate analyses"
		(b) Indicate number of participants with missing data for each variable of interest	11-13	See table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		

		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	11-13	See Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14	See Table 2 (unadjusted bivariate associations) before the final adjusted multivariable models are reported in Tables 3-5
		(*b*) Report category boundaries when continuous variables were categorized	11-13	We report category boundaries in Table 1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	16-18	As discussed in the methods, we opted to use Poisson models to calculate prevalence ratio. Overall descriptive statistics for dependent variables are reported in Tables 1 and 2

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	18	See this page for sensitivity analyses results
Discussion				
Key results	18	Summarise key results with reference to study objectives	19	Initial paragraph of discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21-22	We discuss some of the definitional limitations as well as study weaknesses/limitations
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	20-22	We give a cautious interpretation of these results and attempt to locate this study within the broader literature in Guatemala and globally
Generalisability	21	Discuss the generalisability (external validity) of the study results	21-22	We discuss that a weakness of this study is lack of generalizability outside of Guatemala, though this study might motivate others to assess growth and contraception in other countries.
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	29	We report funding.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Paediatrics Open

Associations between contraception and stunting in Guatemala: Secondary analysis of the 2014-2015 Demographic and Health Survey

Journal:	*BMJ Paediatrics Open*
Manuscript ID	bmjpo-2019-000510.R1
Article Type:	Original article
Date Submitted by the Author:	11-Jul-2019
Complete List of Authors:	Flood, David; Wuqu' Kawoq Petersen, Ashley; University of Minnesota Martinez, Boris; Wuqu' Kawoq, Chary, Anita; Wuqu' Kawoq Austad, Kirsten; Wuqu' Kawoq Rohloff, Peter
Keywords:	Comm Child Health, Epidemiology, Growth, Health services research

Associations between contraception and stunting in Guatemala: Secondary analysis of the 2014-2015 Demographic and Health Survey

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Abstract word count: 270

Main body text word count: 2,896

Number of references: 47

Number of tables: 4

Number of figures: 0

Acknowledgments: The authors thank colleagues and program beneficiaries at Wuqu' Kawoq in Guatemala.

Sources of funding: This research was supported by the National Institutes of Health's National Center for Advancing Translational Sciences, grant UL1TR002494. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health's National Center for Advancing Translational Sciences.

Conflict of interest statement: The authors declare no conflicts of interest.

Contributor statements: DF conceptualized the study, conducted the statistical analysis, wrote the initial manuscript draft, and revised the manuscript. AP conducted the statistical analysis and revised the manuscript. BM, AC, and KA assisted in the interpretation of the statistical models,

and revised the manuscript. PR conceptualized the study, assisted in designing and interpreting the statistical models, and revised the manuscript All authors reviewed and approved the final manuscript.

ABSTRACT

Background: There has been limited research on the relationship between contraception and child growth in low- and middle-income countries (LMICs). This study examines the association between contraception and child linear growth in Guatemala, a LMIC with a very high prevalence of child stunting. We hypothesize that contraceptive use is associated with better child linear growth and less stunting in Guatemala.

Methods: Using representative national data on 12,440 children 0-59 months of age from the 2014-2015 Demographic and Health Survey in Guatemala, we constructed multivariable linear and Poisson regression models to assess whether child linear growth and stunting were associated with contraception variables. All models were adjusted for a comprehensive set of pre-specified confounding variables.

Results: Contraceptive use was generally associated with modest, statistically significant greater height-for-age z-score. Current use of a modern method for at least 15 months was associated with a prevalence ratio of stunting of 0.87 (95% CI 0.81 to 0.94; $p<0.001$), and prior use of a modern method was associated with a prevalence ratio of stunting of 0.93 (95% CI 0.87 to 0.98; $p<0.05$). The severe stunting models found generally similar associations with modern contraceptive use as the stunting models. There was no significant association between use of a modern method for less than 15 months and the prevalence ratio of stunting or severe stunting.

Conclusions: Contraceptive use was associated with better child linear growth and less child stunting in Guatemala. In addition to the human rights imperative to expand contraceptive access and choice, family planning merits further study as a strategy to improve child growth in Guatemala and other countries with high prevalence of stunting.

What is known about the subject:

- There has been limited research on the relationship between contraception and child growth in low- and middle-income countries like Guatemala.
- Prior studies have shown that indirect markers of family planning utilization such as maternal age, birth intervals, and family size are often associated with improved child growth.
- However, these proxy markers of contraception are disconnected from real-world access and use.

What this study adds:

- Use of contraceptive methods were generally associated with modestly better child linear growth and less stunting and severe stunting in Guatemala.
- This is one of the first studies to assess the relationship between contraceptive use and child growth in a low- and middle-income country.
- This analysis adds to the evidence that family planning may have positive spillover effects on child growth.

INTRODUCTION

Approximately 200 million women in low- and middle-income countries (LMICs) wish to avoid pregnancy but do not use modern contraceptive methods.[1] Access to family planning averts maternal deaths[2] and is supported by rights-based frameworks.[3] Family planning also likely has important spillover effects for child growth, which have been explored in detail by the field of evolutionary anthropology.[4] One mechanistic pathway involves trade-offs between offspring quantity and child health, where larger family size dilutes parental investments, while another involves trade-offs between reproduction and maternal health in which high fertility diminishes maternal physiologic resources directed to the growing child in the post-natal period.[5]

This study examines the relationship between contraception and child linear growth in Guatemala, an upper-middle income country in Central America. Guatemala has Latin America's highest prevalence of stunting,[6] and rural children in Guatemala are among the most stunted populations in the world.[7] Stunting confers significant short- and long-term health risks, and it is thus a critical child health issue in Guatemala and globally.

Understanding the relationship between contraception and child growth is relevant to policymakers and program implementers in Guatemala and other similar contexts seeking to address high levels of child stunting. In the authors' own community nutrition programs in Guatemala, we anecdotally have observed more rapid improvements in child growth in communities with higher utilization of contraception.[8] In general, research in LMICs has demonstrated that pregnancy intention is variably associated with stunting[9-15] and that proxy

markers of family planning utilization such as maternal age, birth intervals, and family size are associated with improved child linear growth.[4 16-19] However, retrospective assessments of pregnancy intention are subject to bias,[20 21] and the import of proxy markers of family planning utilization are not always intuitive to health policy decision makers who must make concrete decisions about investments to expand contraceptive access or uptake. Few studies of child stunting have utilized direct measures of family planning such as modern contraceptive use or unmet need for family planning, which have emerged as critical metrics in the family planning movement.[22] Within this background, we examine contraception usage in Guatemala using direct measures, and we hypothesize that usage is associated with better child linear growth and less stunting.

METHODS

Study design and sample

To assess the association between contraception and child growth in Guatemala, we conducted a secondary analysis of survey data from the 2014-2015 Demographic and Health Survey (DHS). Details on survey design can be found in the DHS report.[23] We used the Children's Recode file, which comprises 12,440 children ages 0-59 months.

Patient involvement

Patients were not directly involved in the design of this study.

Dependent variables

The dependent variables related to child growth. Child length/height-for-age z-score (HAZ) was utilized as a continuous dependent variable, and the presence of stunting (HAZ ≤ -2.0) or severe stunting (HAZ ≤ -3.0) were utilized as binary dependent variables. HAZ was based on WHO reference standards.[24]

Independent variables

The independent variables related to contraception use including current use, prior use, and duration of current use (dichotomized to more or less than the median period of use of 15 months). We used DHS definitions of contraceptive type (modern method, traditional method, and no use) with the exception of classifying "folkloric methods" (0.1% of sample) as no use. Modern methods included pills, intrauterine devices, injections, condoms, implant, sterilization, lactational amenorrhea, and other modern methods. Traditional methods included periodic abstinence and withdrawal. Additionally, we included proxy markers of contraception including preceding birth interval (no preceding interval, less than 24 months, or 24 months or greater) and birth order (defined as a continuous variable given observed linearity between HAZ and birth order). Details on the techniques used to collect data on contraceptive use and a full example questionnaire can be found as a technical appendix in the survey's final report.[23]

Confounding variables

Confounding variables were selected *a priori* for model inclusion based on a review of global stunting literature,[7 25] predictors of child stunting reported in previous research conducted in Guatemala,[26 27] and the authors' country-specific expertise.[28-30]

Continuous confounding variables included age of child in months, age of mother in years, and household wealth index. Given known non-linearity between HAZ and these continuous variables, for each we pre-specified restricted cubic splines with five knots at quantiles as recommended by Harrell.[31]

Categorical confounding variables included child sex, area of residence (urban, rural), maternal and partner education attainment (none, incomplete primary, primary, incomplete secondary, complete secondary, and higher), maternal literacy (not literate, semi-literate, literate), maternal marital status (never in union, partnered, or formerly partnered), region of country, ethnic group by self-identification, language spoken in the home, and presence of diarrhea in the last two weeks. Of note, variables relating to sanitation facilities and water access were controlled through their incorporation into the household wealth index.

Statistical analysis

We took into account survey weighting, clustering at the PSU level, and sampling design using Stata's *svyset* command and estimated variance using the Taylor linearization. We used Stata version 13 (College Station, TX) for all analyses and did not correct p-values for multiple testing.

First, we generated population descriptive statistics and assessed the bivariate relationships between independent and dependent variables.

We then constructed a set of multivariable linear regression models to test the hypothesis that contraception is associated with HAZ. The same pre-specified confounding variables were included in all models. The first set of models utilized independent variables related to contraceptive use: current contraceptive use (Model 1A); adding prior contraceptive use to Model 1A (Model 1B); adding duration of current contraceptive use to Model 1B (Model 1C), and adding proxy variables of contraception of birth interval and birth order to Model 1C (Model 1D).

Next, in order to test whether contraception was associated with the presence of stunting and severe stunting, we specified two multivariable Poisson regression models with the same independent variables as in the most specified model that did not include proxy variables of contraception (Model 1C); we made this decision based on our assumption that birth interval and birth order were assessing the same underlying concept as the independent variables of contraceptive use. Poisson rather than logistic regression was used in order to facilitate the interpretation of results as prevalence ratios rather than odds ratios.[32] The same pre-specified confounding variables were included in the Poisson models.

Finally, we carried out sensitivity analyses. First, we added maternal height as a continuous variable to the models with listwise deletion of records with missing data. A powerful predictor

of child growth both globally[33 34] and in Guatemala,[27 35] maternal height was excluded from the primary models due to the degree of missing data (8.0% records missing). Second, we re-specified the models to include proxy variables of family health care access including place of delivery, money and distance as a problem in accessing medical care, and number of antenatal visits (categorized into fewer than 4 visits, 4 or more visits, or missing data). We opted not to include these variables in the main models as we assumed they were measuring a similar underlying concept as access to contraception. Third, given widespread food insecurity in Guatemala[30] and the previously reported association between dietary indicators and growth,[36] we included minimum meal frequency (if a child receives meals the minimum number of times per day, adjusted for breastfeeding and age) and minimum dietary diversity (if a child consumes food from 4 or more food groups per day) as dichotomous variables based on WHO definitions and ran the models on applicable children ages 6-23 months (n=3,520).[37] In addition to main results reported in the manuscript, full regression results from all models and sensitivity analyses are includes as online Supplementary Files.

Ethics

The use of survey data for this study was approved by DHS. We followed STROBE guidelines in reporting our research.[38]

RESULTS

Sample characteristics and bivariate analyses

The characteristics of children included in the analyses are shown in Table 1 and bivariate relationships in Table 2. Child height data was available for 11,674 of the 12,440 records available in the DHS file (missing data of 6.2%). Among these children, the mean HAZ was -1.68 (SD 1.14), the prevalence of stunting was 39.1% (95% CI 37.4 to 40.8), and the prevalence of severe stunting was 12.1% (95% CI 11.0 to 13.4). Among the mothers of these children, the prevalence of current modern contraceptive use less than 15 months was 22.9% (95% CI 21.7 to 24.2) and greater than 15 months of 21.9% (95% CI 20.8 to 23.1). Among users of less than 15 months, the most common methods were short-acting hormonal injections (47.9%), sterilization (21.1%), and condoms (12.6%); among users of more than 15 months, the most common methods similarly were short-acting hormonal injections (42.6%), sterilization (38.3%), and condoms (5.5%). Among all users the overall prevalence of prior modern contraceptive use was 38.8% (95% CI 37.3 to 40.3). In the bivariate analysis, use of modern and traditional contraceptive types was generally associated with better HAZ and lower prevalence of stunting and severe stunting.

[Table 1]

[Table 2]

Multivariable regression with dependent variable of HAZ

Table 3 shows the results of the independent variables in multivariable linear regression Models 1A-1D. Full results of models are provided in the Supplementary File 1. Current and prior use of contraceptive methods were associated with statistically significant better HAZ (overall p-value <0.001 for these categorical variables in all models). When duration of current modern use was included (Model 1C), use for ≥15 months was associated with a 0.20 (95% CI 0.13 to 0.26, p<0.001) higher in HAZ, but modern use for <15 months was not statistically significant. The addition of variables of birth interval and birth order (Model 1D) did not significantly change the coefficient estimates for the contraceptive variables.

Multivariable regression with dependent variable of stunting and severe stunting

[Table 4]

Table 4 shows the results of the multivariable Poisson regression models assessing stunting and severe stunting. Full results of models are provided in the Supplementary File 1. The independent variables of current and prior use of contraception both were statistically significant for the outcomes of stunting and severe stunting (overall p-value <0.05). Compared with no contraceptive use, current use of a modern contraceptive method for ≥15 months was associated with a prevalence ratio of stunting of 0.87 (95% CI 0.81 to 0.94, p<0.001) and severe stunting of 0.61 (95% CI 0.50 to 0.73, p<0.001). Prior use of either traditional or modern contraceptive types also was associated with statistically significantly lower prevalence of stunting and severe stunting.

Sensitivity analyses

Selected regression output for the sensitivity analyses is included in Supplementary File 2. The results of the sensitivity analyses with maternal height and dietary covariates were similar to the main analysis. When variables relating to health care access were included, the same significant associations of HAZ with contraceptive use were observed in the linear models though the estimate sizes appeared smaller. In the Poisson models, inclusion of health care access variables made the associations between modern contraceptive use and stunting non-significant; the significant association between modern contraceptive use and severe stunting persisted.

DISCUSSION

This study was a secondary analysis of contraception and child growth using 2014-2015 Guatemala DHS data. In the multivariable linear regression models, contraceptive use and need were associated with statistically significant changes in child linear growth as measured by HAZ. In the multivariable Poisson regression models, contraceptive use was associated with statistically significant lower prevalence of stunting and severe stunting.

While the magnitude of the associations reported in this study is modest, these results should be viewed in the context of other strategies to improve child growth. A meta-analysis of evidence-based interventions for child nutrition reported the effect size of nutrition education in food-insecure populations of 0.25 HAZ and complementary food provision of 0.39 HAZ.[39] Trials of water, sanitation, and hygiene (WASH) interventions have not consistently found benefit.[40] A

review of context-specific nutrition programs found a median reduction in child stunting of 3% per year.[41] These sobering figures reiterate that stunting arises from a complex political, economic, and social context that can only be partially attenuated via technical intervention.[25]

This research is, to our knowledge, one of the few studies assessing direct measures of modern contraceptive use against child growth. As discussed in the introduction, other researchers have explored the relationship between family planning and child growth principally by focusing on pregnancy intention or indirect metrics of contraception like birth intervals, maternal age, and family size. Such measures have generally been found to be associated with child growth, often using underlying DHS data. [4 16-19] However, indirect measures are difficult to translate into policy decision, whereas contraceptive usage rates lend themselves best to discussion of improving investments and infrastructure for delivery. Here, our results demonstrating that direct measures of contraceptive use are associated with better child growth in Guatemala provide further concrete support for policy officials and global health workers of the spillover benefits of family planning.

Several findings that emerged from this work merit additional comment. First, an unexpected result was that use of traditional methods was generally associated with similar changes in child growth and stunting compared to use of modern methods. We caution that our study was not intended to test the ordering of contraceptive types on child growth, does not address contraceptive efficacy, and is subject to methodological issues. For example, self-reporting of traditional contraceptive use might reflect residual confounders such as maternal autonomy, which was not incorporated in this analysis but has been associated with stunting in other

settings.[42] In addition, we used DHS-aligned definitions of contraceptive type (modern or traditional), but the distinction between modern versus traditional methods has been debated.[43] We justify the definitions utilized in this study as appropriate given that it is the classification scheme currently recommended by DHS.

Second, the relationship between current modern contraceptive use and HAZ seemed to be "dose-dependent," as current use of modern methods for 15 or more months was associated with statistically significant improvements in child HAZ and stunting, while users of less than 15 months had no significant difference in child growth compared to those not using contraception.

Third, the association between contraception and child growth persisted even in the analysis (Model 1D) that controlled for birth number and antecedent birth intervals. Although we cannot exclude the possibility of residual confounding in our models, this may suggest that the impact of contraception on child growth may not be solely mediated through offspring number and timing. As discussed in the introduction, there are various potential causal mechanisms put forth by evolutionary anthropologists linking contraception to child growth; the most well-described pathway involves increased household resources directed to children in smaller families. As discussed below, future research using methods like structural equation modeling might help elucidate these pathways.

The strengths of this study include use of a recently released, representative DHS survey that permitted current population-level estimates of change in HAZ and stunting in Guatemala. Additionally, our prior ethnographic and programmatic experience in Guatemala assisted in

selection of a comprehensive set of covariates tailored to the setting. In response to critiques of DHS studies arising from the economics literature, we also carefully specified non-linear relationships between continuous covariates and HAZ.[44] A final study strength is our thorough sensitivity analyses. Most of our sensitivity analyses supported our primary findings, although inclusion of variables relating to access to and utilization of health services weakened the association between stunting and contraception use in the Poisson regression model.

This research has some additional limitations and weaknesses. First, this study used data from a single survey in Guatemala, which limits generalizability to other countries. At the same time, an advantage of using single-country data is that it allowed us to carefully select confounders of interest based on stunting risk factors in a single context. Second, use of secondary survey data does not permit us to infer causality and raises the possibility of residual confounding. Potential examples include dimensions of wealth not captured in asset-based indices,[45] maternal autonomy,[42] or paternal anthropometry.[46] Third, we are unsure of the accuracy of self-reported contraceptive data in large surveys in Guatemala. In our own ethnographic and programmatic experience, family planning can be a delicate topic in Guatemalan households.

Our study suggests multiple directions for future research on the relationship between contraception and child growth. Since our analysis was not intended to assess mechanism of impact of contraception on child growth, use of structural equation modeling with DHS data would permit could delineate pathways and mediators of this relationship. Multi-country studies would be useful to further evaluate the association between contraceptive need and child growth. Aggregating data across countries would also facilitate analysis of the association between child

growth and use of long-acting reversible contraceptives, which are increasingly emphasized in the global reproductive health literature. Given the difficulty in designing an ethically rigorous randomized trial examining the impact of a contraception intervention on child growth, alternative methodological and statistical approaches to infer causality would be helpful. Such strategies could also help better understand the dynamic process of contraceptive discontinuation and its impact on child growth.[47]

In conclusion, using secondary survey data in Guatemala, this study found an association between direct measures of contraception and better child growth outcomes that was modest in magnitude yet significant from a public health perspective. In addition to the human rights imperative to expand contraceptive access and choice, family planning merits further research and policy consideration as a strategy to improve child growth in Guatemala and similar countries with high prevalence of stunting.

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TABLES

Table 1: Survey-weighted characteristics of children in the sample

Characteristic	Number	Population estimate
Dependent variables		
HAZ, mean (SD)	11,674	-1.68 (1.14)
Stunted, % (95% CI)	11,674	39.1 (37.4 to 40.8)
Severely stunted, % (95% CI)	11,674	12.1 (11.0 to 13.4)
Independent variables		
Maternal current contraceptive use, % (95% CI)	12,440	
No use		44.3 (42.8 to 45.9)
Traditional method		10.9 (10.1 to 11.7)
Modern method, <15 months		22.9 (21.7 to 24.2)
Modern method, ≥15 months		21.9 (20.8 to 23.1)
Maternal prior contraceptive use, % (95% CI)	12,440	
No use		49.8 (48.3 to 51.4)
Traditional method		11.4 (10.5 to 12.4)
Modern method		38.8 (37.3 to 40.3)
Birth interval, % (95% CI)	12,440	
Less than 24 months		12.8 (12.0 to 13.6)
24 months or greater		55.3 (54.2 to 56.5)
No preceding interval		31.9 (30.9 to 33.0)
Birth order, median (IQR)	12,440	2 (1 to 4)
Confounding variables		
Child's age in months, median (IQR)	11,962	29 (14 to 44)
Mother age in years, median (IQR)	12,440	27 (23 to 32)
Wealth index, median (IQR)	12,440	-49,854 (-107,310 to 33,359)

Male sex, % (95% CI)	12,440	51.9 (50.9 to 52.9)
Rural area of residence, % (95% CI)	12,440	64.2 (62.2 to 66.2)
Maternal education, % (95% CI)	12,440	
None		18.9 (17.5 to 20.3)
Incomplete primary		35.2 (33.7 to 36.7)
Primary		17.3 (16.3 to 18.3)
Incomplete secondary		17.7 (16.6 to 18.9)
Complete secondary		7.4 (6.6 to 8.2)
Higher		3.6 (3.2 to 4.2)
Partner education, % (95% CI)	12,440	
No education		12.5 (11.5 to 13.7)
Incomplete primary		31.0 (29.7 to 32.4)
Primary		19.6 (18.6 to 20.7)
Incomplete secondary		19.3 (18.1 to 20.6)
Complete secondary		8.4 (7.7 to 9.2)
Higher		4.4 (3.9 to 5.0)
No partner or unknown		4.7 (4.2 to 5.2)
Maternal literacy, % (95% CI)	12,432	
Not literate		21.4 (19.8 to 23.0)
Semi-literate		12.9 (11.9 to 13.9)
Literate		65.8 (63.9 to 67.6)
Maternal marital status, % (95% CI)	12,440	
Never in union		4.5 (4.0 to 5.0)
Current partner		87.5 (86.7 to 88.3)
Former partner		8.0 (7.4 to 8.7)
Region of country, % (95% CI)	12,440	
Metropolitan Guatemala City		15.4 (13.8 to 17.2)

North		11.3 (10.0 to 12.8)
Northeast		9.1 (8.0 to 10.4)
Southeast		8.9 (8.0 to 9.9)
Central		10.7 (9.7 to 11.9)
Southwest		23.6 (22.2 to 25.1)
Northwest		16.9 (15.3 to 18.6)
Petén		4.0 (3.3 to 4.9)
Indigenous ethnicity, % (95% CI)	12,436	51.9 (49.4 to 54.4)
Mayan language spoken in home, % (95% CI)	12,440	30.5 (27.9 to 33.2)
Diarrhea last 2 weeks, % (95% CI)	12,038	19.2 (18.3 to 20.3)

CI, confidence interval; HAZ, height-for-age z-score; IQR, interquartile range; SD, standard deviation. “Population estimate” refers to calculations that account for survey weighting and sampling design, thus making the values nationally representative in Guatemala. Of note, estimates differ slightly from the DHS report, which uses the Household Member Recode in its calculations.

Table 2: Bivariate relationships between dependent and independent variables

	HAZ, mean (95% CI)	Stunted, % (95% CI)	Severely stunted, % (95% CI)
Current contraceptive use			
No use	-1.86 (-1.92 to -1.80)	45.1 (42.8 to 47.6)	16.3 (14.5 to 18.2)
Traditional method	-1.72 (-1.81 to -1.63)	40.5 (36.8 to 44.4)	12.1 (9.8 to 15.0)
Modern method, <15 months	-1.53 (-1.60 to -1.47)	33.4 (30.6 to 36.3)	9.1 (7.6 to 10.8)
Modern method, ≥15 months	-1.47 (-1.53 to -1.41)	32.5 (30.2 to 34.8)	7.2 (6.0 to 8.5)
Prior contraceptive use			
No use	-1.83 (-1.89 to -1.78)	44.5 (42.3 to 46.7)	15.4 (13.8 to 17.2)
Traditional method	-1.65 (-1.74 to -1.56)	36.7 (33.2 to 40.3)	9.9 (7.9 to 12.3)
Modern method	-1.50 (-1.55 to -1.45)	32.9 (30.8 to 35.0)	8.5 (7.3 to 9.8)
Birth interval			
Less than 24 months	-1.98 (-2.06 to -1.90)	49.7 (46.5 to 52.8)	18.8 (16.3 to 21.6)
24 months or greater	-1.74 (-1.79 to -1.69)	41.5 (39.6 to 43.5)	13.0 (11.6 to 14.5)
No preceding interval	-1.46 (-1.51 to -1.41)	30.5 (28.5 to,32.7)	7.9 (6.8 to 9.2)
Birth order*	-0.11 (-0.12 to -0.10)	1.20 (1.17 to 1.23)	1.18 (1.14 to 1.21)

* Birth order (continuous value) presented as bivariate regression coefficients and 95% CI. HAZ, height-for-age z-score; CI, confidence interval. Estimates account for sampling design.

Table 3: Coefficient estimates and 95% CI from linear regression models relating to contraceptive use and HAZ (n=11,501)

	Model 1A	Model 1B	Model 1C	Model 1D
Current contraceptive use	***	***	***	***
No use	(Reference)	(Reference)	(Reference)	(Reference)
Traditional	0.12** (0.04 to 0.20)	0.11** (0.03 to 0.19)	0.12** (0.04 to 0.19)	0.12** (0.04 to 0.19)
Modern, any duration	0.10*** (0.05 to 0.16)	0.10*** (0.05 to 0.16)	N/A	N/A
Modern, <15 months	N/A	N/A	0.02 (-0.05 to 0.08)	0.02 (-0.04 to 0.09)
Modern, ≥15 months	N/A	N/A	0.20*** (0.13 to 0.26)	0.21*** (0.15 to 0.28)
Prior contraceptive use		***	***	***
No use		(Reference)	(Reference)	(Reference)
Traditional		0.09* (0.02 to 0.17)	0.11** (0.03 to 0.18)	0.11** (0.04 to 0.19)
Modern		0.10*** (0.04 to 0.15)	0.11*** (0.06 to 0.17)	0.12*** (0.07 to 0.18)
Birth interval				***
No preceding interval				(Reference)
Less than 24 months				-0.18*** (-0.26 to -0.10)
24 months or greater				-0.11*** (-0.17 to -0.05)
Birth order				-0.04*** (-0.06 to -0.02)

CI, confidence interval; N/A, not applicable. * p<0.05, ** p<0.01, *** p<0.001. Asterisks not associated with estimates reflect the overall p-value of the variable. The same pre-specified confounding variables were included in all models: age of child, age of mother, wealth index, child sex, area of residence, maternal and partner education attainment, maternal literacy, maternal marital status, region of country, ethnic group, language, and presence of diarrhea in the last two weeks. Estimates account for sampling design.

Table 4: Prevalence ratios of stunting and severe stunting estimated from multivariable Poisson regression models using contraceptive use

	Prevalence ratio of stunting (95% CI)	Prevalence ratio of severe stunting (95% CI)
Current contraceptive use	*	***
No use	(Reference)	(Reference)
Traditional method	0.93 (0.86 to 1.02)	0.84 (0.69 to 1.03)
Modern method, <15 months	1.01 (0.94 to 1.10)	0.93 (0.79 to 1.09)
Modern method, ≥15 months	0.87*** (0.81 to 0.94)	0.61*** (0.50 to 0.73)
Prior contraceptive use	**	***
No use	(Reference)	(Reference)
Traditional method	0.89* (0.81 to 0.98)	0.71** (0.59 to 0.87)
Modern method	0.93* (0.87 to 0.98)	0.79** (0.69 to 0.92)

CI, confidence interval. * p<0.05, ** p<0.01, *** p<0.001. Asterisks not associated with estimates reflect the overall p-value of the variable. The same pre-specified confounding variables were included in all models: age of child, age of mother, wealth index, child sex, area of residence, maternal and partner education attainment, maternal literacy, maternal marital status, region of country, ethnic group, language, and presence of diarrhea in the last two weeks. Estimates account for sampling design.

Supplementary File 1: Full results of models

Model 1A:

HAZ	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Current method						
None or folkloric	0	(base)				
Traditional	.1211671	.0388904	3.12	0.002	.0448294	.1975049
Modern	.1044309	.0271529	3.85	0.000	.0511326	.1577291
Child sex						
Male	-.0155443	.0202571	-0.77	0.443	-.0553067	.0242182
Child age: Spline 1	-.106146	.0048012	-22.11	0.000	-.1155703	-.0967217
Child age: Spline 2	.4893727	.0276793	17.68	0.000	.4350412	.5437043
Child age: Spline 3	-1.274893	.0825057	-15.45	0.000	-1.436843	-1.112943
Child age: Spline 4	1.202289	.1042562	11.53	0.000	.9976451	1.406933
Mother age: Spline 1	.0017027	.0109052	0.16	0.876	-.0197031	.0231084
Mother age: Spline 2	.0085074	.0871711	0.10	0.922	-.1626001	.179615
Mother age: Spline 3	-.0656902	.3048907	-0.22	0.829	-.6641582	.5327777
Mother age: Spline 4	.1177456	.3492799	0.34	0.736	-.5678537	.8033449
Maternal education						
No education	0	(base)				
Incomplete primary	.0367643	.047059	0.78	0.435	-.0556075	.129136
Complete primary	.1440098	.0530075	2.72	0.007	.0399617	.2480579
Incomplete secondary	.1944541	.0568369	3.42	0.001	.0828893	.306019
Complete secondary	.1658597	.0664803	2.49	0.013	.0353661	.2963534
Higher	.0353242	.0909657	0.39	0.698	-.1432318	.2138802
Paternal education						
No education	0	(base)				
Incomplete primary	.0662492	.0407716	1.62	0.105	-.0137811	.1462796
Complete primary	.1606222	.0450818	3.56	0.000	.0721315	.249113
Incomplete secondary	.2186094	.048891	4.47	0.000	.1226417	.3145772
Complete secondary	.2883964	.0604127	4.77	0.000	.1698128	.4069801
Higher	.3721726	.0796786	4.67	0.000	.2157719	.5285733
Missing	.2141107	.2224335	0.96	0.336	-.2225024	.6507239
Wealth index: Spline 1	3.43e-06	1.35e-06	2.54	0.011	7.82e-07	6.07e-06
Wealth index: Spline 2	9.86e-06	.0000173	0.57	0.568	-.000024	.0000437
Wealth index: Spline 3	-.0000282	.0000404	-0.70	0.486	-.0001075	.0000511
Wealth index: Spline 4	.0000271	.0000326	0.83	0.406	-.0000368	.000091
Maternal Literacy						
Not literate	0	(base)				
Semi-literate	.1331506	.0494539	2.69	0.007	.0360778	.2302234
Literate	.0744441	.0479646	1.55	0.121	-.0197054	.1685936
Region						
metropolitana	0	(base)				
norte	.2640545	.0800842	3.30	0.001	.1068577	.4212512
nororiente	.0592136	.0661443	0.90	0.371	-.0706206	.1890479
suroriente	-.0541307	.0559854	-0.97	0.334	-.164024	.0557626
central	-.0962306	.0505558	-1.90	0.057	-.1954662	.0030049
suroccidente	-.1789787	.0446085	-4.01	0.000	-.2665404	-.0914171
noroccidente	-.2629405	.061064	-4.31	0.000	-.3828027	-.1430784
petÈn	.4091089	.0575714	7.11	0.000	.2961025	.5221154
Rural or urban						
urban	0	(base)				
rural	.046483	.0338391	1.37	0.170	-.0199396	.1129056
Ethnicity						
Indigenous	-.1902424	.0330231	-5.76	0.000	-.2550632	-.1254215

Marital status						
Never in union	0	(base)				
Current partner	-.0727036	.2283634	-0.32	0.750	-.5209565	.3755493
Formerly had partner	.0728528	.2230525	0.33	0.744	-.3649755	.5106811
Diarrhea						
Diarrhea last 2 weeks	.0617092	.0296525	2.08	0.038	.0035045	.1199139
language						
Indigenous language	-.2098944	.0467888	-4.49	0.000	-.3017359	-.1180529
_cons	-.7253478	.3697329	-1.96	0.050	-1.451094	.0003984

Model 1B:

HAZ	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Current method						
None or folkloric	0	(base)				
Traditional	.1103493	.0389104	2.84	0.005	.0339724	.1867262
Modern	.1015471	.027303	3.72	0.000	.0479541	.15514
Method prior						
None or folkloric	0	(base)				
Traditional	.0922166	.0389465	2.37	0.018	.0157689	.1686643
Modern	.0954721	.0268876	3.55	0.000	.0426946	.1482495
Child sex						
Male	-.0152405	.0201744	-0.76	0.450	-.0548407	.0243596
Child age: Spline 1	-.1054394	.0047732	-22.09	0.000	-.1148086	-.0960702
Child age: Spline 2	.4847697	.0275748	17.58	0.000	.4306433	.5388961
Child age: Spline 3	-1.261863	.0822797	-15.34	0.000	-1.423369	-1.100356
Child age: Spline 4	1.190734	.1041271	11.44	0.000	.9863437	1.395124
Mother age: Spline 1	-.0028259	.0109626	-0.26	0.797	-.0243443	.0186924
Mother age: Spline 2	.0188868	.0870796	0.22	0.828	-.1520412	.1898148
Mother age: Spline 3	-.0780209	.3045816	-0.26	0.798	-.6758821	.5198402
Mother age: Spline 4	.1117886	.3492652	0.32	0.749	-.5737819	.797359
Maternal education						
No education	0	(base)				
Incomplete primary	.0350125	.0470799	0.74	0.457	-.0574002	.1274252
Complete primary	.1415199	.0530149	2.67	0.008	.0374573	.2455825
Incomplete secondary	.191268	.0564561	3.39	0.001	.0804507	.3020853
Complete secondary	.1648404	.0668087	2.47	0.014	.0337021	.2959787
Higher	.036343	.0906348	0.40	0.689	-.1415635	.2142495
Paternal education						
No education	0	(base)				
Incomplete primary	.0644083	.0405075	1.59	0.112	-.0151037	.1439202
Complete primary	.1591843	.0449085	3.54	0.000	.0710337	.247335
Incomplete secondary	.2163043	.0485848	4.45	0.000	.1209374	.3116711
Complete secondary	.2892365	.0603871	4.79	0.000	.1707032	.4077699
Higher	.3740162	.0793104	4.72	0.000	.2183383	.5296941
Missing	.2272545	.2190948	1.04	0.300	-.2028052	.6573142
Wealth index: Spline 1	3.30e-06	1.34e-06	2.46	0.014	6.66e-07	5.93e-06
Wealth index: Spline 2	.0000103	.0000172	0.60	0.547	-.0000234	.000044
Wealth index: Spline 3	-.0000287	.0000402	-0.71	0.475	-.0001077	.0000503
Wealth index: Spline 4	.0000268	.0000325	0.82	0.410	-.000037	.0000905

Maternal Literacy						
Not literate	0	(base)				
Semi-literate	.1311569	.0496269	2.64	0.008	.0337447	.2285692
Literate	.0693309	.0477956	1.45	0.147	-.0244868	.1631485
Region						
metropolitana	0	(base)				
norte	.2525059	.0799788	3.16	0.002	.095516	.4094958
nororiente	.0525636	.0658498	0.80	0.425	-.0766925	.1818197
suroriente	-.0615479	.0560928	-1.10	0.273	-.171652	.0485563
central	-.1015673	.0505702	-2.01	0.045	-.2008312	-.0023035
suroccidente	-.1839533	.0447326	-4.11	0.000	-.2717586	-.096148
noroccidente	-.2680866	.0611569	-4.38	0.000	-.388131	-.1480422
petÈn	.3951212	.057324	6.89	0.000	.2826003	.507642
Rural or urban						
urban	0	(base)				
rural	.0509141	.0339828	1.50	0.134	-.0157904	.1176187
Ethnicity						
Indigenous	-.1821777	.0327233	-5.57	0.000	-.24641	-.1179453
Marital status						
Never in union	0	(base)				
Current partner	-.07856	.224884	-0.35	0.727	-.5199833	.3628632
Formerly had partner	.0686949	.2194465	0.31	0.754	-.3620551	.499445
Diarrhea						
Diarrhea last 2 weeks	.0596247	.0297158	2.01	0.045	.0012959	.1179536
language						
Indigenous language	-.2025057	.0464782	-4.36	0.000	-.2937375	-.1112739
_cons	-.6796019	.3684975	-1.84	0.066	-1.402923	.0437194

Model 1C

HAZ	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Current method duration						
None or folkloric	0	(base)				
Traditional	.1163098	.0387077	3.00	0.003	.0403308	.1922889
Modern, <15 months	.0179315	.0329476	0.54	0.586	-.0467412	.0826042
Modern, 15+ months	.1982897	.0322742	6.14	0.000	.1349389	.2616405
Method prior						
None or folkloric	0	(base)				
Traditional	.1074334	.0389791	2.76	0.006	.0309217	.1839452
Modern	.1134376	.0269662	4.21	0.000	.0605058	.1663695
Child sex						
Male	-.0150201	.020208	-0.74	0.458	-.0546862	.024646
Child age: Spline 1	-.1056312	.0047423	-22.27	0.000	-.1149399	-.0963225
Child age: Spline 2	.4712375	.0272155	17.32	0.000	.4178163	.5246587
Child age: Spline 3	-1.215065	.0813606	-14.93	0.000	-1.374767	-1.055362
Child age: Spline 4	1.131548	.1036733	10.91	0.000	.9280486	1.335048
Mother age: Spline 1	-.0024754	.0108667	-0.23	0.820	-.0238055	.0188547
Mother age: Spline 2	.0065996	.0865527	0.08	0.939	-.1632942	.1764933
Mother age: Spline 3	-.0380759	.3034389	-0.13	0.900	-.6336942	.5575424
Mother age: Spline 4	.0745868	.3486809	0.21	0.831	-.6098366	.7590102

Maternal education						
No education	0	(base)				
Incomplete primary	.0356453	.0472893	0.75	0.451	-.0571785	.1284691
Complete primary	.1432782	.0533829	2.68	0.007	.0384933	.2480631
Incomplete secondary	.1971216	.0565086	3.49	0.001	.0862013	.308042
Complete secondary	.1732884	.0673791	2.57	0.010	.0410304	.3055465
Higher	.0488132	.0903492	0.54	0.589	-.1285326	.226159
Paternal education						
No education	0	(base)				
Incomplete primary	.0635725	.0406598	1.56	0.118	-.0162384	.1433835
Complete primary	.1569125	.0449145	3.49	0.001	.0687502	.2450748
Incomplete secondary	.2140789	.0484619	4.42	0.000	.1189533	.3092045
Complete secondary	.2817726	.0600371	4.69	0.000	.1639262	.3996191
Higher	.370392	.0784557	4.72	0.000	.2163918	.5243922
Missing	.2366697	.2168101	1.09	0.275	-.1889054	.6622448
Wealth index: Spline 1	3.31e-06	1.34e-06	2.48	0.013	6.89e-07	5.93e-06
Wealth index: Spline 2	9.12e-06	.0000171	0.53	0.595	-.0000245	.0000428
Wealth index: Spline 3	-.0000255	.0000402	-0.64	0.525	-.0001043	.0000533
Wealth index: Spline 4	.0000238	.0000324	0.73	0.463	-.0000397	.0000873
Maternal Literacy						
Not literate	0	(base)				
Semi-literate	.1294599	.0498202	2.60	0.010	.0316682	.2272516
Literate	.0634793	.0478016	1.33	0.185	-.0303502	.1573087
Region						
metropolitana	0	(base)				
norte	.251501	.0804394	3.13	0.002	.093607	.409395
nororiente	.0512248	.0656366	0.78	0.435	-.0776128	.1800624
suroriente	-.0598625	.0560991	-1.07	0.286	-.1699791	.0502541
central	-.096976	.0506262	-1.92	0.056	-.1963498	.0023978
suroccidente	-.18133	.0447297	-4.05	0.000	-.2691297	-.0935304
noroccidente	-.2668419	.0611087	-4.37	0.000	-.3867919	-.146892
petÈn	.3888047	.0577036	6.74	0.000	.2755386	.5020707
Rural or urban						
urban	0	(base)				
rural	.0492273	.0341321	1.44	0.150	-.0177704	.116225
Ethnicity						
Indigenous	-.1805182	.0326311	-5.53	0.000	-.2445695	-.1164668
Marital status						
Never in union	0	(base)				
Current partner	-.0676426	.2227174	-0.30	0.761	-.5048132	.369528
Formerly had partner	.0813559	.2173025	0.37	0.708	-.3451858	.5078976
Diarrhea						
Diarrhea last 2 weeks	.0559771	.0298013	1.88	0.061	-.0025198	.1144739
language						
Indigenous language	-.2005675	.0461466	-4.35	0.000	-.2911483	-.1099867
_cons	-.6566571	.366243	-1.79	0.073	-1.375553	.0622388

Model 1D:

HAZ	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Current method duration						

None or folkloric	0	(base)				
Traditional	.1166987	.0389429	3.00	0.003	.0402579	.1931394
Modern, <15 months	.0225894	.0329246	0.69	0.493	-.0420381	.087217
Modern, 15+ months	.2136212	.0318983	6.70	0.000	.1510082	.2762341
Method prior						
None or folkloric	0	(base)				
Traditional	.1135981	.0383521	2.96	0.003	.0383171	.1888792
Modern	.1223868	.0268274	4.56	0.000	.0697276	.1750461
birth_order_number	-.0371225	.0091092	-4.08	0.000	-.0550029	-.019242
ant_birth_interval_cat						
<24 months	-.1795951	.0400326	-4.49	0.000	-.2581748	-.1010154
>= 24 months	-.1113712	.0314998	-3.54	0.000	-.1732019	-.0495404
No preceding birth	0	(base)				
Child sex						
Male	-.0175694	.0200552	-0.88	0.381	-.0569356	.0217968
Child age: Spline 1	-.1070204	.0047895	-22.34	0.000	-.1164217	-.0976191
Child age: Spline 2	.4723683	.0273577	17.27	0.000	.418668	.5260687
Child age: Spline 3	-1.217166	.0816164	-14.91	0.000	-1.37737	-1.056962
Child age: Spline 4	1.131767	.1035916	10.93	0.000	.9284278	1.335106
Mother age: Spline 1	.0133682	.011393	1.17	0.241	-.0089951	.0357315
Mother age: Spline 2	.0009846	.0869334	0.01	0.991	-.1696565	.1716257
Mother age: Spline 3	-.0465822	.3040882	-0.15	0.878	-.6434749	.5503105
Mother age: Spline 4	.1092713	.3495462	0.31	0.755	-.5768507	.7953933
Maternal education						
No education	0	(base)				
Incomplete primary	.0305441	.0469836	0.65	0.516	-.0616797	.1227679
Complete primary	.1238691	.0534981	2.32	0.021	.018858	.2288801
Incomplete secondary	.1638845	.0556268	2.95	0.003	.054695	.2730739
Complete secondary	.1173887	.0674048	1.74	0.082	-.0149198	.2496972
Higher	-.0307197	.0894726	-0.34	0.731	-.2063448	.1449054
Paternal education						
No education	0	(base)				
Incomplete primary	.0579351	.040595	1.43	0.154	-.0217486	.1376187
Complete primary	.1398775	.0448697	3.12	0.002	.051803	.2279519
Incomplete secondary	.1893224	.0483602	3.91	0.000	.0943964	.2842484
Complete secondary	.2550182	.0604863	4.22	0.000	.1362901	.3737464
Higher	.3408014	.078709	4.33	0.000	.1863039	.4952988
Missing	.2158817	.2185283	0.99	0.324	-.2130661	.6448295
Wealth index: Spline 1	3.29e-06	1.33e-06	2.47	0.014	6.75e-07	5.90e-06
Wealth index: Spline 2	7.05e-06	.0000171	0.41	0.680	-.0000265	.0000406
Wealth index: Spline 3	-.0000209	.00004	-0.52	0.600	-.0000994	.0000575
Wealth index: Spline 4	.0000208	.0000322	0.65	0.517	-.0000423	.000084
Maternal Literacy						
Not literate	0	(base)				
Semi-literate	.1168495	.0506464	2.31	0.021	.0174361	.2162629
Literate	.0476243	.0482118	0.99	0.324	-.0470104	.142259
Region						
metropolitana	0	(base)				
norte	.246735	.0809016	3.05	0.002	.0879338	.4055362
nororiente	.0564199	.0660488	0.85	0.393	-.0732269	.1860668
suroriente	-.0640409	.0558115	-1.15	0.252	-.1735929	.0455112
central	-.0971845	.0510282	-1.90	0.057	-.1973474	.0029784
suroccidente	-.1827254	.0448307	-4.08	0.000	-.2707233	-.0947275
noroccidente	-.2653872	.0620476	-4.28	0.000	-.3871799	-.1435944
petÈn	.3930161	.0578208	6.80	0.000	.2795201	.5065121

Rural or urban						
urban	0	(base)				
rural	.0482019	.0341772	1.41	0.159	-.0188843	.1152882
Ethnicity						
Indigenous	-.1769919	.0324946	-5.45	0.000	-.2407754	-.1132084
Marital status						
Never in union	0	(base)				
Current partner	-.0205614	.2252452	-0.09	0.927	-.4626937	.421571
Formerly had partner	.1149221	.2199739	0.52	0.602	-.3168632	.5467075
Diarrhea						
Diarrhea last 2 weeks	.0580342	.0298005	1.95	0.052	-.0004611	.1165295
language						
Indigenous language	-.2057576	.0458019	-4.49	0.000	-.2956618	-.1158534
_cons	-.8419261	.3705811	-2.27	0.023	-1.569337	-.1145148

Model 2A

Stunted	IRR	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Current method duration						
None or folkloric	1	(base)				
Traditional	.9328999	.041227	-1.57	0.116	.8553861	1.017438
Modern, <15 months	1.012191	.0415058	0.30	0.768	.9339118	1.097031
Modern, 15+ months	.8749756	.0330205	-3.54	0.000	.8125024	.9422523
Method prior						
None or folkloric	1	(base)				
Traditional	.8898078	.0427152	-2.43	0.015	.8097915	.9777306
Modern	.9226536	.0294662	-2.52	0.012	.8665902	.982344
Child sex						
Male	.9981576	.0240958	-0.08	0.939	.9519633	1.046593
Child age: Spline 1	1.147278	.0092394	17.06	0.000	1.129284	1.165558
Child age: Spline 2	.5583597	.0212496	-15.31	0.000	.5181689	.6016679
Child age: Spline 3	4.361083	.4574102	14.04	0.000	3.54963	5.358037
Child age: Spline 4	.266644	.0314163	-11.22	0.000	.2115887	.3360248
Mother age: Spline 1	1.01197	.0146406	0.82	0.411	.9836367	1.04112
Mother age: Spline 2	.9038194	.0956332	-0.96	0.339	.7343132	1.112454
Mother age: Spline 3	1.434583	.5097398	1.02	0.310	.7142041	2.881568
Mother age: Spline 4	.6696236	.260711	-1.03	0.303	.311838	1.437913
Maternal education						
No education	1	(base)				
Incomplete primary	.9245653	.0416069	-1.74	0.082	.8463985	1.009951
Complete primary	.7764337	.0488322	-4.02	0.000	.6862617	.8784539
Incomplete secondary	.7121522	.0549524	-4.40	0.000	.6120581	.8286153
Complete secondary	.797104	.0832392	-2.17	0.030	.6493721	.9784447
Higher	.6903204	.1268405	-2.02	0.044	.4813001	.9901146
Paternal education						
No education	1	(base)				
Incomplete primary	.9582091	.0297854	-1.37	0.170	.9014914	1.018495
Complete primary	.9131667	.0396738	-2.09	0.037	.8385194	.9944593
Incomplete secondary	.8197172	.0485059	-3.36	0.001	.7298268	.920679
Complete secondary	.6779779	.0616789	-4.27	0.000	.5671029	.8105302
Higher	.7128195	.1124964	-2.15	0.032	.5229294	.971664

Missing	1.063175	.2147334	0.30	0.762	.7151996	1.580454
Wealth index: Spline 1	.9999979	1.00e-06	-2.07	0.039	.999996	.9999999
Wealth index: Spline 2	.9999877	.0000164	-0.75	0.456	.9999555	1.00002
Wealth index: Spline 3	1.000023	.0000419	0.56	0.578	.999941	1.000106
Wealth index: Spline 4	.9999857	.0000395	-0.36	0.717	.999908	1.000063
Maternal Literacy						
Not literate	1	(base)				
Semi-literate	.9841694	.0475299	-0.33	0.741	.8951589	1.082031
Literate	1.050414	.0512834	1.01	0.314	.9544234	1.156059
Region						
metropolitana	1	(base)				
norte	.8942517	.096157	-1.04	0.299	.7240942	1.104395
nororiente	1.05239	.1080992	0.50	0.619	.8602258	1.287481
suroriente	1.169861	.1083458	1.69	0.091	.975401	1.40309
central	1.24418	.1093738	2.49	0.013	1.046993	1.478505
suroccidente	1.32017	.1135557	3.23	0.001	1.115074	1.56299
noroccidente	1.301392	.1221737	2.81	0.005	1.082377	1.564723
petÈn	.7645364	.0751074	-2.73	0.006	.6304518	.9271381
Rural or urban						
urban	1	(base)				
rural	.944827	.034907	-1.54	0.125	.8787338	1.015891
Ethnicity						
Indigenous	1.223458	.0499713	4.94	0.000	1.129198	1.325585
Marital status						
Never in union	1	(base)				
Current partner	1.414501	.3011366	1.63	0.104	.9313611	2.148269
Formerly had partner	1.284493	.2597571	1.24	0.216	.8636542	1.910397
Diarrhea						
Diarrhea last 2 weeks	.9816709	.032857	-0.55	0.581	.919249	1.048331
language						
Indigenous language	1.157584	.0512192	3.31	0.001	1.061288	1.262616
_cons	.0497515	.0196101	-7.61	0.000	.0229506	.1078495

Model 2B

Severe stunted	IRR	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Current method duration						
None or folkloric	1	(base)				
Traditional	.8392504	.0862571	-1.71	0.089	.6859231	1.026852
Modern, <15 months	.9309835	.0768322	-0.87	0.386	.7917518	1.0947
Modern, 15+ months	.6066651	.0581278	-5.22	0.000	.5026539	.7321987
Method prior						
None or folkloric	1	(base)				
Traditional	.7137948	.0706891	-3.40	0.001	.5876929	.8669544
Modern	.794928	.0575065	-3.17	0.002	.689697	.9162147
Child sex						
Male	1.005594	.0556635	0.10	0.920	.9020589	1.121012
Child age: Spline 1	1.270901	.0246087	12.38	0.000	1.223504	1.320135
Child age: Spline 2	.3714861	.0323475	-11.37	0.000	.3131213	.44073

Child age: Spline 3	11.79388	2.751101	10.58	0.000	7.461128	18.64272
Child age: Spline 4	.1167925	.0296469	-8.46	0.000	.0709611	.1922246
Mother age: Spline 1	.9839426	.0329506	-0.48	0.629	.921344	1.050794
Mother age: Spline 2	1.301007	.3119129	1.10	0.273	.8126458	2.08285
Mother age: Spline 3	.4106408	.3278755	-1.11	0.265	.0856655	1.968423
Mother age: Spline 4	2.389217	2.054046	1.01	0.311	.4419477	12.91636
Maternal education						
No education	1	(base)				
Incomplete primary	.9373759	.0797913	-0.76	0.448	.7931394	1.107843
Complete primary	.7122443	.0954174	-2.53	0.011	.5475521	.9264724
Incomplete secondary	.6133594	.101701	-2.95	0.003	.4429621	.8493047
Complete secondary	.5102681	.1337213	-2.57	0.010	.3050693	.8534899
Higher	.945368	.394662	-0.13	0.893	.4166	2.145272
Paternal education						
No education	1	(base)				
Incomplete primary	.9442337	.068	-0.80	0.426	.8197617	1.087605
Complete primary	.8342584	.0822415	-1.84	0.066	.6874854	1.012366
Incomplete secondary	.7443619	.1001206	-2.19	0.028	.571639	.9692736
Complete secondary	.8341412	.1647484	-0.92	0.359	.5660703	1.229161
Higher	.5584609	.2441698	-1.33	0.183	.2367418	1.317379
Missing	.8798822	.5991978	-0.19	0.851	.2311489	3.349325
Wealth index: Spline 1	.9999967	2.43e-06	-1.35	0.176	.999992	1.000001
Wealth index: Spline 2	.9999832	.0000372	-0.45	0.652	.9999102	1.000056
Wealth index: Spline 3	1.000015	.0000971	0.15	0.880	.9998241	1.000205
Wealth index: Spline 4	1.000019	.0000968	0.20	0.841	.9998294	1.000209
Maternal Literacy						
Not literate	1	(base)				
Semi-literate	.8336295	.085653	-1.77	0.077	.6813714	1.019911
Literate	.9618646	.0909112	-0.41	0.681	.7989909	1.15794
Region						
metropolitana	1	(base)				
norte	.9415956	.2559688	-0.22	0.825	.5522338	1.605483
nororiente	1.524393	.4104816	1.57	0.118	.8985592	2.586111
suroriente	1.780875	.4518732	2.27	0.023	1.082255	2.93047
central	1.515512	.3895433	1.62	0.106	.9150436	2.510019
suroccidente	1.857053	.4496952	2.56	0.011	1.154498	2.987138
noroccidente	1.873418	.4713894	2.49	0.013	1.143234	3.06997
petÈn	.5704913	.1689922	-1.89	0.058	.3189535	1.020401
Rural or urban						
urban	1	(base)				
rural	1.076438	.0987893	0.80	0.422	.8989876	1.288914
Ethnicity						
Indigenous	1.317971	.1274795	2.85	0.004	1.090062	1.593531
Marital status						
Never in union	1	(base)				
Current partner	1.183601	.851894	0.23	0.815	.2881636	4.861512
Formerly had partner	.8207678	.5900323	-0.27	0.784	.2001683	3.365467
Diarrhea						
Diarrhea last 2 weeks	1.013406	.0764558	0.18	0.860	.8739149	1.175163
language						
Indigenous language	1.228431	.1295886	1.95	0.051	.9986704	1.511051
_cons	.0068571	.0069515	-4.91	0.000	.0009374	.0501594

Supplementary File 2: Selected results of sensitivity analysis

SENSITIVITY ANALYSIS 1: INCLUSION OF MATERNAL HEIGHT

Model 1C:

haz	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Method current duration						
None or folkloric	0	(base)				
Traditional	.0828215	.0383321	2.16	0.031	.0075797	.1580634
Modern, <15 months	-.0099689	.0321823	-0.31	0.757	-.0731394	.0532015
Modern, 15+ months	.1628285	.0330641	4.92	0.000	.0979273	.2277298
Prior method						
None or folkloric	0	(base)				
Traditional	.0808978	.0386124	2.10	0.036	.0051059	.1566898
Modern	.0923037	.026018	3.55	0.000	.0412331	.1433743
Maternal height	.0591105	.0023173	25.51	0.000	.0545619	.0636592
Child sex						
male	-.0181955	.0203327	-0.89	0.371	-.0581063	.0217154
Child age: Spline 1	-.1030885	.0047464	-21.72	0.000	-.1124052	-.0937717
Child age: Spline 2	.4563764	.0267942	17.03	0.000	.4037821	.5089706
Child age: Spline 3	-1.176262	.0795339	-14.79	0.000	-1.332379	-1.020146
Child age: Spline 4	1.094194	.1012968	10.80	0.000	.8953594	1.293029
Mother age: Spline 1	-.0028331	.0107914	-0.26	0.793	-.0240154	.0183493
Mother age: Spline 2	-.0031073	.0860255	-0.04	0.971	-.1719662	.1657516
Mother age: Spline 3	.0308981	.3005511	0.10	0.918	-.5590517	.6208479
Mother age: Spline 4	-.0534912	.3436003	-0.16	0.876	-.7279419	.6209595
Maternal education						
No education	0	(base)				
Incomplete primary	.0535684	.0441148	1.21	0.225	-.0330244	.1401611
Complete primary	.1220872	.0523067	2.33	0.020	.0194148	.2247597
Incomplete secondary	.1343054	.0552716	2.43	0.015	.0258131	.2427977
Complete secondary	.1243386	.067072	1.85	0.064	-.0073167	.2559938
Higher	-.0020645	.090059	-0.02	0.982	-.1788406	.1747117
Paternal education						
No education	0	(base)				
Incomplete primary	.0426493	.0388873	1.10	0.273	-.0336823	.1189809
Complete primary	.1261663	.0428735	2.94	0.003	.0420102	.2103224
Incomplete secondary	.1396516	.0457162	3.05	0.002	.0499154	.2293877
Complete secondary	.186344	.0588145	3.17	0.002	.0708974	.3017906
Higher	.2905144	.07469	3.89	0.000	.1439059	.4371229
Missing	.1928098	.2556019	0.75	0.451	-.3089094	.6945291
Wealth index: Spline 1	3.19e-06	1.28e-06	2.50	0.013	6.81e-07	5.70e-06
Wealth index: Spline 2	-2.88e-06	.0000162	-0.18	0.859	-.0000346	.0000289
Wealth index: Spline 3	5.97e-06	.0000378	0.16	0.874	-.0000681	.0000801
Wealth index: Spline 4	-6.04e-06	.0000304	-0.20	0.843	-.0000658	.0000537
Maternal literacy						
Not literate	0	(base)				
Semi-literate	.0555965	.0480634	1.16	0.248	-.0387468	.1499399
Literate	-.0055979	.0458467	-0.12	0.903	-.0955901	.0843944
Region						
metropolitana	0	(base)				
norte	.1536683	.0683883	2.25	0.025	.0194294	.2879073
nororiente	.0012608	.0593786	0.02	0.983	-.115293	.1178146
suroriente	-.1415546	.052056	-2.72	0.007	-.243735	-.0393741

central	-.0805888	.0476305	-1.69	0.091	-.1740825	.0129049
suroccidente	-.1524722	.0430143	-3.54	0.000	-.2369048	-.0680397
noroccidente	-.2637109	.0565273	-4.67	0.000	-.3746679	-.1527538
petÈn	.261967	.0525765	4.98	0.000	.1587649	.3651691
Rural or urban						
urban	0	(base)				
rural	.0276319	.0304003	0.91	0.364	-.0320405	.0873044
Ethnicity						
Indigenous	-.0802691	.0308467	-2.60	0.009	-.1408178	-.0197204
Marital status						
Never in union	0	(base)				
Current partner	-.0447689	.256917	-0.17	0.862	-.5490696	.4595319
Formerly had partner	.0743129	.2540367	0.29	0.770	-.424334	.5729598
diarrhea						
Diarrhea last 2 weeks	.0441847	.028702	1.54	0.124	-.0121544	.1005237
Language						
Indigenous language	-.1483903	.0423154	-3.51	0.000	-.2314509	-.0653298
_cons	-9.272564	.525307	-17.65	0.000	-10.30369	-8.241443

Model 2A:

haz_sev_stunted	IRR	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Method current duration						
None or folkloric	1	(base)				
Traditional	.847348	.0913044	-1.54	0.125	.6858121	1.046932
Modern, <15 months	.8755858	.0733789	-1.59	0.113	.7427741	1.032145
Modern, 15+ months	.6016019	.0594584	-5.14	0.000	.4955144	.7304023
Prior method						
None or folkloric	1	(base)				
Traditional	.7499991	.0795429	-2.71	0.007	.6090454	.9235743
Modern	.8174482	.060223	-2.74	0.006	.7073866	.9446342
Maternal height	.917066	.0052369	-15.16	0.000	.9068438	.9274034
Child sex						
male	1.029091	.061708	0.48	0.633	.9148212	1.157634
Child age: Spline 1	1.273988	.0256308	12.04	0.000	1.224658	1.325305
Child age: Spline 2	.3706372	.0339715	-10.83	0.000	.3096091	.4436948
Child age: Spline 3	11.78008	2.914875	9.97	0.000	7.247881	19.14631
Child age: Spline 4	.1183067	.0323553	-7.80	0.000	.0691622	.2023715
Mother age: Spline 1	.9809999	.0344006	-0.55	0.585	.9157468	1.050903
Mother age: Spline 2	1.332721	.3331131	1.15	0.251	.8159507	2.176781
Mother age: Spline 3	.3793163	.3161591	-1.16	0.245	.0738698	1.947763
Mother age: Spline 4	2.582762	2.326212	1.05	0.292	.4408473	15.13145
Maternal education						
No education	1	(base)				
Incomplete primary	.9087908	.0866642	-1.00	0.316	.7536509	1.095866
Complete primary	.7142723	.1035881	-2.32	0.021	.5373199	.9494995
Incomplete secondary	.6679059	.1168679	-2.31	0.021	.4737534	.9416256
Complete secondary	.5842808	.154255	-2.04	0.042	.3479857	.9810291
Higher	.9858746	.4278208	-0.03	0.974	.4206203	2.310751

Paternal education						
No education	1	(base)				
Incomplete primary	.9723348	.0725437	-0.38	0.707	.839875	1.125685
Complete primary	.9165204	.0947696	-0.84	0.399	.748161	1.122766
Incomplete secondary	.8091604	.1129314	-1.52	0.130	.6152592	1.06417
Complete secondary	.936959	.191337	-0.32	0.750	.6275327	1.398958
Higher	.6079404	.2760464	-1.10	0.273	.249333	1.482321
Missing	1.058006	.5500403	0.11	0.914	.3813297	2.935456
Wealth index: Spline 1	.9999974	2.45e-06	-1.04	0.297	.9999926	1.000002
Wealth index: Spline 2	.999996	.0000374	-0.11	0.915	.9999226	1.000069
Wealth index: Spline 3	.9999758	.0000975	-0.25	0.804	.9997844	1.000167
Wealth index: Spline 4	1.000063	.0000973	0.65	0.519	.9998718	1.000254
Maternal literacy						
Not literate	1	(base)				
Semi-literate	.9205011	.1023287	-0.75	0.456	.7400447	1.144961
Literate	1.060289	.1160898	0.53	0.593	.8552399	1.3145
Region						
metropolitana	1	(base)				
norte	1.003565	.2525018	0.01	0.989	.6124335	1.644493
nororiente	1.447222	.3632849	1.47	0.141	.8841893	2.368782
suroriente	1.635587	.3854981	2.09	0.037	1.029795	2.597746
central	1.249691	.3003985	0.93	0.354	.7796259	2.003174
suroccidente	1.562954	.3466153	2.01	0.044	1.011331	2.415454
noroccidente	1.64692	.3814011	2.15	0.032	1.045329	2.59473
petÈn	.5683658	.1635465	-1.96	0.050	.3230946	.99983
Rural or urban						
urban	1	(base)				
rural	1.092721	.0911866	1.06	0.288	.9276225	1.287205
Ethnicity						
Indigenous	1.254387	.1209521	2.35	0.019	1.038086	1.515758
Marital status						
Never in union	1	(base)				
Current partner	1.428884	.8119557	0.63	0.530	.4683641	4.359238
Formerly had partner	.9576589	.5410263	-0.08	0.939	.3159429	2.902773
diarrhea						
Diarrhea last 2 weeks	1.033534	.0809129	0.42	0.674	.8863123	1.205211
Language						
Indigenous language	1.062018	.1125	0.57	0.570	.862639	1.307479
_cons	1927.347	2445.22	5.96	0.000	159.7454	23253.66

SENSITIVITY ANALYSIS 2: INCLUSION OF HEALTH CARE ACCESS VARIABLES

Model 1C:

haz	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Method current duration						
None or folkloric	0	(base)				

Traditional	.0725817	.0382755	1.90	0.058	-.0025491 .1477125
Modern, <15 months	.0190927	.032698	0.58	0.559	-.0450901 .0832755
Modern, 15+ months	.1008337	.0327849	3.08	0.002	.0364804 .165187
Prior method					
None or folkloric	0	(base)			
Traditional	.1152733	.0371883	3.10	0.002	.0422767 .1882698
Modern	.0989718	.0268963	3.68	0.000	.0461771 .1517664
Place of delivery					
respondent's home	0	(base)			
other home	.068746	.0629048	1.09	0.275	-.0547295 .1922214
government hospital	.2481459	.0336807	7.37	0.000	.1820342 .3142575
second level (health centers, mate..)	.1732056	.0418517	4.14	0.000	.0910552 .255356
first level (health post, converge..)	.3562333	.2634611	1.35	0.177	-.1609129 .8733794
other public sector	1.459564	.0828591	17.62	0.000	1.29692 1.622208
private hospital/clinic	.3970499	.0588869	6.74	0.000	.2814612 .5126387
doctor's office	.140329	.3723062	0.38	0.706	-.5904684 .8711264
family protection association (apr..)	.7317799	.1252055	5.84	0.000	.4860148 .9775451
social security (igss)	.3283781	.0595729	5.51	0.000	.2114429 .4453133
other	.1096082	.1269328	0.86	0.388	-.1395474 .3587639
Antenatal visits					
<4 antenatal visiits	0	(base)			
4+ antenatal visits	.037495	.0341487	1.10	0.273	-.0295352 .1045253
Missing data	-.22444	.0392897	-5.71	0.000	-.3015614 -.1473185
Distance problem health					
no problem	0	(base)			
big problem	-.0088258	.0287711	-0.31	0.759	-.0653005 .0476489
Money problem health					
no problem	0	(base)			
big problem	-.0335589	.0281148	-1.19	0.233	-.0887452 .0216274
Child sex					
male	-.0257067	.0200563	-1.28	0.200	-.065075 .0136616
Child age: Spline 1	-.1042883	.0047175	-22.11	0.000	-.1135482 -.0950283
Child age: Spline 2	.486759	.0269165	18.08	0.000	.4339248 .5395932
Child age: Spline 3	-1.256639	.0801067	-15.69	0.000	-1.41388 -1.099398
Child age: Spline 4	1.166348	.1016581	11.47	0.000	.9668041 1.365892

Mother age: Spline 1	.0019125	.0108567	0.18	0.860	-.019398	.0232231
Mother age: Spline 2	-.0224618	.0847035	-0.27	0.791	-.1887258	.1438022
Mother age: Spline 3	.0398879	.2963025	0.13	0.893	-.5417223	.6214981
Mother age: Spline 4	.0071627	.3412394	0.02	0.983	-.6626539	.6769792
Maternal education						
No education	0	(base)				
Incomplete primary	.0488759	.0463821	1.05	0.292	-.0421671	.139919
Complete primary	.1588457	.0527452	3.01	0.003	.0553126	.2623788
Incomplete secondary	.1883882	.0554991	3.39	0.001	.0794494	.297327
Complete secondary	.1462645	.0662169	2.21	0.027	.0162877	.2762413
Higher	.027146	.0887089	0.31	0.760	-.14698	.2012721
Paternal education						
No education	0	(base)				
Incomplete primary	.0481782	.0404576	1.19	0.234	-.0312358	.1275922
Complete primary	.129144	.0435088	2.97	0.003	.0437408	.2145471
Incomplete secondary	.1699761	.048209	3.53	0.000	.0753469	.2646053
Complete secondary	.2264776	.0594698	3.81	0.000	.1097448	.3432104
Higher	.2946884	.0784935	3.75	0.000	.140614	.4487628
Missing	.199421	.2238784	0.89	0.373	-.2400284	.6388703
Wealth index: Spline 1	2.54e-06	1.29e-06	1.97	0.050	2.94e-09	5.07e-06
Wealth index: Spline 2	8.90e-06	.0000165	0.54	0.588	-.0000234	.0000412
Wealth index: Spline 3	-.0000238	.0000386	-0.62	0.538	-.0000996	.0000521
Wealth index: Spline 4	.0000212	.0000314	0.68	0.499	-.0000404	.0000829
Maternal literacy						
Not literate	0	(base)				
Semi-literate	.107135	.0493893	2.17	0.030	.010189	.204081
Literate	.0213437	.0467924	0.46	0.648	-.0705048	.1131922
Region						
metropolitana	0	(base)				
norte	.2036165	.0795694	2.56	0.011	.0474302	.3598027
nororiente	.0574702	.0633673	0.91	0.365	-.066913	.1818534
suroriente	-.0750771	.0550973	-1.36	0.173	-.1832271	.033073
central	-.1015134	.0512412	-1.98	0.048	-.2020943	-.0009324
suroccidente	-.1759579	.0449696	-3.91	0.000	-.2642286	-.0876873
noroccidente	-.2467906	.0592465	-4.17	0.000	-.3630853	

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-.130496
                                petÈn |   .370497   .0589341     6.29   0.000     .
2548157    .4861783
                                      |
                     Rural or urban   |
                               urban |          0  (base)
                               rural |   .0608038   .0326108     1.86   0.063    -.
0032077    .1248152
                                      |
                           Ethnicity  |
                           Indigenous |  -.149591    .032084    -4.66   0.000    -.2125684
-.0866136
                                      |
                      Marital status  |
                       Never in union |          0  (base)
                      Current partner |  -.0293857    .229826    -0.13   0.898    -.
4805096    .4217382
                    Formerly had partner |   .0765962    .225326     0.34   0.734    -.
3656947     .518887
                                      |
                             Diarrhea |
                    Diarrhea last 2 weeks |   .0536243   .0295232     1.82   0.070    -.
0043265    .1115752
                                      |
                            Language  |
                   Indigenous language |  -.1596944   .0452356    -3.53   0.000    -.2484871
-.0709018
                                      |
                                _cons |  -.9697053   .3672133    -2.64   0.008    -1.690506
-.2489047
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Model 2A:

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------------------------------------------------------------------------------
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                                      |               Linearized
                         haz_stunted  |        IRR   Std. Err.       t    P>|t|     [95%
Conf. Interval]
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+----------------------------------------------------------------
                     Method current duration |
                          None or folkloric  |          1  (base)
                                Traditional  |   .9736735   .0433095    -0.60   0.549     .8922671
1.062507
                        Modern, <15 months   |   1.020183    .041465     0.49   0.623     .9419539
1.104909
                        Modern, 15+ months   |   .9691469   .0389473    -0.78   0.436     .8956351
1.048692
                                             |
                              Prior method   |
                          None or folkloric  |          1  (base)
                                Traditional  |   .8874898   .0415205    -2.55   0.011     .
8096197    .9728496
                                     Modern  |   .9446191   .0304602    -1.77   0.078     .8866819
1.006342
                                             |
                           Place of delivery |
                         respondent's home   |          1  (base)
                                other home   |   .935322   .0654678    -0.96   0.340     .8152527
1.073075
                       government hospital   |   .8092617   .0273822    -6.25   0.000     .
7572593    .8648351
second level (health centers, mate..)       |   .8899902   .0476118    -2.18   0.030     .
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8012728    .9885304
first level (health post, converge..)  |   .9960216   .3459124    -0.01   0.991     .5037438
1.969372
                other public sector  |   5.49e-06   5.59e-06   -11.90   0.000
7.45e-07    .0000405
          private hospital/clinic  |    .645203   .0723079    -3.91   0.000     .
5177972    .8039576
                doctor's office  |   1.621294   .7549979     1.04   0.300     .6499576
4.044254
family protection association (apr..)  |   .3501999    .125604    -2.93   0.004     .
1732067    .7080557
           social security (igss)  |   .6572189   .0701198    -3.93   0.000      .
533038    .8103301
                         other  |   .9140263   .1605213    -0.51   0.609     .6475111
1.290239
                                |
                Antenatal visits |
              <4 antenatal visiits  |          1  (base)
               4+ antenatal visits  |   .9101499    .034101    -2.51   0.012     .
8456154    .9796094
                   Missing data  |    1.12977   .0490516     2.81   0.005     1.037475
1.230275
                                |
            Distance problem health |
                      no problem  |          1  (base)
                      big problem  |   .9943968   .0309518    -0.18   0.857     .9354605
1.057046
                                |
               Money problem health |
                      no problem  |          1  (base)
                      big problem  |    1.02647    .034594     0.78   0.438     .9607626
1.09667
                                |
                         Child sex |
                             male  |   1.011284   .0240865     0.47   0.638     .9650926
1.059685
                                |
                Child age: Spline 1  |   1.145524   .0091958    16.92   0.000     1.127615
1.163718
                Child age: Spline 2  |   .5508882   .0209425   -15.68   0.000     .
5112766    .5935689
                Child age: Spline 3  |   4.519798   .4729857    14.41   0.000     3.680525
5.550451
                Child age: Spline 4  |   .2596322   .0304667   -11.49   0.000     .
2062169    .3268833
                Mother age: Spline 1  |   1.008775   .0147986     0.60   0.552     .9801409
1.038245
                Mother age: Spline 2  |    .925124   .0992332    -0.73   0.468     .7494791
1.141932
                Mother age: Spline 3  |   1.339683   .4818316     0.81   0.416     .6613034
2.713961
                Mother age: Spline 4  |   .7177368   .2823167    -0.84   0.399     .3316276
1.553387
                                |
                  Maternal education |
                       No education  |          1  (base)
                  Incomplete primary  |   .9189638   .0407664    -1.91   0.057     .8423286
1.002571
                    Complete primary  |   .7696611   .0477883    -4.22   0.000     .
6813486    .8694202
                 Incomplete secondary  |   .7269131   .0563186    -4.12   0.000     .
6243612    .8463093
                  Complete secondary  |    .824937   .0847815    -1.87   0.061     .6742319
1.009328
                             Higher  |   .7291965    .135635    -1.70   0.090      .50615
1.050533
```

Paternal education					
No education	1	(base)			
Incomplete primary	.967624	.0301925	-1.05	0.292	.9101377 1.028741
Complete primary	.9316916	.0390207	-1.69	0.092	.858162 1.011521
Incomplete secondary	.8535782	.0494047	-2.74	0.006	.761908 .9562779
Complete secondary	.7165442	.0653463	-3.65	0.000	.5991015 .8570093
Higher	.7784518	.1224135	-1.59	0.112	.571713 1.05995
Missing	1.047753	.2206321	0.22	0.825	.6930233 1.584053
Wealth index: Spline 1	.9999984	9.87e-07	-1.58	0.115	.9999965 1
Wealth index: Spline 2	.9999886	.0000161	-0.71	0.478	.9999571 1.00002
Wealth index: Spline 3	1.000021	.0000411	0.51	0.611	.9999402 1.000102
Wealth index: Spline 4	.9999887	.000039	-0.29	0.772	.9999121 1.000065
Maternal literacy					
Not literate	1	(base)			
Semi-literate	.999049	.0467439	-0.02	0.984	.911383 1.095148
Literate	1.086007	.0519898	1.72	0.085	.9886051 1.193006
Region					
metropolitana	1	(base)			
norte	.9152934	.1002066	-0.81	0.419	.7382972 1.134722
nororiente	1.020258	.1044201	0.20	0.845	.8345683 1.247262
suroriente	1.165443	.1091232	1.64	0.102	.9697773 1.400587
central	1.233659	.11076	2.34	0.020	1.034329 1.471403
suroccidente	1.292893	.1135373	2.93	0.004	1.088181 1.536115
noroccidente	1.26257	.1198525	2.46	0.014	1.047931 1.521173
petÈn	.7669317	.0764422	-2.66	0.008	.6306498 .9326637
Rural or urban					
urban	1	(base)			
rural	.934225	.0335915	-1.89	0.059	.8705616 1.002544
Ethnicity					
Indigenous	1.18551	.0488264	4.13	0.000	1.093441 1.285331
Marital status					
Never in union	1	(base)			
Current partner	1.296881	.2866138	1.18	0.240	.8404295 2.001238
Formerly had partner	1.231397	.2608077	0.98	0.326	.8125421 1.866167
Diarrhea					

Diarrhea last 2 weeks	.9867626	.0334428	-0.39	0.694	.9232538 1.05464
Language					
Indigenous language	1.122292	.0484577	2.67	0.008	1.031094 1.221557
_cons	.0718451	.0285113	-6.64	0.000	. 0329684 .1565657

SENSITIVITY ANALYSIS 3: INCLUSION OF FEEDING INDICATORS

Model 1C:

haz	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Method current duration						
None or folkloric	0	(base)				
Traditional	.1880863	.0643656	2.92	0.004	.0617335	.3144392
Modern, <15 months	.1366338	.048101	2.84	0.005	.0422091	.2310584
Modern, 15+ months	.2434807	.066285	3.67	0.000	.1133598	.3736015
Method prior						
None or folkloric	0	(base)				
Traditional	.0703693	.0582608	1.21	0.227	-.0439996	.1847382
Modern	.0885428	.0387279	2.29	0.023	.0125181	.1645675
Diet frequency						
0	0	(base)				
1	-.0668101	.0472393	-1.41	0.158	-.1595432	.0259229
Diet diversity						
0	0	(base)				
1	.0779764	.040871	1.91	0.057	-.0022554	.1582082
Child sex						
male	-.1354291	.0353817	-3.83	0.000	-.2048851	-.0659731
Child age: Spline 1	-.088294	.0147444	-5.99	0.000	-.117238	-.05935
Child age: Spline 2	.2479096	.128152	1.93	0.053	-.0036591	.4994784
Child age: Spline 3	.3304688	1.672652	0.20	0.843	-2.953031	3.613968
Child age: Spline 4	0	(omitted)				
Mother age: Spline 1	.0040045	.0172142	0.23	0.816	-.0297877	.0377968
Mother age: Spline 2	.0151235	.138368	0.11	0.913	-.2564997	.2867467
Mother age: Spline 3	-.1805745	.4840328	-0.37	0.709	-1.130755	.7696059
Mother age: Spline 4	.3379249	.564284	0.60	0.549	-.7697926	1.445643
Maternal education						
No education	0	(base)				
Incomplete primary	-.0041856	.0786636	-0.05	0.958	-.1586062	.1502349
Complete primary	.110394	.0932532	1.18	0.237	-.0726667	.2934547
Incomplete secondary	.1384189	.1018207	1.36	0.174	-.0614602	.3382979
Complete secondary	.1469192	.1092599	1.34	0.179	-.0675634	.3614018
Higher	.0710917	.1653868	0.43	0.667	-.2535708	.3957542
Paternal education						
No education	0	(base)				
Incomplete primary	-.0255779	.0623578	-0.41	0.682	-.1479892	.0968335
Complete primary	.031635	.0685071	0.46	0.644	-.1028478	.1661179

Incomplete secondary	.0639965	.0745999	0.86	0.391	-.0824468	.2104399
Complete secondary	.0916259	.0933234	0.98	0.327	-.0915725	.2748243
Higher	.208465	.1518507	1.37	0.170	-.0896255	.5065554
Missing	1.435638	.9525824	1.51	0.132	-.4343286	3.305604
Wealth index: Spline 1	4.46e-06	2.10e-06	2.12	0.034	3.28e-07	8.59e-06
Wealth index: Spline 2	-.0000144	.0000266	-0.54	0.590	-.0000666	.0000379
Wealth index: Spline 3	.0000247	.0000625	0.40	0.692	-.0000979	.0001474
Wealth index: Spline 4	-7.00e-06	.0000505	-0.14	0.890	-.0001062	.0000922
Maternal literacy						
Not literate	0	(base)				
Semi-literate	.0604922	.0839243	0.72	0.471	-.1042555	.2252398
Literate	.0535773	.08147	0.66	0.511	-.1063524	.213507
Region						
metropolitana	0	(base)				
norte	.3005916	.1128077	2.66	0.008	.0791445	.5220387
nororiente	.1807732	.0852208	2.12	0.034	.0134805	.3480659
suroriente	.0498577	.0898449	0.55	0.579	-.1265123	.2262277
central	-.096746	.0821803	-1.18	0.239	-.25807	.0645781
suroccidente	-.1433444	.0753869	-1.90	0.058	-.2913326	.0046438
noroccidente	-.2780176	.0921514	-3.02	0.003	-.4589154	-.0971199
petÈn	.4479386	.1041991	4.30	0.000	.2433905	.6524866
Rural or urban						
urban	0	(base)				
rural	.1446199	.048833	2.96	0.003	.0487583	.2404816
Ethnicity						
Indigenous	-.1376972	.0482618	-2.85	0.004	-.2324374	-.042957
Marital status						
Never in union	0	(base)				
Current partner	1.12376	.9571631	1.17	0.241	-.7551986	3.002719
Formerly had partner	1.256197	.9543959	1.32	0.188	-.6173295	3.129724
Diarrhea						
Diarrhea last 2 weeks	.0721225	.0441852	1.63	0.103	-.0146151	.1588602
Language						
Indigenous language	-.1802509	.0611046	-2.95	0.003	-.3002023	-.0602996
_cons	-1.815738	1.078544	-1.68	0.093	-3.932973	.3014976

Model 2A:

haz_stunted	IRR	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
Method current duration						
None or folkloric	1	(base)				
Traditional	.8788432	.0653663	-1.74	0.083	.7594538	1.017001
Modern, <15 months	.9167734	.0522975	-1.52	0.128	.8196503	1.025405
Modern, 15+ months	.8664282	.0690317	-1.80	0.072	.7409814	1.013113
Method prior						
None or folkloric	1	(base)				
Traditional	.8646904	.0717855	-1.75	0.080	.7346555	1.017742
Modern	.9895231	.0499375	-0.21	0.835	.8961926	1.092573
Diet frequency						
0	1	(base)				

1	1.022899	.0551032	0.42	0.674	.9202519	1.136996
Diet diversity						
0	1	(base)				
1	.9208599	.0415069	-1.83	0.068	.8428805	1.006054
Child sex						
male	1.140052	.0485236	3.08	0.002	1.048668	1.239398
Child age: Spline 1	1.114475	.0237148	5.09	0.000	1.068881	1.162015
Child age: Spline 2	.64956	.1046418	-2.68	0.008	.4734541	.8911702
Child age: Spline 3	6.559257	12.08427	1.02	0.308	.1762778	244.0684
Child age: Spline 4	1	(omitted)				
Mother age: Spline 1	1.031112	.0213616	1.48	0.140	.9900198	1.073911
Mother age: Spline 2	.7373484	.1196865	-1.88	0.061	.5361521	1.014046
Mother age: Spline 3	2.929473	1.662338	1.89	0.059	.9616394	8.924149
Mother age: Spline 4	.3191586	.2098133	-1.74	0.083	.0878112	1.160014
Maternal education						
No education	1	(base)				
Incomplete primary	1.027713	.0778599	0.36	0.718	.8856923	1.192506
Complete primary	.9114823	.0855711	-0.99	0.324	.7580721	1.095938
Incomplete secondary	.8045485	.0968907	-1.81	0.071	.635158	1.019114
Complete secondary	.7545891	.1204316	-1.76	0.078	.5516274	1.032227
Higher	.704365	.2037452	-1.21	0.226	.3992004	1.24281
Paternal education						
No education	1	(base)				
Incomplete primary	.9667114	.0574509	-0.57	0.569	.8602624	1.086332
Complete primary	.9411576	.0661749	-0.86	0.389	.8198195	1.080454
Incomplete secondary	.880693	.0719756	-1.55	0.120	.7501527	1.03395
Complete secondary	.8743804	.1071246	-1.10	0.274	.6874663	1.112114
Higher	.8291396	.1980682	-0.78	0.433	.5187631	1.325215
Missing	.6870408	.3758151	-0.69	0.493	.2347673	2.010608
Wealth index: Spline 1	.9999974	1.67e-06	-1.57	0.117	.9999941	1.000001
Wealth index: Spline 2	.9999977	.000026	-0.09	0.931	.9999467	1.000049
Wealth index: Spline 3	1.000009	.0000666	0.13	0.896	.999878	1.000139
Wealth index: Spline 4	.9999857	.000063	-0.23	0.820	.999862	1.000109
Maternal literacy						
Not literate	1	(base)				
Semi-literate	.9973228	.0843055	-0.03	0.975	.844829	1.177342
Literate	1.024735	.0816006	0.31	0.759	.8764414	1.19812
Region						
metropolitana	1	(base)				
norte	.8166099	.1263305	-1.31	0.191	.6027337	1.106379
nororiente	.9398082	.1331987	-0.44	0.661	.7115554	1.24128
suroriente	1.087546	.1477269	0.62	0.537	.8329952	1.419883
central	1.265704	.1567134	1.90	0.057	.9926005	1.613949
suroccidente	1.324226	.1628081	2.28	0.023	1.040269	1.685693
noroccidente	1.286635	.1790628	1.81	0.071	.9790526	1.690849
petÈn	.6743899	.1205663	-2.20	0.028	.4747829	.957915
Rural or urban						
urban	1	(base)				
rural	.8930934	.0487958	-2.07	0.039	.8022628	.9942076
Ethnicity						
Indigenous	1.180856	.07445	2.64	0.009	1.043389	1.336434
Marital status						
Never in union	1	(base)				
Current partner	.9039778	.5057601	-0.18	0.857	.3014222	2.711067
Formerly had partner	.8441088	.4662847	-0.31	0.759	.2854009	2.496557

Diarrhea						
Diarrhea last 2 weeks	.9602702	.0448894	-0.87	0.386	.8760723	1.05256
Language						
Indigenous language	1.190726	.0768103	2.71	0.007	1.0491	1.351472
_cons	.0642134	.0500596	-3.52	0.000	.0138995	.296655

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	See title
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4	See abstract text
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7	The introductory text describes the scientific background and builds the study rationale
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 7	"Within this background, we hypothesize that maternal contraception is associated with better child linear growth and less stunting in Guatemala."
Methods				
Study design	4	Present key elements of study design early in the paper	Page 7	See text under "Study design and sample"
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 7	See text under "Study design and sample"
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 7	"…we conducted a secondary analysis of survey data from the 2014-2015 Demographic and Health Survey (DHS). Details on survey design can be found in the DHS report.23 We used the Children's Recode file, which comprises 12,440 children ages 0-59 months."
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and		

		unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9	In the text on these pages, we extensively define and discuss all variables.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7	This study is a secondary analysis of DHS data, so we cite the DHS report which has further details on survey collection and data processing
Bias	9	Describe any efforts to address potential sources of bias	8-9	We imply that we protected against bias by using pre-specified confounding variables, and we state that we do not correct for multiple hypothesis testing.
Study size	10	Explain how the study size was arrived at	7	We state we that we use the nationally representative sample of children available in the original DHS survey.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10	We extensively discuss our quantitative dependent variable (HAZ) and confounding variables.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-10	See text under "statistical analysis"
		(*b*) Describe any methods used to examine subgroups and interactions	N/A	Subgroup analysis was not performed
		(*c*) Explain how missing data were addressed	9	Eight percent of children were excluded due to missing data when fitting these models.
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	10	See extensive discussion of sensitivity analyses
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13	In the Results section beginning on page 11, we specify the number of records available for each variable. We also discuss on page 9 how missing records were handled in the regression analyses.
		(b) Give reasons for non-participation at each stage	N/A	Given use of secondary survey data, this is not applicable
		(c) Consider use of a flow diagram	N/A	Given use of secondary survey data, we chose not to use a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-13	See section under "Sample characteristics and bivariate analyses"
		(b) Indicate number of participants with missing data for each variable of interest	11-13	See table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		

		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	11-13	See Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14	See Table 2 (unadjusted bivariate associations) before the final adjusted multivariable models are reported in Tables 3-5
		(*b*) Report category boundaries when continuous variables were categorized	11-13	We report category boundaries in Table 1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	16-18	As discussed in the methods, we opted to use Poisson models to calculate prevalence ratio. Overall descriptive statistics for dependent variables are reported in Tables 1 and 2

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	18	See this page for sensitivity analyses results
Discussion				
Key results	18	Summarise key results with reference to study objectives	19	Initial paragraph of discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21-22	We discuss some of the definitional limitations as well as study weaknesses/limitations
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	20-22	We give a cautious interpretation of these results and attempt to locate this study within the broader literature in Guatemala and globally
Generalisability	21	Discuss the generalisability (external validity) of the study results	21-22	We discuss that a weakness of this study is lack of generalizability outside of Guatemala, though this study might motivate others to assess growth and contraception in other countries.
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	29	We report funding.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.