Adolescent contraceptive use and its effects on early marriage and fertility

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Abstract

Background: Adolescent reproductive health and avoidance of child marriage are internationally agreed development goals. However, unmarried adolescents, especially sexually active, are not included in standard indicators.

Objective: We attempt to quantify the effects of adolescent contraceptive use on marriage and fertility by providing different scenarios for contraceptive prevalence.

Methods: We use Linear Mixed Models with country-specific random effects to estimate changes in adolescent marriage and fertility from 120 DHS surveys for 34 developing countries.

Results: We estimate 10% of an increase in contraceptive prevalence for unmarried adolescents would lead to a 3.6% reduction in the probability of early marriage. Regarding fertility, increasing contraceptive prevalence has already resulted in a 9.1% reduction in the adolescent birth rate for exposed women in Latin America and a 3.1% reduction in Sub-Saharan Africa. Meeting the total demand for contraceptives would lead to a decrease in fertility of 8.9% and 17.4% for both Regions, respectively. These estimates would further increase to 11.3% and 22.6% of reduction for both Regions if we include the indirect effect through the reduction of marriage.

Conclusions: Large reductions both in adolescent marriage and fertility would be derived from merely reducing unmet need for contraception of sexually active unmarried adolescents, with significant health consequences and improved well-being for this and the next generation.

Contribution: We provide evidence to demonstrate meeting the contraceptive needs and priorities of unmarried adolescents should become a priority for health systems given the large impact estimated.

1. Introduction

Total demand and contraceptive use are key measures of access to Sexual and Reproductive Health and Rights (SRHR). Universal access to Sexual and Reproductive Health (SRH) by 2030 corresponds to targets 3.7 and 5.6 of the United Nations Sustainable Development Goals (SDGs), and was also recognized in target 5.B of the Millennium Development Goals (MDGs) (UN 2015). Expansion of contraceptive use in poorest countries is also the goal of the Family Planning 2020 global partnership (Family Planning 2020 2015). Despite the mention of universal access, monitoring of these aims has focused only on women married or in-union (UN 2016; UNFPA 2010). As a result, groups with special needs, such as sexually active unmarried women and, in particular, adolescents, are left out of sight.

Based on available global data on the contraceptive use of adolescents we evaluate the specific effects of the contraceptive use of sexually active unmarried adolescents on unintended pregnancy and age at marriage. An increasing age at marriage could be the most critical factor in postponing adolescent childbearing (ICRW 2014; UN 2013). It is known that unmarried adolescents have a larger unmet need for contraceptives than married women of their same age (Blanc et al. 2009) since many of them do not make use of contraceptive methods (Greene and Merrick 2015) due to lack of access (Chandra-Mouli et al. 2014), even with the consequences of unintended conceptions being more serious for them, including, among others, unintended childbearing, unsafe abortion, maternal and child mortality, reduced earning potential and lower educational achievements for the present and the next generation (Greene and Merrick 2015; Hindin et al. 2016; Santhya and Jejeebhoy 2015; UN 2013). In this respect, changing the contraceptive behavior seems more achievable than changing sexual behavior in adolescents (ICRW 2014).

Not leaving adolescents behind is explicit in the Global Strategy for Women's, Children's and Adolescents' Health of the Every Woman Every Child global movement (Every Woman Every Child 2015), and it is in line with other SDGs on achieving gender equality and empowering all women and girls, such as target 5.3 on ending child marriage (UN 2015). At present time, about sixteen million young women between ages from 15 to 19 give birth every year, and three million undergo unsafe abortions, making pregnancy and childbirth the leading cause of death for adolescent girls (Advocates for Youth 2013). Approximately 11% of global births occur to adolescent women, 95% of them in developing countries (Vogel et al. 2015; WHO 2011a).

Indeed, meeting contraceptive needs is essential to allow individuals to control the moment and circumstances of having a child. Unplanned pregnancies out of marriage are more likely to end in abortion (WHO 2010). Unintended childbearing may result in leaving school and early marriage (Galati 2015). Early marriage, commonly referred as girl child marriage, is a gender-based health and human rights violation affecting women and girls globally (UNICEF 2005). Also, early marriage reinforces gender inequality (Raj and Boehmer 2013) and goes hand in hand with girls' exclusion from the decision on when and whom to marry (Banerji et al. 2008; WHO 2011a). Due to the higher health risks of adolescent pregnancies, it is estimated that a 10% reduction in child marriage could contribute to a 70% decrease in a country's maternal mortality rates and a 3% decrease in infant mortality rates (Every Woman Every Child 2015; Raj and Boehmer 2013).

The 2012 London Summit on Family Planning stated the need of bringing modern contraceptive methods to women and girls. Furthermore, it recognized the importance of family planning as a powerful path to change the world (Family Planning 2020 2015), in addition to lower health costs and other social benefits (Greene and Merrick 2015; Chandra-Mouli et al. 2014).

Despite of this apparent consensus, very few studies focus on adolescent contraceptive use, and even fewer on unmarried sexually active adolescents. Most of these studies do not quantify the consequences of adolescent contraceptive use. While this is partly due to the scarcity of data, this is no excuse in a context where SRH continues to elude many. Our goal is to assess contraceptive use and demand for both married and unmarried adolescents in developing countries and to quantify the effects of satisfying the demand for adolescent marriage and childbearing allowing to make decisions on SRH policy well informed.

2. Data and methods

This research analyzes the behavior of adolescent women, both married or in-union and unmarried, using data from 120 Demographic and Health Surveys (DHS) for 34 developing countries[1] belonging to Latin America and the Caribbean (LAC) and Sub-Saharan Africa (SSA). The selection was based on countries with complete data and with at least 2 data points to analyze changes over time. Figure 1 displays the composition of our sample. The data has been obtained through STATcompiler (The DHS Program 2015).

Exploratory data analysis provides estimates of contraceptive use and total demand for married or in-union and unmarried adolescents separately. Total demand for contraceptives is the sum of contraceptive prevalence and unmet need for contraception.

[1] Countries included are Benin, Bolivia, Brazil, Burkina Faso, Cameroon, Colombia, Congo, Congo D.R., Cote d'Ivoire, Dominican Republic, Ethiopia, Gabon, Ghana, Guinea, Haiti, Honduras, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Nicaragua, Nigeria, Peru, Rwanda, Sierra Leone, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

The goal of this paper, as stated above, is to explore the different effects of adolescent contraceptive use on marriage and fertility. First, the effect of contraceptive use by unmarried adolescents on delaying marriage; and, second, the consequences of contraceptive use on the general age-specific fertility rate for women from age 15 to 19[2], also known as adolescent birth rate (ABR). Given the unbalanced panel structure of our data, we use Linear Mixed Models (LMM) with country-specific random effects for each of our variables of interest (Galecki and Burzykowski 2013; Pinheiro et al. 2015). Each observation could be written as:

$$y_{it} = \beta' X_{it} + \epsilon_i + \delta_{it}$$

Where y_{it} is the variable of interest, β the vector of coefficients, X_{it} the vector of regressors, ϵ_i the country-specific random-effect and δ_{it} the observation-specific error term. The linear model estimate that does not take the unbalanced panel structure into account provides inconsistent variance estimates to the extent that the variance of the random-effects is different from 0. We have tested such restriction in all cases based on the exact LR test (Scheipl et al. 2008) with p-values very close to zero indicating the need to use LMM estimation.

For LMM estimation to be consistent, it is necessary that the random-effects are not correlated with the regressors. This will not always be the case: in our specific examples, for instance, we find a correlation between the random fertility effects and the contraceptive prevalence: beyond the possible causal effect of higher contraceptive prevalence on fertility, contraceptive prevalence provides a signal of whether this is a high or low fertility country. There are reasons why this could occur, among others the fact that unmet need for contraception is connected to cultural and/or structural factors in the country. To estimate consistently in the presence of such correlation, there are many solutions including fixed-effects estimation or the inclusion of the country-specific means of the regressors as additional covariates in an extended mixed-effects LMM model (Snijders and Berkhof 2008). We adopt the latter

[2] Computed for the last three years before the survey.

approach, generally called within-between or Mundlak's specification (Bell and Jones 2015; Dieleman and Templin 2014). It is appropriate given our focus on inference about the β coefficients. It is possible to test for correlation between the regressors and the random-effects with a Hausman-type test corresponding to the LR test of the general model containing the means versus the null model corresponding to regular LMM estimation. We report the results of both models in all cases. When the null of no correlation is rejected, the only consistent estimate of the causal effects is given by the extended LMM model. When the null is not rejected at the 5% level, both estimates are consistent, and our preferred model is the regular LMM model. The preferred model in all model tables is indicated by bold face, with the p-value mentioned in the text.

Based on the preferred model and to interpret the results regarding their policy significance, simulations of the effect on fertility and marriage rates of contraceptive prevalence are provided in the following scenarios:

- What would have been the levels of fertility and marriage if contraceptive prevalence had remained at the levels of the first available survey? This indicates the effects of increasing levels of contraceptive prevalence in the sample.
- What would have been the levels of fertility and marriage if total demand for contraceptives had been satisfied? Since adolescents in developing countries and, in particular, those unmarried, face high levels of unmet need, this simulation provides an idea of the potential impact of meeting total demand.

Data manipulation, estimation, and manuscript edition are carried out in R (R Core Team 2017)[3].

[3] `broom` (Robinson 2017) and `tidyverse` (Grolemund and Wickham 2017; Wickham 2017) for manipulation; `nlme` for estimation (Pinheiro et al. 2017); `knitr` (Xie 2014, 2015, 2016) and `texreg` (Leifeld 2013) for the edition.

3. Results

Panel (a) of Figure 2 displays the contraceptive prevalence of both sexually active unmarried and married or in-union adolescent women at the latest DHS survey. In most countries, contraceptive prevalence is higher for unmarried women, implying the importance of bringing contraceptive methods to them and for being able to decide when to begin childbearing and when to get married.

Panel (b) highlights even larger differences in total demand for contraceptives. While levels of demand for married adolescents varies widely among countries, total demand for unmarried adolescents is high almost everywhere, with an average of 84.7% and 80% for LAC and SSA countries, respectively. As a result, levels of unmet need for contraception are higher for sexually active unmarried adolescents, implying specific problems of access to SRHR for them. Thus, contraceptive prevalence for unmarried adolescents in LAC countries is 60.3% on average while in SSA countries it is around 38.6%. Moreover, unmet need for unmarried adolescents is 24.4% and 41.4% on average for both regions, respectively.

3.1 Contraceptive Prevalence and Early Marriage

Early marriage is a complex phenomenon occurring all over the world, especially in developing countries. Within the determinants for early marriage it is possible to include customs and traditions, gender roles in a patriarchal society, control over sexuality, developing an alliance between families, molding the behavior of the child girl, anxiety about suitable matches, mass marriages, and pressure of society and relatives, among others (Bell Bajao 2013). However, many paths appear as an opportunity to prevent early marriage, or at least to delay marriage, for example, school retention for both primary and secondary levels, sexual education, improvement of access to contraceptives, and censoring of coerced sex and contract marriages (WHO 2011b).

Based on these determinants and the actions stated to prevent early marriage we propose a model to estimate the probability of early marriage. We include the contraceptive prevalence of unmarried adolescent women because we want to prove that improvements in access to contraceptives are a solution to early marriage, regarding control over adolescent women sexuality determines child marriage. Furthermore, contraceptive use is also a proof of sexual education and could avoid a forced molding of adolescent sexual behavior. Also, we assume that a higher proportion of sexually active young women could lead to marriage due to unintended pregnancy because society and families could wield pressure over them, despite the increasing rates of childbearing outside a marriage context. Moreover, we include the proportion of adolescents already married at 15 years of age to control cultural effects as well as mass marriages or any event that ended in a child marriage. Finally, the intention of only including unmarried adolescent women is to estimate the effect of contraceptive use on the probability of changing their marital status towards marriage. Subsequently, the proposed model to estimate the probability of early marriage is given by:

$$log(MP)_{it} = \beta_0 + \beta_1 CPU_{it} + \beta_2 log(SAU)_{it} + \beta_3 M15_{it} + \epsilon_i + \delta_{it}$$

Where,

- MP_{it}: Probability of first marriage from age 15 to current age for women currently aged 15 to 19. This probability has been obtained from the percentage of adolescent women ever married (M_{it}) and the percentage of adolescent women married by age 15 ($M15_{it}$) as: $MP_{it} = \frac{M_{it} - M15_{it}}{100 - M15_{it}}$.
- CPU_{it}: Proportion of current use of any contraceptive method by sexually active unmarried adolescent women. A negative coefficient is expected.
- SAU_{it}: Proportion of sexually active among unmarried adolescent women. A higher proportion of sexually active adolescent women is supposed to lead to a higher nuptiality

due to unintended childbearing.

- $M15_{it}$: Percentage of adolescent women already married by the age 15. Since we are already controlling for marriage before age 15 in the computation of the dependent variable, a positive coefficient might signal culture/marriage-market effects and social interactions: women are more likely to marry early when their group of reference marries earlier.

For this model, four LMM estimations are provided (see Table 1). The Hausman-type test applied to estimations LMM 1.1a, and LMM 1.1b presents a p-value of 0.279, meaning the preferred estimation is the regular LMM. The same case occurs when the Hausman-type test is applied to LMM 1.2a and LMM 1.2b, where the p-value is 0.414. In any case, regular LMM estimation should be preferable. Also, LMM 1.1a includes $M15_{it}$ as independent variable while LMM 1.2a does not. LMM 1.1a should be preferable for the estimation of the effect of contraceptive use since the use of contraceptives by adolescents might be associated with the likelihood of marrying before 15.

All coefficients have their expected signs in LMM 1.1a, and there is a statistically significant negative effect of contraceptive use on the odds of getting married. According to model LMM 1.1a, 10% of an increase in contraceptive prevalence lead, on average, to a 3.6 percentage points reduction in the probability of marriage, for a given level of sexual activity.

As seen, SAU_{it} is not statistically significant and changes sign from models LMM 1.1a to LMM 1.2a, with the expected sign in LMM 1.1a. This would indicate that female adolescents do not necessarily associate sexual intercourse with marriage. The positive and significant effect of $M15_{it}$ suggest both cultural components related to marriage and marriage market effects.

3.2 Contraceptive Prevalence and Adolescent Birth Rate

Changes in the proximate determinants of fertility, such as marriage and contraceptive prevalence, should provoke direct changes on fertility. The classic proximate determinants of fertility framework capture this in the equation $ASFR = C_m \times C_c \times C_a \times C_i \times AF$, linking, for a given age-group, potential fecundity AF to the actual age-specific fertility rates $ASFR$ through a set of reduction factors connected to marriage, C_m; contraception, C_c; abortion, C_a; and postpartum infecundability, C_i (Bongaarts 1978; Bongaarts and Potter 1983). Stover (1998) criticizes this classic model suggesting using sexual activity rather than marriage to indicate exposure, a point incorporated by Boongarts (2015). While this recognizes that not only married women contribute to fertility, it is yet simplistic for our purposes since it treats all sexually active women alike when there are differences in the proximate determinants between married and unmarried sexually active adolescents as highlighted in Figure 2. For this reason, we want to work with both groups separately.

The separation in fertility of married and unmarried women is in line with the Princeton model of fertility (Coale and Watkins 1986). This project produces joint estimates of fertility, I_f, from a weighted average of married and unmarried fertility, I_g and I_h, using weights based on the proportion married, I_m, but with no particular regard to contraceptive use: $I_f = I_g \times I_m + I_h \times (1 - I_m)$.

Since our purpose is to determine the effects on fertility of contraceptive prevalence for married and unmarried women separately, we need a combination of the proximate determinants and the Princeton approach. First, we distinguish adolescent women according to exposure to sexual activity. The proportion of women not exposed due to lack of sexual activity (NEX) corresponds to unmarried women without sexual activity in the last year. We, therefore, assume that all married or in-union adolescents are sexually active. Women exposed are further classified into four groups according to marital status and contraceptive use, each of which is expected to have its fertility rate according to their proximate determinants. We define the proportion of women exposed in each category as:

- MU = Proportion of ever married or in-union adolescent women currently using any contraceptive method among those exposed: $MU = \frac{M \cdot CPM}{1-NEX}$ with CPM being the proportion of married or in-union women using any contraceptive method.

- MN = Proportion of ever married or in-union adolescent women currently not using any contraceptive method among those exposed: $MN = \frac{M \cdot (1-CPM)}{1-NEX}$.

- UN = Proportion of sexually active unmarried adolescent women currently not using any contraceptive method among those exposed: $UN = \frac{(1-M) \cdot (1-CPU) \cdot SAU}{1-NEX}$.

- UU = Proportion of sexually active unmarried adolescent women currently using any contraceptive method among those exposed: $UU = \frac{(1-M) \cdot CPU \cdot SAU}{1-NEX}$.

By definition, these four proportions add up to 1. To avoid multicollinearity, in our analysis we use the fertility of married women not using contraception as the reference category. The coefficients for the rest of proportions indicate to what extent fertility is lower when the proportions in the other categories increase. In the model proposed, we expect all coefficients to be negative, regardless the country-specific averages:

$$ABRE_{it} = \beta_0 + \beta_1 MU_{it} + \beta_2 UN_{it} + \beta_3 UU_{it} + \epsilon_i + \delta_{it}$$

Where,

- $ABRE_{it}$: Adolescent birth rate among adolescent women exposed as $ABRE_{it} = \frac{ABR_{it}}{1-NEX_{it}}$

The result of the p-value in the Hausman-type test between LMM 2.1 and LMM 2.2 is 3e-04, thus, only LMM 2.1 is consistent thanks to the inclusion of country-specific means (see Table 2). It is worth noticing the change of sign of MU_{it} among LMM 2.1 and LMM 2.2, with the expected sign in LMM 2.1 when bias is corrected. This change of sign is in line with the explanation given above: the country-specific random effect is correlated with MU_{it} since countries where the proportion married is high at adolescence are countries that have higher fertility, irrespective of the causal mechanism of the preventive effect of contraceptive use. For this reason, it is important to test for endogeneity and adopt a solution such as using LMM 2.1.

All coefficients have their expected signs in LMM 2.1 indicating that fertility is higher when the reference category, the proportion married not using, is greater. The reduction connected to the use of contraception in marriage is smaller than those related to the proportions of sexually active unmarried indicating that the latter have a lower risk of childbearing. The marginal effect of using versus not using is also more important for sexually active unmarried adolescent women: while a switch from not using to using means for married adolescents a change of the fertility rate from 0 (the reference category) to -60.6. In the case of unmarried women, the change goes from -256 to -490.5, being 3.9 times more intense. A possible explanation is that women already married in adolescence would expect to have children soon.

3.3 Model fit and Simulation analysis

To better evaluate the meaning of the previous results, we present the model fit together with simulations that highlight the role adolescent contraceptive use has had on the reduction of adolescent marriage and fertility, and its potential role if the current unmet need is satisfied.

Figure 3 shows the model fit and the simulations for the marriage model. Regarding fit, there are many countries where the model reproduces observed trends, like Cameroon, Colombia or Uganda, with some others, like Brazil, Ethiopia or Guinea where the model fits more poorly. The simulation highlights the importance of contraceptive trends in reducing early marriage. `SimCP` shows that, for most countries, the proportion married at adolescence would have been higher if prevalence had remained at the levels of the first survey given increasing prevalence. In some countries like Bolivia or Namibia, increasing prevalence accounts for the reduction in the prevalence of early marriage. In others, like Colombia, in the absence of increasing contraception, early marriage would have increased. For LAC countries, if contraceptive prevalence had remained at its initial levels, early marriage in the rest of surveys would have been 9.1% higher, on average. In SSA countries, meanwhile, early marriage would have been 3.1% higher. The greater effect for LAC countries is due to the faster-observed increase in prevalence levels. Regarding the potential contribution of meeting demand, `SimTD` shows that for most countries early marriage would have been much lower if the demand for contraceptives had been achieved. This is mainly observed in countries with high levels of unmet need such as Haiti, Lesotho, Malawi, Mali or Zimbabwe. On average, for SSA countries, if unmarried adolescents could meet their total demand, early marriage would decline by 14.1%. In LAC countries, the decline would be 11.2%, on average. In this case, the potential effect is higher in SSA due to higher levels of unmet need.

Model fit and simulations for $ABRE$ are presented in Figure 4. The first most salient aspect is that model fit is quite right: the model can reproduce trends in adolescent fertility in most countries. Exceptions include Congo D.R., Madagascar, Malawi, Rwanda, Togo or Zambia. The `SimCP` simulation by keeping constant, at their first value, contraceptive prevalence for unmarried adolescents, highlights to what extent fertility declines are due to increasing prevalence. In some countries like Namibia, most of the decline is due to higher contraceptive prevalence. In others, like Bolivia, Brazil, Colombia, Ghana or Peru it makes a substantial contribution, instead of countries with low contraceptive prevalence for unmarried adolescents, where it has made little impact to the observed decline. The average impact as a percent of observed levels in surveys after the first is 6.8% for LAC countries and 4.1% for SSA countries. Again, the average contribution is higher in LAC where prevalence has increased faster. The `SimTD` simulation highlight the potential role of meeting the demand for unmarried adolescents. In this particular case, in addition to the regular `SimTD` simulation, `SimTD+M` adds the possible contribution of delaying marriage, as estimated in Table 1, to the direct effect of meeting the demand and shifting adolescents from the UN to the UU category in

Table 2. Meeting total demand would have a sizable effect on adolescent fertility in almost every country. Fertility would decline by 8.9% and 17.4% for LAC and SSA respectively. If we add the indirect effect through marriage, the average percent decline increases to 11.3% in LAC and 22.6% in SSA.

At this point, we have dealt only with the effect of meeting the demand of unmarried adolescents: this has, in general, a bigger impact than meeting the demand of married adolescents because the fertility reduction connected to using is larger in Table 2, Moreover, the levels of unmet need and total demand are higher for them since many married adolescents expect to have children. The contribution of meeting the total demand for married adolescents would be an additional 3.5% reduction in LAC and 2.9% reduction in SSA.

4. Discussion

International agreements targets on SRHR are emphasizing "universal access". However, adolescents, and in particular those unmarried sexually active, are left out of sight. This is unfortunate since the lack of access is particularly intense for them: the vast majority of unmarried sexually active adolescents have a demand for family planning, which is larger than that for married adolescents. Their levels of unmet need are also higher. Our analysis shows that increasing levels of contraceptive use by sexually active unmarried adolescents explain the reductions observed in the prevalence of child marriage and adolescent fertility in many countries. Also, satisfying their demand for family planning has a double effect: first, it reduces the likelihood of getting married, which is a concern given the negative implications of child marriage and the right about freely deciding when and whom to marry. Second, it reduces adolescent fertility both of unmarried adolescents and of married adolescents through the reduction in marriage. This leads to lower risks of maternal and child mortality, unintended pregnancy, unsafe abortion, and the negative consequences of early childbearing including educational dropout, lower incomes or, in general, a reduction of well-being for this and the next generation. These effects are sizable: an 11.3% in LAC and 22.6% in SSA. Strengthening health systems to meet the needs and priorities of unmarried adolescents should, therefore, be a priority.

A second concern regards data availability. While DHS fill a significant data gap, there are still many countries that do not report on demand for contraceptives, sexual activity and other SRH dimensions for unmarried adolescents, and STATcompiler does not provide information about adolescent fertility by marital status. This is particularly unfortunate since our research highlights that looking at unmarried adolescents is essential from an SRHR perspective.

Regarding the limitations of our study, we have not explicitly addressed the effectiveness of contraceptive methods used by adolescents. Using more efficient methods, combined with condom use for the prevention of sexually transmitted diseases would imply a public health impact beyond the current estimates.

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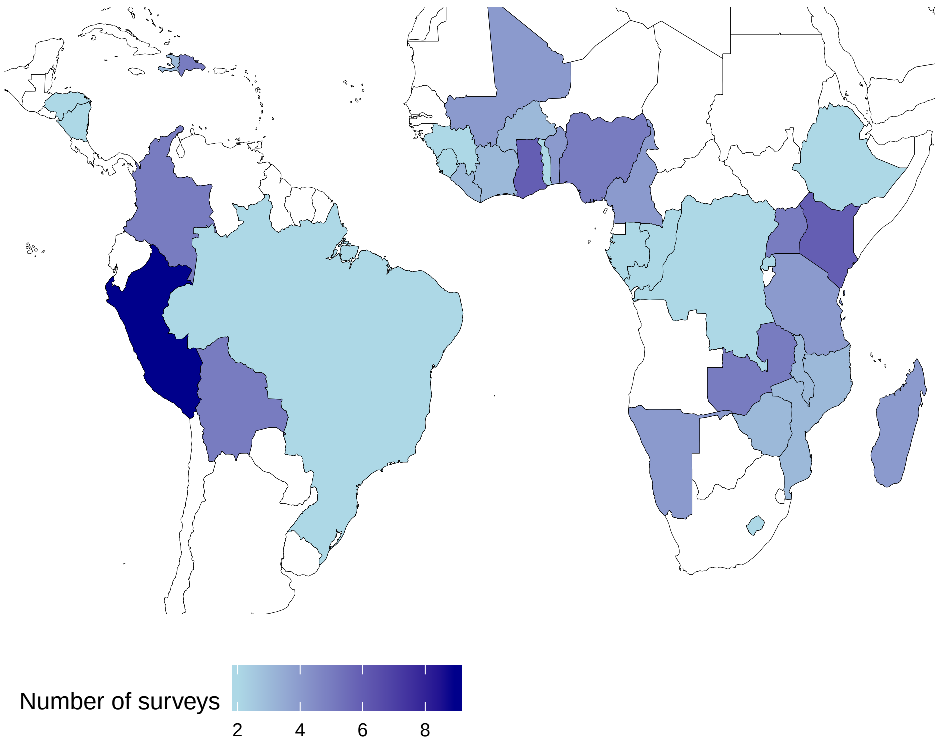

Figure 1: Number of surveys for each country included for the purpose of this research.

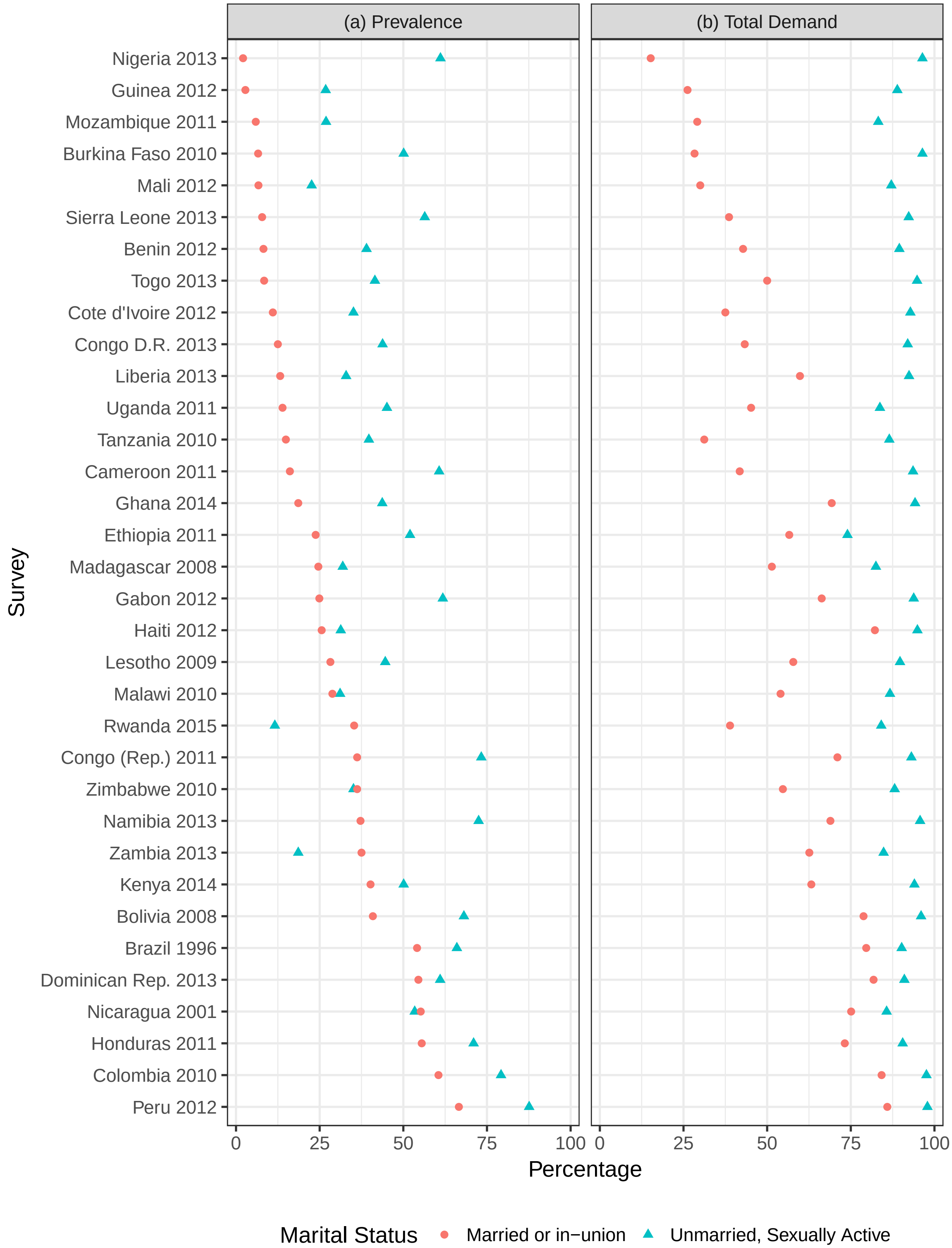

Figure 2: Contraceptive Prevalence and Total Demand for contraceptives for adolescent women by marital status in latest DHS survey.

	LMM1.1a	LMM 1.1b	LMM 1.2a	LMM 1.2b	LM 1
Intercept	-2.044^{***}	-1.880^{***}	-1.729^{***}	-1.430^{***}	-1.849^{***}
	(0.140)	(0.242)	(0.156)	(0.286)	(0.121)
CPU_{it}	-0.361^{**}	-0.263	-0.445^{**}	-0.343^{*}	-0.629^{***}
	(0.159)	(0.180)	(0.184)	(0.203)	(0.172)
$log(SAU)_{it}$	0.046	0.003	-0.007	-0.038	0.113^{***}
	(0.040)	(0.047)	(0.046)	(0.053)	(0.043)
$M15_{it}$	0.057^{***}	0.051^{***}			0.063^{***}
	(0.008)	(0.010)			(0.007)
$\overline{CPU_i}$		-0.258		-0.445	
		(0.442)		(0.554)	
$\overline{log(SAU)_i}$		0.151		0.121	
		(0.092)		(0.113)	
$\overline{M15_i}$		0.020			
		(0.018)			
BIC	51.925	62.445	85.803	93.613	128.442
Log Likelihood	-11.600	-9.679	-30.933	-30.050	-52.252
Num. obs.	120	120	120	120	120
sigma	0.184	0.183	0.210	0.209	0.380
sigma. RE	0.361^{***}	0.346^{***}	0.465^{***}	0.455^{***}	
Mundlak test (p-value)	0.279		0.414		

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 1: Effect of contraceptive prevalence on the probability of marriage for adolescent women.

	LMM2.1	LMM 2.2	LM 2
Intercept	342.584***	428.059***	375.367***
	(25.787)	(19.383)	(16.714)
MU_{it}	-60.630	125.461*	276.064***
	(106.309)	(69.392)	(56.275)
UN_{it}	-256.046***	-192.752***	-109.621***
	(54.586)	(44.775)	(41.378)
UU_{it}	-490.514***	-440.670***	-347.411***
	(39.206)	(34.158)	(33.882)
$\overline{MU_i}$	382.785***		
	(133.793)		
$\overline{UN_i}$	181.864**		
	(84.222)		
$\overline{UU_i}$	210.505***		
	(69.054)		
BIC	1281.014	1285.658	1319.857
Log Likelihood	-618.963	-628.466	-647.960
Num. obs.	120	120	120
sigma	34.161	35.446	54.472
sigma. RE	34.448***	43.182***	
Mundlak test (p-value)	0.000		

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 2: Effect of contraceptive prevalence on adolescent birth rate.

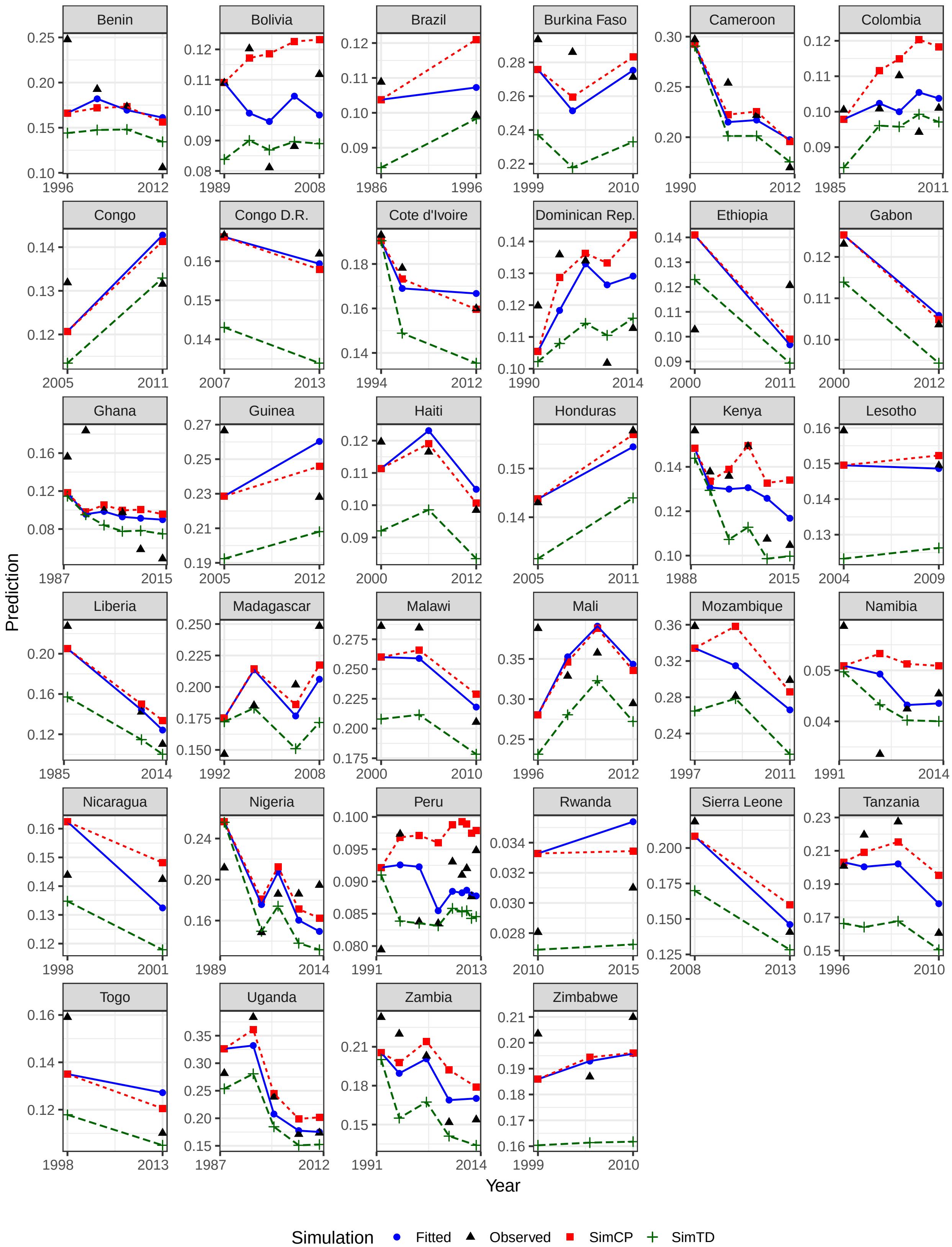

Figure 3: Early marriage: Model fit and simulations under stalled contraceptive prevalence (SimCP) and met total demand (SimTD) scenarios.

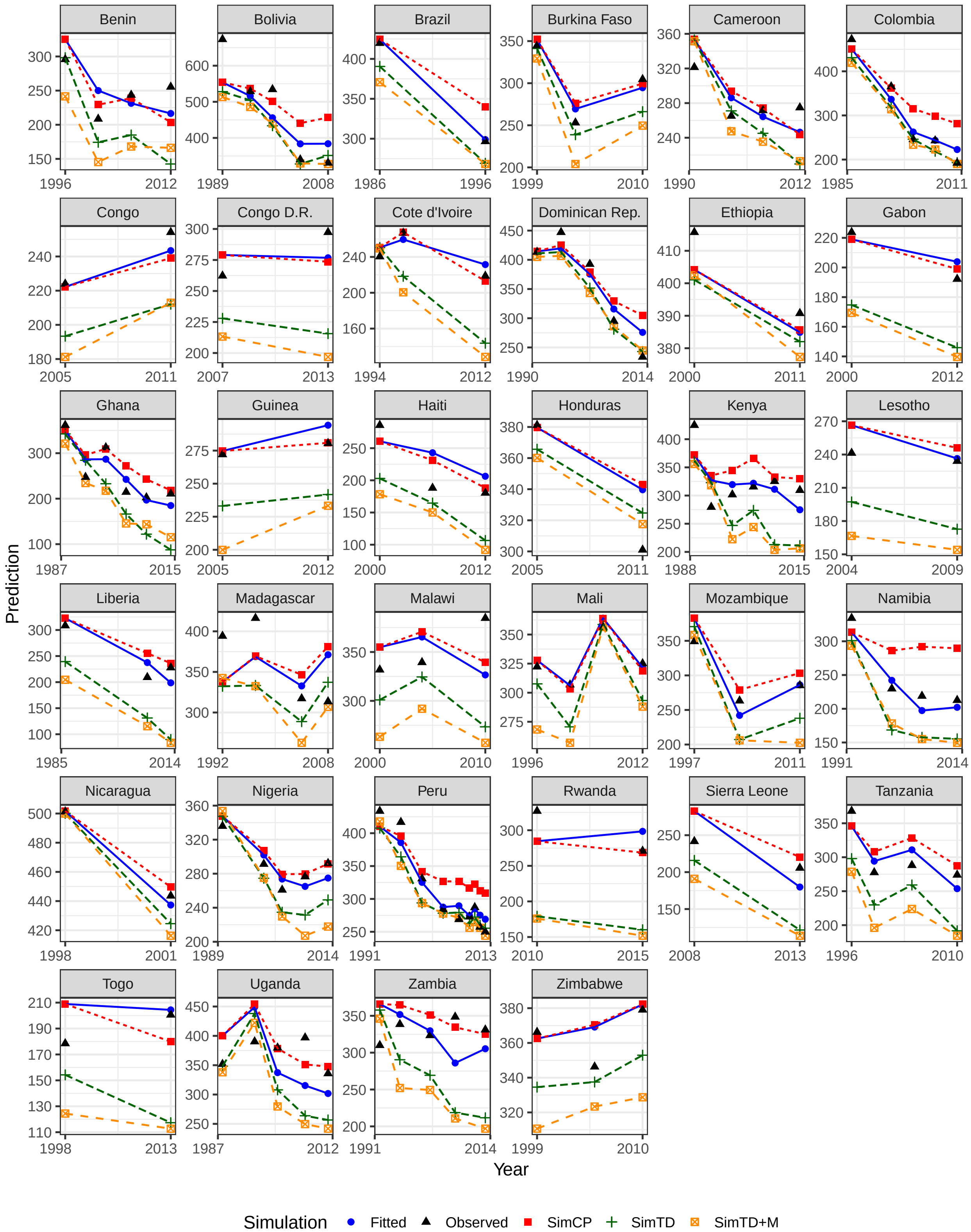

Figure 4: Adolescent birth rate for exposed women: Model fit and simulations under stalled contraceptive prevalence for unmarried adolescents (SimCP), met total demand for unmarried adolescents (SimTD) and met demand for unmarried adolescents adjusting for marriage (SimTD+M) scenarios.