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Tesis presentada para optar al título de Doctor:

Temas de Salud Reproductiva:

El uso de anticonceptivos y su efecto en la fecundidad

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1 Introducción general

La salud reproductiva va más allá de solo evitar enfermedades de transmisión sexual. Engloba el bienestar general de un individuo desde una perspectiva física, mental y social. Salud reproductiva se refiere a gozar de derechos reproductivos como la vida sexual satisfactoria, sin riesgos y la procreación, en un marco de libertad de decidir cuándo, con quién y con qué frecuencia mantener relaciones sexuales (United Nations Population Information Network 1994). Parte de los derechos reproductivos incluye el acceso a servicios de planificación familiar, es decir, a anticonceptivos.

A partir de la década de los 90s la salud reproductiva cobra especial relevancia en la agenda internacional de desarrollo. En 1994 se realiza la Conferencia Internacional sobre la Población y el Desarrollo en el Cairo donde participan 179 países para acordar un programa de acción durante los siguientes 20 años. Dentro de los temas tratados se incluyen, entre otros, mortalidad infantil y materna, control de natalidad, planificación familiar y educación sexual (International Conference on Population and Development 1994). Esta conferencia marca el hito para incluir a la salud reproductiva en los 'Objetivos de Desarrollo del Milenio' de la Organización de las Naciones Unidas (ONU), específicamente, en el objetivo 5 "Mejorar la salud materna" (United Nations 2000). La meta 5.B incluía "Lograr, para 2015, el acceso universal a la salud reproductiva". Sus indicadores, entre otros, se referían a reducir el embarazo adolescente, aumentar el uso de métodos de anticonceptivos y reducir la demanda insatisfecha de anticonceptivos. En cuanto a la prevalencia de anticonceptivos, los resultados fueron un incremento desde 55% al 64%, entre 1990 y 2015 respectivamente (United Nations 2015a).

Posteriormente, los acuerdos internacionales no solo que se ratifican en la importancia de la salud reproductiva, sino que se expanden para monitorear una mayor cantidad de dimensiones. Por ejemplo, la ONU incluye en los 'Objetivos de Desarrollo Sostenible' las metas 3.7 "Para 2030, garantizar el acceso universal a los servicios de salud sexual y reproductiva, incluidos los de planificación de la familia, información y educación, y la integración de la salud reproductiva en las estrategias y los programas nacionales" y 5.6 "Garantizar el acceso universal a la salud sexual y reproductiva y los derechos reproductivos, de conformidad con el Programa de Acción de la Conferencia Internacional sobre la Población y el Desarrollo, la Plataforma de Acción de Beijing y los documentos finales de sus conferencias de examen" (United Nations 2015b). Adicionalmente, la Cumbre de Londres de 2012, respaldada por la ONU, se realiza exclusivamente en temas enfocados en salud sexual y reproductiva. A partir de ella se crea la iniciativa 'Family Planning 2020' con el objetivo de asegurar el acceso a servicios y derechos de salud sexual y reproductiva, especialmente acceso a anticonceptivos, reducción de la demanda insatisfecha, reducción de embarazos no deseados y abortos evitados (Family Planning 2020 2018).

En términos generales, parte importante de las políticas públicas radica en la correcta medición de los indicadores y las metas. Sin embargo, las iniciativas señaladas anteriormente incluyen solo información para mujeres casadas en parte por dificultades en el acceso a datos de solteras, especialmente adolescentes, ya sea por razones sociales o religiosas. Este problema no solo afecta a *policymakers*, también a investigadores. Por ejemplo, los demógrafos utilizan generalmente el enfoque de los determinantes próximos para calcular tasas de fecundidad (Bongaarts 1978). Este enfoque fue concebido a finales de la década de los 70 y propone que la tasas de fecundidad específica por edad ($ASFR$) está conectada con la fertilidad potencial (AF) a través de una serie de factores reductores de la fecundidad como el matrimonio (C_m), uso de anticonceptivos (C_c), aborto (C_a) e infertilidad posparto (C_i):

$$ASFR = C_m \times C_c \times C_a \times C_i \times AF$$

Cerca de dos décadas después, el enfoque de los determinantes próximos es criticado por solo incluir a las mujeres casadas y se propone reemplazar ese coeficiente por el porcentaje de mujeres sexualmente activas (Stover 1998). Este comentario fue incluido en la reformulación de los determinantes próximos en el año 2015 (Bongaarts 2015). Si bien es cierto que la actualización de los determinantes próximos reconoce que no solo las mujeres casadas explican la fecundidad, una de las razones por las que se ha realizado esta tesis se debe a que no es suficiente incluir la actividad sexual como variable explicativa de la fecundidad, sino que es necesario separar a mujeres casadas de solteras[1] ya que los patrones de actividad sexual para cada una de ellas son diferentes, así como sus intenciones de embarazo.

El rol de los anticonceptivos es clave para la medición de las tasas de fecundidad y de las metas de planes y programas. De hecho, muchos de los objetivos monitoreados internacionalmente se desprenden de la prevalencia de anticonceptivos. Por ejemplo, la demanda insatisfecha y los embarazos no deseados. En el caso de este último, puede ocurrir por dos razones, la primera, que usando anticonceptivos exista un embarazo debido a un fallo en el uso o, la segunda, que exista un embarazo en una mujer que no utiliza anticonceptivos por problemas en el acceso a ellos, aunque su deseo es usarlos. La consecuencia principal de un embarazo no deseado es el aborto (Bradley, Croft, and Rutstein 2011; Cleland and Ali 2004; Polis et al. 2016). Dado que los anticonceptivos sirven para discriminar un embarazo deseado de otro que no lo es, estudiarlo es centrarse en salud reproductiva.

Esta tesis doctoral se compone de tres investigaciones independientes que están unidas por un hilo conductor: la necesidad de diferenciar a las mujeres en el enfoque de los determinantes próximos y cómo al hacerlo se obtienen mediciones más precisas que contribuyen al monitoreo de la salud reproductiva. De manera adicional a esta introducción, se incluyen cuatro secciones. La primera de ellas se centra en el efecto del uso de anticonceptivos en la fecundidad adolescente, que es la meta 17 de la iniciativa 'Family Planning 2020', utilizando modelos de regresión mixtos con datos agregados. La segunda investigación se centra en el efecto de los anticonceptivos en el aborto inducido y espontáneo ya que la probabilidad que un embarazo culmine en un nacido vivo es central en la medición de la fecundidad. Para ello

[1] En este documento se utiliza como sinónimo mujeres casadas o 'en union', y mujeres solteras o 'no en unión'. El primer grupo incluye mujeres casadas o que cohabitan con su pareja. El segundo grupo incluye mujeres que nunca se han casado, separadas, viudas o divorciadas.

se estiman modelos multinomiales a partir de datos micro. La tercera investigación analiza los patrones demográficos de las muertes fetales en función del uso de anticonceptivos al momento del embarazo, y propone un método sencillo para estimar la proporción de embarazos que terminan en aborto inducido en aquellos países donde no se ha reportado dicha información. Para este fin se realiza un análisis demográfico derivando los indicadores a partir de datos micro. La última sección presenta las conclusiones generales de las tres investigaciones.

Para todas las investigaciones se utiliza la misma fuente de información, esto es las Encuestas Demográficas y de Salud (DHS, por sus siglas en inglés), principalmente porque incluye un calendario reproductivo para cada mujer que retrocede hasta los últimos 72 meses antes de la entrevista (The DHS Program 2019). Estas encuestas se levantan periódicamente desde el año 1985 en países de ingresos medios y bajos de África, América Latina, Asia y el este de Europa. En dicho calendario se incluyen los meses de embarazo, su resultado y el uso de anticonceptivos mes a mes. Cabe señalar que pocos estudios internacionales han utilizado las DHS para los fines de esta tesis, por lo que las tres investigaciones son innovadoras y originales tanto en concepto como en datos.

Dado que cada una de las investigaciones ha sido preparada de manera independiente ya que están publicadas o en proceso de serlo, su redacción está en inglés e incluyen la siguiente estructura: introducción, datos y métodos, resultados y discusión. Adicionalmente, las tres investigaciones son en coautoría con José Antonio Ortega, Profesor Titular del Departamento de Economía e Historia Económica y director de esta tesis, a quien agradezco por su gran dedicación y generosidad en este proceso.

2 Adolescent contraceptive use and its effects on fertility[2,3]

2.1 Resumen

Motivación: La salud reproductiva de las adolescentes forma parte de los objetivos de desarrollo acordados internacionalmente, que incluyen el acceso a anticonceptivos y fecundidad adolescente. Las adolescentes solteras generalmente no están incluidas en el monitoreo de las metas pese a que las consecuencias de la maternidad no deseada son más perjudiciales para ellas.

Metodología: Proponemos un modelo de fecundidad extendiendo el enfoque de los determinantes próximos ya que separamos a las mujeres casadas y a las solteras sexualmente activas. Se obtienen estimadores a partir de Modelos Lineales Mixtos a partir de 120 encuestas DHS para 34 países en desarrollo.

Resultados: Aumentar la prevalencia de anticonceptivos ha reducido ya la fecundidad adolescente en 6.8% en América Latina y en 4.1% en África sub-Sahariana. Si las adolescentes solteras satisfacen su demanda total de anticonceptivos podrían reducir adicionalmente su fecundidad en un 8.9% y 17.4%, respectivamente en ambas regiones.

Discusión: La demanda y prevalencia de anticonceptivos son generalmente más altas para las adolescentes solteras sexualmente activas. Los aumentos en la prevalencia ya han llevado a reducciones en la tasa de nacimientos de adolescentes. Hay un efecto potencial más grande, particularmente en África sub-Sahariana, si se eliminan los altos niveles de demanda insatisfecha. Expandimos el enfoque de los determinantes próximos analizando separadamente a las adolescentes de acuerdo con su estado civil y uso de anticonceptivos. Proveemos evidencia

[2] Este capítulo se encuentra publicado. Su referencia es Sánchez-Páez, DA and Ortega, JA (2018). Adolescent contraceptive use and its effects on fertility. *Demographic Research* 38(45): 1359-1388. doi: 10.4054/DemRes.2018.38.45. url: http://www.demographic-research.org/Volumes/Vol38/45/

[3] Una versión previa de este capítulo fue presentada en la XXVIII IUSSP International Population Conference en Ciudad del Cabo, Sudáfrica.

demostrando que satisfacer las necesidades de anticonceptivos de las adolescentes solteras tiene un impacto significativo en su salud y en la maternidad no deseada.

2.2 Abstract

Background: Adolescent reproductive health is part of internationally agreed development goals. Unmarried adolescents are not commonly included in global monitoring of contraceptive use despite the more severe consequences of unintended childbearing for them.

Methods: We propose a fertility model informed by the proximate determinants framework separating adolescents by marital status. Linear Mixed Model estimates are based on aggregate data from 120 DHS surveys for 34 developing countries.

Results: Increasing contraceptive prevalence has already reduced adolescent fertility by 6.8% in Latin America and 4.1% in sub-Saharan Africa. Meeting the total demand for contraceptives of unmarried adolescents would lead to an additional decrease in fertility of 8.9% and 17.4% respectively.

Discussion: Contraceptive demand and prevalence are frequently higher for sexually active unmarried adolescent women than for those married. Increasing prevalence has already had an impact but there is a potential larger effect, particularly in sub-Saharan Africa, of eliminating the high levels of unmet need. Such reduction would have a significant impact on adolescent health. We provide evidence of the importance of contraceptive use of unmarried sexually active adolescent women in explaining trends in adolescent fertility. We estimate the potential effect of meeting the contraceptive needs of married and unmarried adolescents on unintended childbearing.

2.3 Background

Total demand and contraceptive use are fundamental 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 it was also recognized in target 5.B of the Millennium Development Goals (United Nations 2015b). In fact, indicator 3.7.2 of the SDGs explicitly refers to Adolescent Birth Rate. Expansion of contraceptive use in most impoverished countries is also the goal of the Family Planning 2020 global partnership (Family Planning 2020 2015). 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). Following international practice, the key measure of adolescent fertility is the age-specific fertility rate for women aged 15 to 19 (United Nations 2013). At present, 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 teenage 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 2011).

Despite the mention to universal access, global monitoring of these aims has centered on women married or in-union (United Nations 2016; UNFPA 2010). As a result, groups with special needs, such as sexually active unmarried adolescent women are often left out of sight. Based on available global data on contraceptive use of adolescents, we bring into the debate the specific effect of contraception of sexually active unmarried adolescents on adolescent fertility. It is a factor of increasing importance to the extent that marriage is postponed with an increasing gap between sexual initiation and marriage (Blanc and Way 1998; Clark, Koski, and Smith-Greenaway 2017). Contraceptive use is therefore key to avoid unintended childbearing, that makes up a proportion between 50% and 90% of births to adolescent women depending on the country (Neelofur-Khan and WHO 2007; Sedgh, Singh, and Hussain 2014). Still, most of teenage childbirths take place within marriage[4] mainly because many

[4] In this article, when we refer to marriage or married adolescents, we include both formal marriage and consensual unions following the practice of DHS surveys, our data source.

married adolescents want to have children. In this respect, an increasing age at marriage could be the most critical factor in postponing adolescent childbearing (International Center for Research on Women 2014; United Nations 2013).

While unmarried adolescents have a higher unmet need for contraceptives than married women of their same age (Blanc et al. 2009; MacQuarrie 2014; United Nations 2014), many of them do not make use of contraceptive methods due to lack of access (Chandra-Mouli et al. 2014; Greene and Merrick 2015). This happens despite the fact that the consequences of unwanted conceptions are more severe for them: unintended childbearing, unsafe abortion, maternal and child mortality, school dropout, reduced earning potential, and lower educational achievements for the present and the next generation (Hindin et al. 2016; Neelofur-Khan and WHO 2007; Santhya and Jejeebhoy 2015; United Nations 2013; WHO 2010). In this respect, changing contraceptive behavior seems more achievable than changing sexual behavior in adolescents (International Center for Research on Women 2014).

Unintended pregnancies to unmarried adolescents are also a precipitating factor of early marriage in many societies. An indicator of this is the proportion of first births to married adolescents occurring less than eight months after marriage: The incidence of postconception marriage measured in this way among women aged 20-24 years giving birth before they were 20 years old ranges between 10% and 40% in Latin America and Africa (United Nations 2013). Early unions are more likely to result in the gender-based health and human rights violation of forced marriage (Banerji, Martin, and Desai 2008; UNICEF 2001, 2005; WHO 2011) and reinforce gender inequality (Raj and Boehmer 2013).

Many of the health consequences of unintended adolescent pregnancy relate to unsafe abortion (Hindin et al. 2016; Morris and Rushwan 2015; Neelofur-Khan and WHO 2007; Senanayake, Nott, and Faulkner 2001). Indeed, the prevalence of induced abortion, due to either lack of access or contraceptive failure, and the use of unsafe informal methods in termination attempts, highlights the need for the continued provision of contraceptives and access to safe and affordable pregnancy termination services (Gipson and Hindin 2008; Polis et al. 2016). For this reason, the 2012 London Summit on Family Planning states the need of bringing modern contraceptive methods to women and girls recognizing the importance of family planning as a robust path to change the world (Family Planning 2020 2015), in addition to lower health costs and other social benefits (Chandra-Mouli et al. 2014; Greene and Merrick 2015). Nevertheless, despite agreement on its importance, adolescents often lack access to contraceptives, facing many barriers in acquiring contraceptives and in using them correctly and consistently (Chandra-Mouli et al. 2014). But not only lack of access to contraceptives is a problem. Many adolescents have no access to sex education leading to a lack of knowledge regarding the risks of the early sexual debut (Kirby 2011). Findings suggest that success in avoiding adolescent pregnancy often depends not only on the use of a contraceptive method but also on access to health services, education, and information (Gurr 2014). As a result, despite increasing adolescent contraceptive use, their periods of consistent use are shorter, and contraceptive failures more frequent than for older women (Blanc et al. 2009; United Nations 2014).

Many demographers analyze the role of contraception in reducing fertility through the proximate determinants framework (Bongaarts 1978, 2015). In this framework, contraception is one of the intermediate behavioral factors influencing childbearing, the others being marriage or sexual exposure, abortion and lactational postpartum infecundability. Standard applications of the framework take as inputs contraceptive prevalence and the contraceptive method mix, and based on published average rates of contraceptive failure impute a reduction factor of fertility due to contraception at the population or the age-specific level. Bongaarts (2017) provides an alternative method based on estimating empirically the reduction in fertility due to changes in contraceptive prevalence using fixed-effects panel regression. We follow a similar empirical approach while focusing on adolescent fertility and separating adolescents according to marital status: Earlier formulations of the proximate determinants were based on married women only. Since Stover (1998) most studies include data on all sexually active women, but all sexually active women are grouped together. This is not satisfactory for our purposes since married and sexually active unmarried adolescents have very different behavior regarding contraceptive use and demand, sexual activity, and fertility.

Despite the policy consensus on its importance, until recently not many studies have focused on adolescent contraceptive use and fewer on unmarried sexually active adolescents (Hindin and Kalamar 2017). WHO has contributed to fill that gap providing survey specific country-sheets for 58 countries on adolescent contraceptive use that compare married adolescents and those sexually active unmarried (WHO 2016), and the DHS program has produced a monograph focusing on unmet need for young women 15-24 (MacQuarrie 2014). Loaiza and Liang (2013) and MacQuarrie (2014) show that women aged 15-19 tend to have the highest levels of unmet need for contraception and the lowest proportion of demand satisfied. Our purpose is to quantify the childbearing consequences of adolescent contraceptive use and non-use in developing countries based on the available evidence. We first analyze contraceptive use and total demand for contraceptives of both married and unmarried adolescents and then estimate the effect of such contraceptive use and total demand on fertility. In doing so, we highlight the role that increasing prevalence has had in reducing fertility and estimate the potential effect of satisfying total demand by eliminating current unmet need for contraception. This knowledge can be helpful in reaching better-informed decisions regarding SRHR policy.

2.4 Data and methods

2.4.1 Data

Demographic and Health Surveys (DHS) provide the main source of information for comparative work on adolescent contraceptive use since the 1980s (Kothari et al. 2012; WHO 2016; Bongaarts 2017). We use aggregate information from DHS surveys carried out in developing countries between 1986 and 2015 and contained in the STATcompiler database (The DHS Program 2015). We obtained data on contraceptive use, unmet need and total demand for contraceptives of adolescent women aged 15-19, both married and sexually active unmarried women, proportions of sexually active adolescents, and adolescent fertility measured by the age-specific fertility rate ($ASFR$) 15-19 in the three years prior to the survey. In order to focus in trends over time we restricted our analysis to countries with complete data for at least two surveys. Since almost all countries fulfilling these conditions where located in Latin America and the Caribbean (LAC) and sub-Saharan Africa (SSA) and there was insufficient or no coverage of developing countries in Asia or Northern Africa, we restricted the sample to countries in these two regions. The final sample contains 125 DHS surveys from 34 countries.[5] Table 1 lists the included surveys together with their respective sample sizes. Data manipulation, estimation, and manuscript edition are carried out in R (R Core Team 2019)[6].

Table 1: DHS surveys included in the analysis

		Sample size (women)	
Country	Year	All ages	15-19
Latin America and the Caribbean			
Bolivia	1989	7,923	1,682
Bolivia	1994	8,604	1,805
Bolivia	1998	11,187	2,497
Bolivia	2003	17,654	3,874
Bolivia	2008	16,938	3,518
Brazil	1986	5,892	1,305
Brazil	1996	12,614	2,464
Colombia	1986	5,332	1,208
Colombia	1995	11,141	2,166
Colombia	2000	11,586	2,264
Colombia	2005	38,355	6,902
Colombia	2010	49,818	9,100
Dominican Rep.	1991	7,320	1,711
Dominican Rep.	1996	8,421	1,801
Dominican Rep.	2002	23,384	4,550
Dominican Rep.	2007	27,195	5,580

[5] 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. Kazakhstan was the only Asian country that met our requirements but was excluded from the final sample for the reasons given in the text.

[6] `broom` (Robinson and Hayes 2018) and `tidyverse` (Wickham 2017) for manipulation; `nlme` for estimation (Pinheiro et al. 2017); `knitr` (Yihui 2014, 2015, 2018) and `texreg` (Leifeld 2013) for editing.

Table 1: DHS surveys included in the analysis *(continued)*

		Sample size (women)	
Country	Year	All ages	15-19
Dominican Rep.	2013	9,372	1,820
Haiti	2000	10,158	2,342
Haiti	2006	10,758	2,701
Haiti	2012	14,287	3,352
Honduras	2005	19,948	4,510
Honduras	2011	22,757	5,062
Nicaragua	1998	13,635	3,307
Nicaragua	2001	13,059	3,141
Peru	1992	15,882	3,477
Peru	1996	28,950	6,138
Peru	2000	27,843	5,645
Peru	2004	17,519	3,346
Peru	2007	23,034	4,208
Peru	2009	24,212	4,536
Peru	2010	22,948	4,279
Peru	2011	22,518	4,118
Peru	2012	23,888	4,423
Sub-Saharan Africa			
Benin	1996	5,492	1,075
Benin	2001	6,219	1,233
Benin	2006	17,793	3,067
Benin	2012	16,600	2,907
Burkina Faso	1999	6,446	1,444
Burkina Faso	2003	12,477	2,776
Burkina Faso	2010	17,087	3,312
Cameroon	1991	3,871	919
Cameroon	1998	5,502	1,282
Cameroon	2004	10,656	2,684
Cameroon	2011	15,426	3,589
Congo D.R.	2007	9,995	2,030
Congo D.R.	2013	18,826	4,054
Congo Rep.	2005	7,052	1,566
Congo Rep.	2011	10,820	2,198
Cote d'Ivoire	1994	8,098	1,961
Cote d'Ivoire	1998	3,039	775
Cote d'Ivoire	2012	10,059	2,023
Ethiopia	2000	15,368	3,710
Ethiopia	2011	16,514	4,009
Gabon	2000	6,182	1,587
Gabon	2012	8,423	1,784
Ghana	1988	4,488	849
Ghana	1993	4,562	803
Ghana	1998	4,843	910
Ghana	2003	5,691	1,148
Ghana	2008	4,916	1,025
Ghana	2014	9,396	1,625
Guinea	2005	7,954	1,648
Guinea	2012	9,143	2,023

Table 1: DHS surveys included in the analysis *(continued)*

		Sample size (women)	
Country	Year	All ages	15-19
Kenya	1989	7,150	1,497
Kenya	1993	7,541	1,754
Kenya	1998	7,881	1,851
Kenya	2003	8,195	1,856
Kenya	2008	8,445	1,761
Kenya	2014	31,080	5,820
Lesotho	2004	7,094	1,710
Lesotho	2009	7,624	1,785
Liberia	1986	5,239	1,137
Liberia	2007	7,092	1,312
Liberia	2013	9,239	2,080
Madagascar	1992	6,261	1,420
Madagascar	1997	7,059	1,553
Madagascar	2004	7,948	1,528
Madagascar	2008	17,374	3,956
Malawi	2000	13,219	2,867
Malawi	2004	11,698	2,392
Malawi	2010	23,020	5,005
Mali	1996	9,703	1,883
Mali	2001	12,849	2,565
Mali	2006	14,583	3,104
Mali	2012	10,425	1,891
Mozambique	1997	8,778	1,836
Mozambique	2003	12,417	2,454
Mozambique	2011	13,745	3,061
Namibia	1992	5,422	1,259
Namibia	2000	6,754	1,499
Namibia	2006	9,803	2,246
Namibia	2013	9,176	1,906
Nigeria	1990	8,780	1,612
Nigeria	1999	8,205	1,775
Nigeria	2003	7,620	1,716
Nigeria	2008	33,385	6,493
Nigeria	2013	38,949	7,820
Rwanda	2010	13,671	2,945
Rwanda	2015	13,497	2,768
Sierra Leone	2008	7,373	1,198
Sierra Leone	2013	16,657	3,878
Tanzania	1996	8,119	1,732
Tanzania	1999	4,029	909
Tanzania	2004	10,329	2,245
Tanzania	2010	10,139	2,172
Togo	1998	8,570	1,787
Togo	2013	9,481	1,700
Uganda	1988	4,729	1,157
Uganda	1995	7,069	1,606
Uganda	2000	7,246	1,615
Uganda	2006	8,531	1,936

Table 1: DHS surveys included in the analysis *(continued)*

Country	Year	Sample size (women) All ages	15-19
Uganda	2011	8,674	2,048
Zambia	1992	7,060	1,984
Zambia	1996	8,020	2,003
Zambia	2002	7,657	1,811
Zambia	2007	7,146	1,574
Zambia	2013	16,410	3,625
Zimbabwe	1999	5,907	1,447
Zimbabwe	2005	8,908	2,152
Zimbabwe	2010	9,171	1,945

We first perform descriptive data analysis comparing contraceptive use and total demand of married and sexually active unmarried adolescents. Total demand for contraceptives is calculated as the sum of contraceptive prevalence and unmet need for contraception. Unmet need is defined as the share of fecund and sexually active women who have an unmet need for family planning in percentage terms. The numerator includes all pregnant women whose pregnancies were unwanted or mistimed at the time of conception; postpartum amenorrheic women who are not using family planning and whose last birth was unwanted or mistimed; and all fecund women who are neither pregnant nor postpartum amenorrheic, and who either do not want any more children (unmet need for limiting), or wish to postpone births for at least two years or do not know when or if they want another child (unmet need for spacing), but are not using any contraceptive method (United Nations 2014).

It would have been desirable to have separate estimates of fertility for married and sexually-active unmarried adolescents. Unfortunately, STATcompiler does not provide such data: only the age-specific fertility rate for all women 15-19 is available. Since not all women aged 15-19 are sexually active, the conventional $ASFR$ underestimates the risk of childbearing. We have therefore adjusted for exposure based on information on time at last sexual intercourse, excluding unmarried women not having had sex in the last year.

2.4.2 The model

The idea of the proximate determinants framework is to include the behavioral variables that determine fertility so that the role of socioeconomic determinants would necessarily happen through the impact in some of the proximate determinants (Bongaarts 1978). Baschieri and Hinde (2007) provide confirmation of such hypothesis in Egypt finding that once the proximate determinants are included, the importance of socioeconomic variables in a fertility model based on microdata vanishes. Changes in the proximate determinants of fertility, such as marriage and contraceptive prevalence, should therefore provoke direct changes in fertility. The classic proximate determinants framework captures this in the equation $ASFR = C_m \times C_c \times C_a \times C_i \times AF$. For a given age-group, this equation links the potential fecundity, AF, to the actual $ASFR$ 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) criticized this classic model suggesting the use of sexual activity rather than marriage to indicate exposure, a point subsequently adopted by Bongaarts (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. Precisely our point is that there are differences in the proximate determinants, and especifically in the use of contraception, between married and unmarried sexually active adolescents. Figure 1 highlights the gaps in contraceptive prevalence and total demand. We therefore want to work with both groups separately.

Separating the contribution to fertility of married and unmarried women is in line with the Princeton model of fertility (Coale and Watkins 1986). This project produced joint estimates of total fertility, I_f, as a weighted average of married and unmarried fertility, I_g and I_h, using as weights the proportion married, I_m. Since the purpose was not to model the impact of contraceptive use or sexual exposure it just proposed the decomposition: $I_f = I_g \times I_m + I_h \times (1 - I_m)$.

Given our purpose to determine the effect 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 classify adolescent women according to sexual exposure. 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 are therefore assuming that all married or in-union adolescents are sexually active. Exposed women are further classified into four groups based on marital status and contraceptive use. Each category is expected to have a different fertility rate according to their proximate determinants. We define the proportion of women exposed in each group as:

- MU: Proportion of married or in-union adolescent women currently using a contraceptive method among those exposed: $MU = \frac{M \cdot CPM}{1-NEX}$, where M is the proportion of married or in-union adolescents, and CPM is the proportion of married or in-union women using any contraceptive method.
- MN: Proportion of 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: $UN = \frac{(1-M) \cdot (1-CPU) \cdot SAU}{1-NEX}$, where CPU is the proportion of not married women not using any contraceptive method.
- 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 share in these other groups increases. In the model proposed, we expect all coefficients to be negative, regardless of the country-specific averages:

$$ABRE_{it} = \beta_0 + \beta_1 MU_{it} + \beta_2 UN_{it} + \beta_3 UU_{it} + \epsilon_i + \delta_{it} \quad (1)$$

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

2.4.3 Estimation

Our goal is to estimate the effects of contraceptive use of married and sexually active unmarried adolescents on their fertility. In doing so we are including in our model the two main proximate determinants for adolescents, marriage or sexual exposure, and contraception. Post-partum infecundity is not that relevant for adolescents since most of the births are first births. The only main omitted factor would be abortion, since DHS surveys do not directly measure induced abortion. To the extent that abortion and other factors connected to the effectiveness of contraceptive methods do not change over time, they can be captured by a country-specific fixed or random effect. The fertility level for the reference category could then be interpreted as mean fertility after including average effects of postpartum infecundity and induced abortion, $C_a \times C_i \times AF$ in the proximate determinants terminology. Given the unbalanced panel structure of our data, we use for estimation Linear Mixed Models (LMM) with country-specific random effects (Galecki and Burzykowski 2013; Pinheiro et al. 2017). It is possible to write each observation as:

$$ABRE_{it} = \beta' X_{it} + \epsilon_i + \delta_{it} \quad (2)$$

Where $ABRE_{it}$ is our 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 based on the exact LR test (Scheipl, Greven, and Kuechenhoff 2008) with p-values very close to zero indicating the need to use LMM estimation.

For LMM estimation to be consistent there should not be correlation between the random-effects and the regressors. This will not always be the case. In our specific example, for instance, we find a correlation between the random fertility effects and contraceptive prevalence: beyond the possible causal effect of higher contraceptive prevalence on fertility, contraceptive use provides a signal of whether this is a high or low fertility country. One of the possible reasons why this could occur is a connection between the unmet need for contraception and the cultural or structural factors in the country. There are different methods to estimate consistently in the presence of such correlation, 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 approach, generally called within-between or Mundlak's specification (Bell and Jones 2015; Dieleman and Templin 2014). While both methods provide identical estimates for the coefficients, the random effect specification has several advantages over fixed-effects including the measurement of heterogeneity among countries, the possible inclusion of country-specific time-invariant covariates, or the possibility of applying the model to nations absent in the sample. It is appropriate in our case given our focus on inference about the β coefficients. It is possible to formally 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 of regular LMM estimation. We report the results of both models. When the null of no correlation is rejected, the only consistent estimate of the causal effects is provided by the extended LMM model. When the null is not rejected at the 5% level, both estimates are consistent, and our preferred model would be the regular LMM model. The preferred model in model tables is indicated by boldface, and the p-value of the Mundlak test is provided in the last row.

All the observed variables are measured with an error since they originate in a sample survey, and they are subject to sampling error. In the case of contraceptive prevalence and demand, approximate confidence intervals have been calculated based on the Wilson method (Agresti and Coull 1998) and displayed in figure 1.[7] Measurement error also has potential effects on regression estimates. Note that measurement errors are correlated by design for the different variables: a sample with more unmarried women using contraceptives than in the population would likely have a lower proportion of married women and, most likely, lower fertility than the standard sample. While there are no general insights about the possible estimation bias induced (Carroll et al. 2006), it is reassuring that we would not expect sampling errors to be correlated among different countries or over time. This approach has been proven enough to eliminate bias in some particular cases (Buonaccorsi 2010: 371). Rindfuss et al. (2015) also provide empirical evidence that even when univariate distributions might be biased due to non-response or sampling error, regression estimates might not be affected.

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

- What would have been the levels of fertility if contraceptive prevalence had remained at the levels of the first available survey? This case indicates the effect of increasing levels of contraceptive prevalence in the sample.
- What would have been the levels of fertility 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.

[7]We have used function `binconf` from the `Hmisc` R package (Harrell Jr., Dupont, and others 2018). Statcompiler provides the denominator for each calculation, but it does not provide the design effect or confidence intervals. The approximate confidence intervals are therefore approximations based on random sampling.

2.5 Results

Panel (a) of figure 1 displays the contraceptive prevalence for 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 so that they can decide when to begin childbearing and when to get married. Thus, contraceptive prevalence for unmarried adolescents in LAC countries is 60.3% on average while in SSA countries it is lower at 38.6%.

Panel (b) of the same figure highlights even more significant 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. This implies that levels of unmet need for contraception are higher for sexually active unmarried adolescents, indicating specific problems of access to SRHR for them. Thus, unmet need for single adolescents is 24.4% and 41.4% on average in LAC and SSA respectively.

In most countries, contraceptive prevalence has increased over time, especially for unmarried adolescents (see figure 2), and the pace of increase has usually been faster for unmarried adolescents. Levels of total demand have also increased for unmarried adolescents in most countries, with a less clear pattern for those married. The result of these trends is increasing differences in total demand according to marital status. While in countries like Burkina Faso, Congo D.R., Nigeria, or Zimbabwe the use of contraceptives and total demand for married adolescents have declined over time, prevalence and demand have increased for those sexually active unmarried. These results show the importance of bringing contraceptives to adolescents. However, there are a few countries where prevalence for unmarried women has declined since the first survey despite increasing or stable levels of demand (Benin, Cote d'Ivoire, Guinea, Haiti, or Togo). This indicates problems of access. In other countries such as Burkina Faso, Cameroon, Madagascar or Malawi unmet need for contraceptives has also

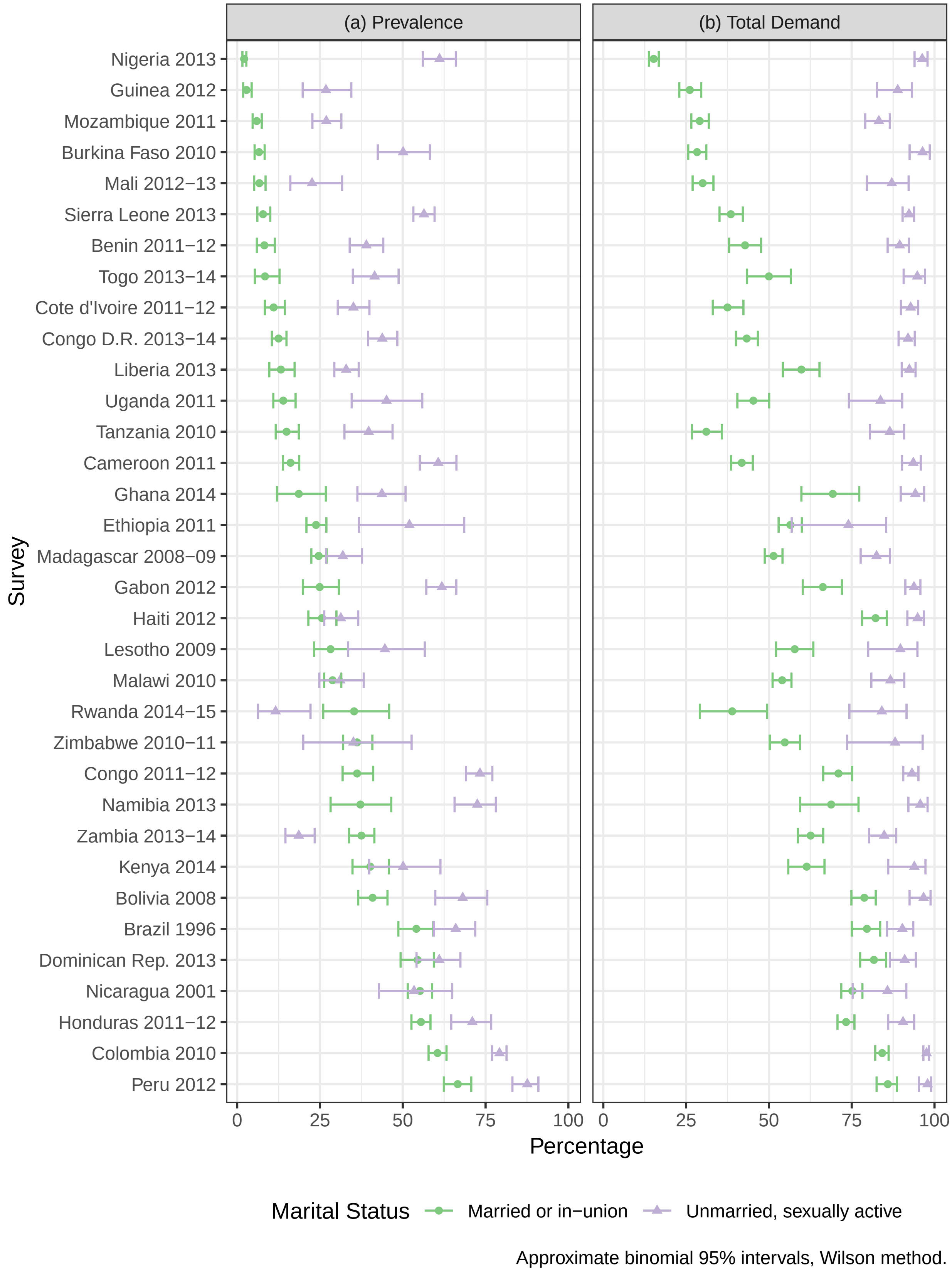


Figure 1: Contraceptive prevalence and total demand for contraceptives for adolescent women by marital status in the latest DHS survey.

increased resulting in an increasing gap between total demand and contraceptive prevalence. Investigating the reasons behind such trends could be relevant to learn what is behind lack of access for policy purposes.

Regarding our fertility model, three different estimates appear in table 2. The first two are LMM regressions, and the last is a linear model. The p-value of the Hausman-type test between LMM 1.1 and LMM 1.2 is 3e-04; therefore, only LMM 1.1 is consistent and the inclusion of country-specific means is necessary. It is worth noticing the change of sign of MU_{it} among LMM 1.1 and LMM 1.2, with the expected sign in LMM 1.1 once bias is corrected. This variation of the sign is in line with the explanation given above: there is a correlation between the country-specific random effects and MU_{it} since countries where the proportion married is high at adolescence are countries that have higher fertility irrespective of the causal mechanism of contraceptive use. For this reason, it is necessary to test for endogeneity and adopt a solution such as using LMM 1.1. Figure 3 maps the distribution of the random effect in the countries of our sample. It highlights that SSA countries have higher variance than LAC countries that are all more alike. An additional model was estimated including region as a covariate. The estimated coefficient for region, 1.956, indicates slightly higher fertility in Sub-Saharan Africa. However the coefficient is very close to zero as indicated by a p-value of 0.94 meaning it cannot be rejected that the coefficient is zero: the difference between SSA and LAC lies in the variance, not in the mean.

All coefficients have their expected signs in LMM 1.1 indicating that fertility is higher when the reference category, MU_{it}, is more numerous. The rest of coefficients can be interpreted as the reduction in births per thousand exposed women occurring when shifting women from the reference category MU to a different group. The reduction connected to the use of contraception in marriage is smaller than those related to the proportions of sexually active unmarried. This indicates 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

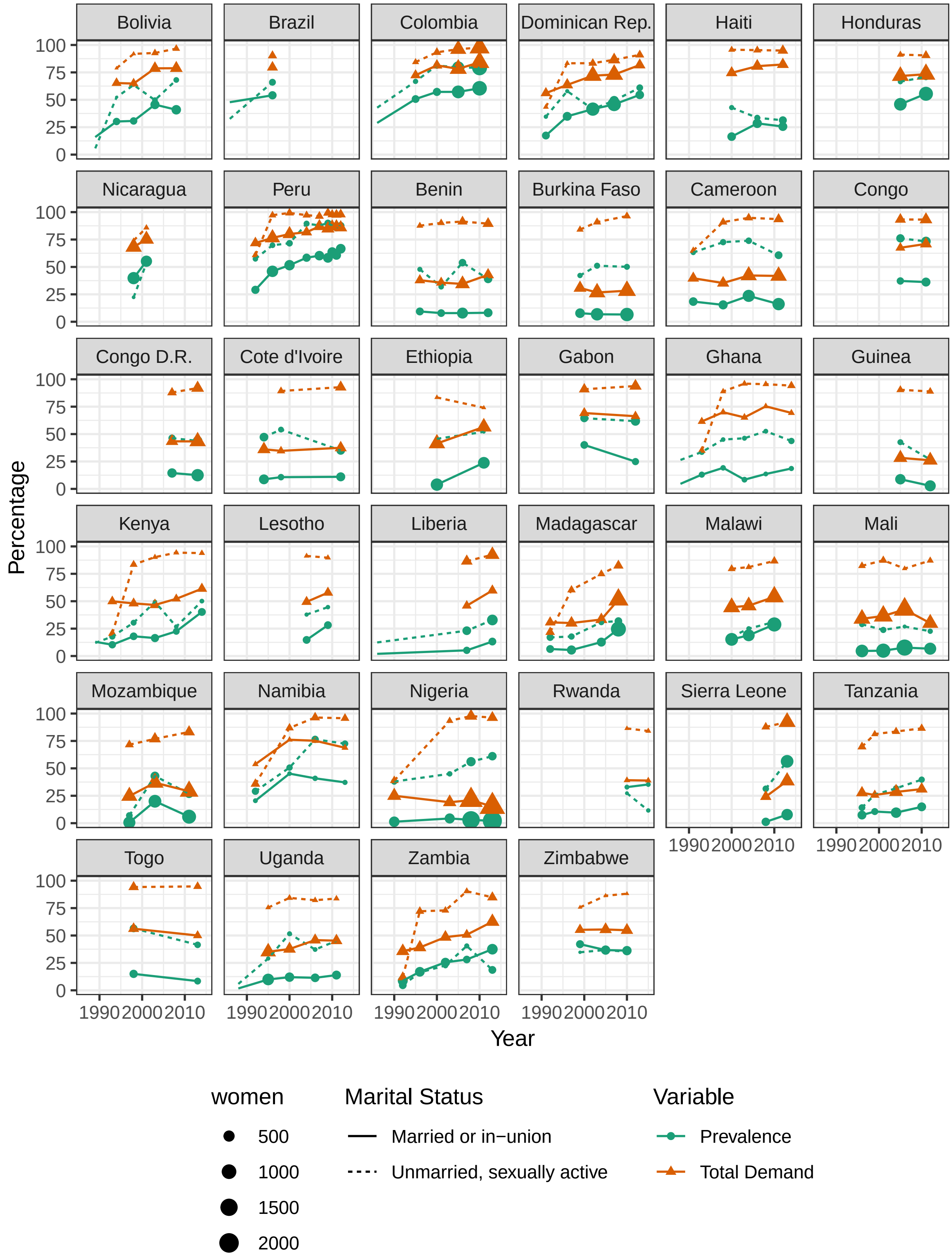


Figure 2: Trends of contraceptive prevalence and total demand for contraceptives for adolescent women by marital status.

Table 2: Model estimates for $ABRE$, adolescent birth rate for exposed women (births per thousand exposed women)

	LMM1.1	LMM 1.2	LM 1
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		

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

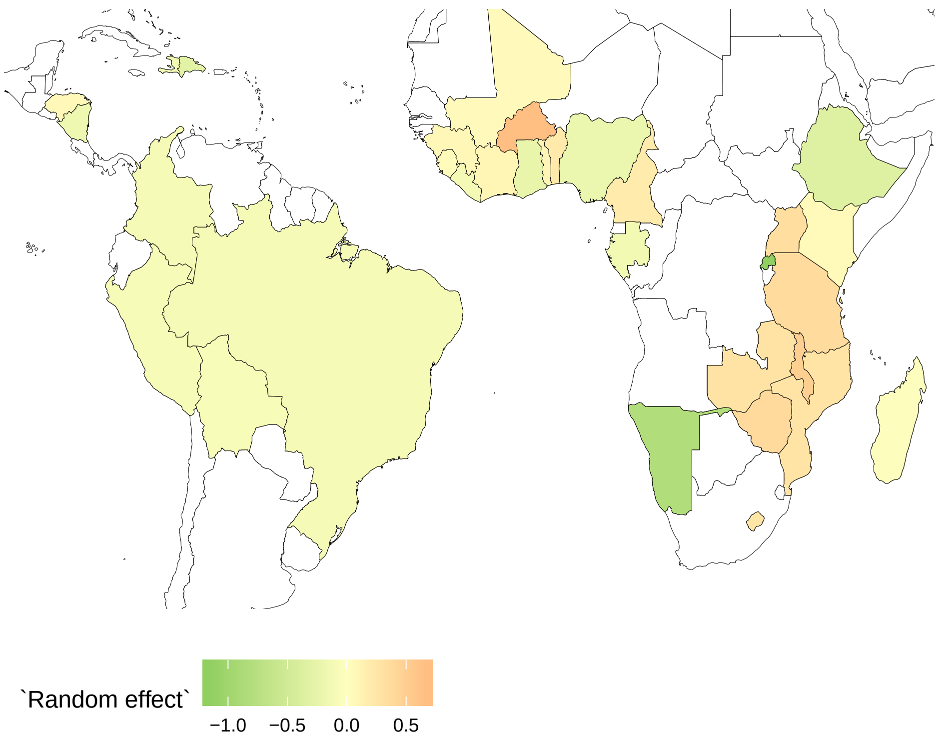


Figure 3: Map of estimated random effects in model LMM1.1. Based on contraceptive prevalence and proportions of married or sexually active adolescents, positive values correspond to countries with adolescent fertility higher than expected.

women: while a switch from not using to using would imply for married adolescents a change of fertility from 0 (the reference category) to -60.6, in the case of unmarried women, the shift goes from -256 to -490.5, being 3.9 times more intense. A possible explanation is that adolescent women that marry do not mind as much or actively seek having a child.

To better evaluate the meaning of the previous results, we present the model fit for *ABRE* together with the relevant simulations in figure 4. The two simulations highlight respectively the effect that unmarried adolescent contraceptive use has already played in the reduction of adolescent fertility, and its potential role if unmet need for contraception was eliminated. In the first simulation, named `SimCP`, the contraceptive prevalence for unmarried adolescents remains at the value of the first available survey. The second scenario, denoted by `SimTD`, answers the question of what would fertility be if unmet need by unmarried adolescents was eliminated with contraceptive prevalence equal to total demand.

The first most salient aspect is that model fit is quite good: the model can reproduce trends in adolescent fertility in most countries. Exceptions include Congo D.R., Madagascar, Malawi, Rwanda, Togo or Zambia. `SimCP` highlights to what extent fertility declines are due to increasing contraceptive prevalence from levels at the first available survey. In some countries like Kenya, Namibia, or Uganda, most of the fall is due to higher contraceptive prevalence. In others, like Bolivia, Brazil, Colombia, Ghana, or Peru it makes a substantial contribution. In contrast, it has made little impact on the observed decline in countries with low contraceptive prevalence for unmarried adolescents. The average effect as a percent of observed levels in surveys after the first is 6.8% for LAC countries and 4.1% for SSA countries. The average contribution is higher in LAC where prevalence has increased faster. If contraceptive prevalence had not increased over time, *ABRE* would be higher according to the difference between the predicted average in the `SimCP` scenario and the model fit. The average difference is 16.9 and 8 births per thousand exposed women in LAC and SSA respectively.

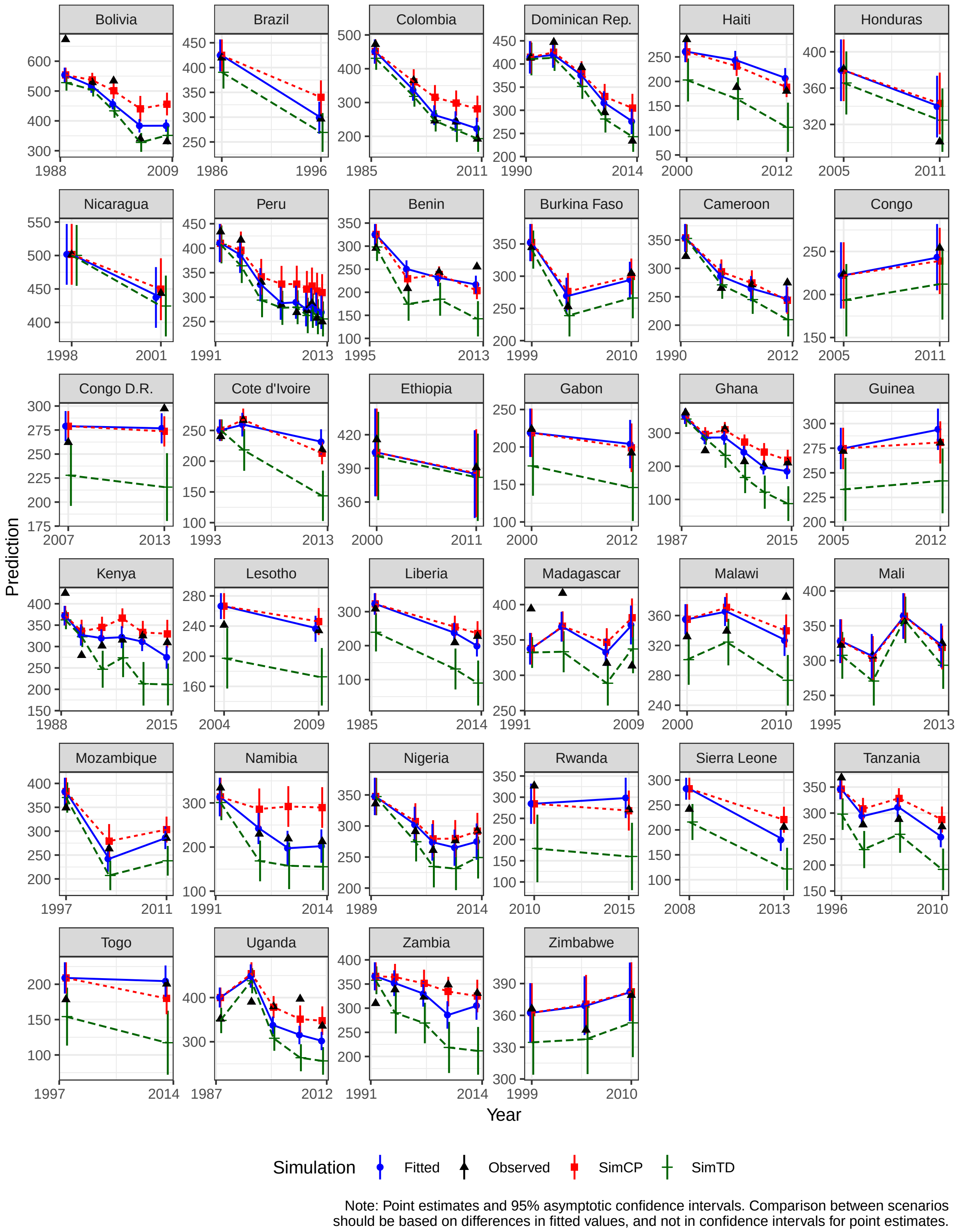


Figure 4: Adolescent birth rate for exposed women: Model fit and simulations under stalled contraceptive prevalence for unmarried adolescents (SimCP) and met total demand for unmarried adolescents (SimTD) scenarios.

The second scenario, `SimTD`, highlights the potential role of meeting the demand for unmarried adolescents. Meeting total demand would have a sizable effect on adolescent fertility in almost every country. *ABRE* would decline by 8.9% and 17.4% for LAC and SSA respectively. The higher impact in SSA is visible in figure 4, especially for countries like Benin, Burkina Faso, Congo, Cote d'Ivoire, Gabon, Lesotho, or Tanzania. The difference between the fertility rates in the `SimTD` scenario and the model fit illustrates that meeting total demand in SSA countries would reduce fertility rates by 47.4 births per thousand exposed women on average. In the case of LAC countries, the potential effect of meeting the demand is less visible given their higher contraceptive prevalence; however, countries like Brazil, Haiti, or Honduras present higher impacts. Fertility rates would decline on average 27.2 births per thousand exposed women in LAC.

At this point, we only have dealt with the effect of meeting the demand of unmarried adolescents: this has, in general, a higher impact than meeting the demand of married adolescents given that the fertility reduction connected to their contraceptive use is larger (see table 2). Moreover, 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.

2.6 Discussion

Internationally agreed goals on SRHR emphasize achieving universal access to contraception, and our analysis corroborates that a focused perspective is needed so adolescents, and in particular those unmarried sexually active, are not left aside in global monitoring. The situation of lack of access is particularly intense for them: a vast majority of unmarried sexually active adolescents have a demand for family planning, which is larger than demand by married adolescents. Levels of unmet need are also larger for those unmarried sexually active.

Through the simulations, it is possible to infer the two sides of the problem at the same time: there would have been higher adolescent fertility if contraceptive use had not increased over time, and there is still a strong potential reduction of adolescent fertility by satisfying current demand levels. Our analysis shows that increasing levels of contraceptive use by sexually active unmarried adolescents play an important role in explaining the reductions observed in adolescent fertility in many countries. While meeting the demand for family planning of both married and unmarried adolescents reduces adolescent fertility, the impact of meeting the demand is higher for the latter. These effects are sizable: meeting the demand of both groups would decrease fertility by a 12.4% in LAC and 20.3% in SSA. There is a substantial literature on the negative consequences of adolescent pregnancy and childbearing regarding maternal and child mortality, unintended pregnancy, unsafe abortion, educational dropout and lower incomes (Hindin et al. 2016; Neelofur-Khan and WHO 2007; Santhya and Jejeebhoy 2015; United Nations 2013; WHO 2010). In this context, lowering the incidence of adolescent pregnancy by satisfying current demand levels could avoid many of these adverse outcomes and the subsequent reduction of well-being for this and the next generation. Strengthening health systems to meet the needs and priorities of unmarried adolescents should, therefore, be a priority.

While we have focused on the impact of increasing contraceptive prevalence, the literature indicates the importance not only of use but also of effective use. In this respect, sex education and the adoption of more efficient methods could play an important additional role. Sex education leads to increasing demand for contraceptives (Kirby 2011; Gurr 2014), but if women do not have access to them, it results in higher rates of unmet need. We estimated through `SimTD` the potential reduction in fertility of satisfying unmet need. Furthermore, some findings show that adolescents are less likely to change their patterns of sexual activity than their contraceptive practice (International Center for Research on Women 2014). Meeting their contraceptive needs can, therefore, avoid unintended pregnancies and unsafe abortions.

The effect on fertility of increasing contraceptive use is larger for unmarried women than for married women signaling that the former are not willing yet to begin childbearing. Indeed, our estimations show a higher impact of contraceptive use on fertility, in the order of almost four to one, in the case of sexually active unmarried women.

Standard demographic models, such as the proximate determinants framework and the Princeton model, are, from the perspective of this research, too simple. The sharp differences in behavior among adolescents according to marital status indicate the need to analyze them separately. We have done this by broadening the proximate determinants framework in the spirit of the Princeton model while making explicit the role of contraceptive use and controlling for sexual exposure. Due to the significant adverse consequences of adolescent childbearing in countries with high rates such as most of SSA and LAC, it is key not to leave any group aside, and not, in particular, those unmarried sexually active. Our results on the importance of contraceptive prevalence are in line with the imputed reductions based on contraceptive prevalence in applications of the demographic determinants framework (Bongaarts and Potter 1983; Bongaarts 2015). The difference is that we are estimating the effect instead of imputing it, a similar approach to Bongaarts (2017). In that paper it is argued, based on fixed-effects regressions, that the impact of contraceptive prevalence on fertility is not different in sub-Saharan Africa to other regions. This is in line with our findings, but we have found a large heterogeneity in the estimated random-effects in SSA that is not found in LAC. This suggests that there are other factors at play in the African case beyond contraceptive prevalence. Singh, Bankole, and Darroch (2017) look at the impact of contraceptive prevalence on fertility in SSA by means of similar scenarios to the ones devised in this paper using a proximate-determinants like accounting framework. They find that fertility would increase 35% in SSA if contraceptive prevalence was set to zero, and that satisfying current unmet need for modern methods would further reduce fertility by an average of 22% for all women 15-49. Our estimates for adolescents 15-49 are of comparable magnitude based on a different approach.

Regarding the limitations of our study, we have not explicitly addressed the effectiveness of contraceptive methods used by adolescents. Using more efficient methods in combination with condom use for the prevention of sexually transmitted diseases would imply a higher public health impact. There is also no information on induced abortion that would have made the estimates more robust.

We have carried out the analysis based on aggregate survey data. While this is enough to hint at the potential impact of meeting contraceptive needs of adolescents, the use of individual data including contraceptive calendar data would allow for a finer control and measurement of the fertility reduction effect of contraceptive use for the different groups of women in different countries. However, not all surveys report information for unmarried women. In this regard, and for our current purposes, it is enough to use aggregate data. Nevertheless, we intend to use individual-level data in future research to estimate more precisely differences in fertility according to marital status and contraceptive use. This can also avoid some of the shortcomings of aggregate indicators, replacing them for more accurate ones. One such case is the measurement of the proportion sexually active. The standard definition of sexual activity is based on intercourse in the last four weeks; nonetheless, this is not the relevant concept from the perspective of fertility, where a more prolonged period would be desirable, in particular for unmarried women (we consider all married adolescents are exposed). Singh, Bankole, and Darroch (2017) extend it to three months. Our operational definition is based on sexual exposure in the last year, assuming that patterns of contraceptive prevalence are similar than for those sexually active in the previous four weeks.

An additional concern regards data availability. Many countries are still not reporting on demand for contraceptives, sexual activity and other SRH dimensions for unmarried adolescents, as is the case of many Asian countries. Lack of data makes the adoption of well-informed policy decisions more difficult, and it might mean that special needs such as those of sexually active unmarried adolescents are not addressed.

3 Spontaneous termination and induced abortion according to contraceptive use at the time of pregnancy[8][9]

3.1 Resumen

Motivación: El uso de anticonceptivos afecta a la fecundidad no solo reduciendo la probabilidad de quedar embarazada sino también porque disminuye la probabilidad que un embarazo termine en nacimiento. Las terminaciones de un embarazo incluyen el aborto inducido y las terminaciones espontáneas. Para una distinción adecuada se requiere tomar en cuenta el riesgo en competencia entre los posibles resultados de un embarazo. No se han realizado estudios comparativos tomando en cuenta la información de los calendarios de vida reproductiva.

Metodología: Usamos 52,616 embarazos de mujeres con edades entre 15 y 49 años a partir de 14 encuestas DHS recogidas entre 2003 y 2017, las cuales incluyen calendarios de historia reproductiva. Estimamos la probabilidad diferencial entre terminación espontánea y aborto inducido de acuerdo con si la mujer usó o no anticonceptivos al momento de quedarse embarazada, controlando por variables demográficas y socioeconómicas. Utilizamos modelos logísticos multinomiales para tomar en cuenta el riesgo en competencia. También, exponemos las limitaciones en el uso de los datos.

Resultados: El uso de anticonceptivos al momento del embarazo está asociado con una mayor probabilidad de aborto inducido y también con un riesgo mayor de terminación espontánea. Si no se toma en cuenta el riesgo en competencia se obtienen estimaciones sesgadas hacia abajo mostrando un menor riesgo de pérdida espontánea. Los gradientes por edad son importantes, pero fuertemente influenciados por la inclusión de las características de

[8]Una versión previa de este capítulo fue presentada en la XIII edition of the Population Days 2019 en Milán, Italia.

[9]Este capítulo se encuentra actualmente bajo revisión por pares en una revista internacional de alto impacto.

la historia reproductiva de la mujer, como paridad, lo que indica el uso del aborto inducido para limitar el tamaño de la familia.

Discusión: Embarazos luego de un fallo en el uso de anticonceptivos tienen una mayor probabilidad de no terminar en un nacimiento debido al mayor riesgo de aborto inducido y de terminación espontánea. Los modelos agregados sobre el impacto de la planificación familiar deberían reflejar que el uso de anticonceptivos y el aborto inducido conforman estrategias interdependientes, mientras que la terminación espontánea es un riesgo en competencia del aborto inducido.

3.2 Abstract

Background: Contraceptive use affects fertility not only by reducing the chances of getting pregnant but also by lowering the probability of a pregnancy ending in a live birth. Pregnancy terminations include both induced abortion and spontaneous terminations. Proper separation requires accounting for the competing risk among pregnancy outcomes. No previous comparative studies of pregnancy outcomes are based on the rich information available in contraceptive calendars.

Methods: Using 52,616 pregnancies of women aged 15-49 from 14 DHS surveys collected between 2003 and 2017 with reproductive history calendars, we estimate the differential odds of spontaneous termination and induced abortion according to contraceptive use at the time of pregnancy, controlling for demographic and socioeconomic covariates and addressing potential data limitations. Multinomial logistic models account for competing risks.

Results: Contraceptive use at the time of pregnancy is associated with much higher odds of induced abortion but also moderately higher risk of spontaneous termination. Not accounting for competing risks biases estimates downwards often indicating a lower risk of spontaneous terminations. Age-gradients are important, but strongly influenced by the inclusion of reproductive history characteristics such as parity suggesting the use of induced abortion to

limit family size.

Discussion: Pregnancies after contraceptive failure are much more likely not to end in a live-birth, because of increased risk of induced abortion but also changing risk of spontaneous termination. Aggregate models of the impact of family planning should reflect that contraceptive use and induced abortion conform interdependent strategies, and that spontaneous termination is a competing risk of induced abortion.

3.3 Background

Fertility levels depend on the probability of pregnancies ending in a live birth. A comparative study shows proportions of pregnancy terminations ranging from 4.9% and 52.0% in 20 countries, with induced abortion explaining the higher values (Bradley, Croft, and Rutstein 2011). Pregnancy terminations include both spontaneous termination (ST) and induced abortion (IA), which are potentially associated with very different factors (Ahmed and Ray 2014). The goal of this article is to analyze the association of contraceptive use at pregnancy with the type of pregnancy outcome.

Global estimates of the regional prevalence of IA range between 12% and 39% of pregnancies in the period 2010-2014 (Sedgh et al. 2016). These are consensus estimates based on relatively good quality data for countries with high incidence but very scanty data from heterogeneous sources for countries where IA laws are restrictive. The prevalence of IA is known to be associated with institutional factors, such as abortion laws and the functioning of health systems, and to characteristics of the woman. At the personal level, IA is a behavioral choice associated with parity, marital status, age, and socioeconomic variables like level of education or wealth (Dickson, Adde, and Ahinkorah 2018; Chae et al. 2017; Maharana 2017; Souza e Silva et al. 2012). In this respect, an unplanned or unwanted pregnancy is the most commonly reported reason behind an IA (Bankole, Singh, and Haas 1998). Current estimates of the potential impact of contraceptive use are based on the probability of IA in unintended pregnancies (Askew et al. 2017; Bearak et al. 2018). However, contraceptive use at pregnancy indicates a more intense desire to avoid pregnancy since an action is already in place. Therefore, we expect that pregnancies resulting from contraceptive failure are more likely to end in IA.

In contrast to IA, ST, including both miscarriages and stillbirths, should not be perceived as a choice. This does not preclude an association with personal and institutional variables: In addition to the role of health systems, there can be differential biological risk and behavioral differences. Empirical studies on ST confirm the relevance of demographic (e.g., age, parity), health (e.g., illness, antenatal care), and socioeconomic determinants (e.g., education, wealth) (Mosley and Chen 2003; Cai and Feng 2005; Norsker et al. 2012; Zheng et al. 2017; Nfii 2017). Country-case studies show estimates of ST ranging from 4% to 20% of pregnancies with incidence rising with age (Carlson, Hoem, and Rychtarikova 1999; Nybo-Andersen et al. 2000; Cai and Feng 2005; Akker 2012), but evidence on global patterns of ST, and in particular its determinants, is still feeble (Lawn et al. 2016; Askew et al. 2017). In most global models of reproductive health, miscarriages are estimated ad-hoc as a fixed proportion of births and IAs (Stover and Winfrey 2017; Darroch 2018), while evidence starts to accumulate regarding global patterns of stillbirths (Blencowe et al. 2016).

The main role of contraception is to avoid pregnancy. Therefore, pregnancies occurring while using contraceptives are labeled as contraceptive failures and are mostly associated with the use of traditional methods, discontinuation or misuse (Polis et al. 2016). The use of contraceptives denotes not only an interest in avoiding pregnancy but also the determination to do something about it. In terms of the `ready, willing, able` framework (Lesthaeghe and Vanderhoeft 2001) we can reasonably expect women experiencing a contraceptive failure to be more likely to engage in an IA to stop their pregnancy. Evidence of this can be found in high-abortion countries (Westoff 2005).

On the other hand, abortion and the use of modern contraceptives can be considered as substitutes regarding birth prevention. This is consistent with the observed reduction in the prevalence of modern contraception in Nepal in areas where new abortion centers opened (Miller and Valente 2016) or a higher likelihood of IA among users of traditional methods compared to users of modern methods in several post-soviet countries (Westoff 2005). Non-contraceptive users are more heterogeneous: They include women that want to get pregnant together with women not wanting to give birth who have an unmet need for contraception (Sedgh, Ashford, and Hussain 2016). Non-users with unmet need for contraception are, in general, less likely than users to abort, but much more likely to do so than women seeking pregnancy (Westoff 2005).

In contrast to IA, less is known about the relationship between contraceptive use at the time of pregnancy and ST. Medical studies agree in the absence of a causal effect of contraceptives on ST (Jellesen et al. 2008; Waller et al. 2010). However, since pregnancies resulting from contraceptive failure are undesired, they are linked to behavioral differences in prenatal care that can result in higher rates of ST (Marston and Cleland 2004; Cheng et al. 2009): Women whose pregnancy is unwanted or mistimed are less likely to seek prenatal care in a 5-country study (Marston and Cleland 2003) and a study from 32 low-income countries (Guliani, Sepehri, and Serieux 2013). However, another study based on seven countries did not find a relevant link between unwantedness and antenatal care (Saad-Haddad et al. 2016). A recent systematic review (Hall et al. 2017) showed increased odds of low birth weight and neonatal mortality for unintended pregnancies; however, it could not locate studies from developing countries looking at the relationship between ST and pregnancy intentions.[10]

A major methodological challenge is that we can view live-births, IA, and ST as competing outcomes. An early ST might make a subsequent IA not necessary, and some pregnancies ending in IA would have otherwise ended in an ST. Moreover, a live-birth requires that the pregnancy did not terminate earlier (Potter, Ford, and Moots 1975; Meister and Schaefer

[10]The review points to one article from Ethiopia, but upon closer inspection, the article looks at the odds of all types of termination including IA.

2008). Naïve estimators based on the proportion of pregnancies ending in an outcome with no control for competing risks are biased, and different alternative indicators have been proposed (Susser 1983; Figà-Talamanca and Repetto 1988; Hammerslough 1992). In terms of statistical modeling, different strategies have been used in the literature to account for the competing risk: A trivariate probit model treating IA, ST, and live-birth as related separate outcomes (Ahmed and Ray 2014); a multinomial logit to differentiate among IA decided by medical persons, IA decided by others, and ST, conditional on pregnancy termination (Maharana 2017); or a multinomial logit considering ST, IA, and ectopic pregnancy conditional on termination (Schwandt et al. 2011). In our case, there are three reasons to model conditional on pregnancy. First, only in this way it is possible to include pregnancy level covariates such as contraceptive use at pregnancy. Second, pregnancy termination only occurs in the context of a previous pregnancy, and third, contraceptive use at pregnancy carries with it a meaning of contraceptive failure that would not be present, for instance, in the trivariate logit model of unconditional risk: Contraceptive use has two different simultaneous effects. It reduces terminations by lowering the risk of pregnancy while increasing the probability of IA conditional on pregnancy since the pregnancy is unintended. Our interest in this research is not on the net effect, but rather on the second effect on the probability of pregnancy outcomes.

Our goal is, therefore, to measure the differential odds of ST and IA according to use of contraceptives at the time of pregnancy while accounting for the competing risk of pregnancy outcomes, and controlling for the demographic and socioeconomic variables indicated as relevant in the literature. We use contraceptive calendar data from Demographic and Health Surveys (DHS) that meet quality checks. The relationship is not necessarily causal: We expect it mostly to be associated with differential behavior.

This research has policy implications regarding aggregate models of the effects of family planning on births, abortions, miscarriages, stillbirths, and maternal mortality (Darroch 2018;

Stover and Winfrey 2017; Askew et al. 2017). While a variety of methods exist to estimate the impact of contraceptive use, an emerging consensus is building around the reference concept of unintended pregnancies in order to estimate IAs (Askew et al. 2017; Bearak et al. 2018). This is a much simpler perspective than the Westoff approach (Westoff 2005) that also subsumes our proposal based on contraceptive use at the time of pregnancy. A significant advantage of our approach is the admission from the outset that contraceptive use and abortion are dependent on each other. This is, for instance, absent in the proximate determinants of fertility framework (Bongaarts and Potter 1983) in which the Spectrum model is based (Stover and Winfrey 2017), and which is also used to estimate IA indirectly by the `residual method` (Rossier 2003). To our knowledge, this is the first time that the risks of ST and IA have been jointly modeled based on DHS calendar data in an international comparison. We are also providing evidence on the determinants of ST. While more evidence is becoming available on stillbirths (Blencowe et al. 2016), very little is known regarding its relationship with contraceptive failure. Miscarriages are a weak point in current aggregate models. Given the lack of reliable statistics (Askew et al. 2017), they are imputed based on ad-hoc assumptions such as a constant rate of miscarriages for all surveys (Stover and Winfrey 2017; Darroch 2018). Our results provide instructive evidence that can help in refining aggregate models. Aggregate models are essential in informing policy since they are used to measure key Family Planning 2020 indicators such as unsafe abortions averted due to modern contraceptive use (Askew et al. 2017).

3.4 Data and methods

3.4.1 Data

DHS surveys include, in most cases, a contraceptive calendar going back up to 72 months before the interview (The DHS Program 2017). In this monthly calendar, women report pregnancies, the outcome of those pregnancies (live-birth or termination), and contraceptive methods used. We use all possible surveys meeting the following requirements: Having a contraceptive calendar, identifying the type of termination (miscarriage, stillbirth, or IA), interviewing women not-in-union, and including all our covariates of interest, in particular education and wealth quintiles. Unfortunately, most DHS surveys do not report the type of pregnancy termination (Christou, Dibley, and Raynes-Greenow 2017). Hence, we can only employ data from 14 DHS surveys collected between 2003 and 2017. Figure 5 shows the countries included in a map and the proportion of pregnancies ending in ST and IA in the different surveys. Our sample includes individual-level information for 52,616 pregnancies of women aged 15-49 at the time of interview that started in the period of 48 to 9 months before the pregnancy (table 3). We exclude pregnancies starting in the eight months preceding the survey to avoid right censoring.

Since we are interested in risk factors at the pregnancy level, we use the available information to infer the values of covariates at the time of pregnancy. Our main variable of interest, contraceptive use at the time of pregnancy, is directly available in the contraceptive calendar. The pregnancy history makes it possible to calculate the woman's parity and the number of previous terminations for each pregnancy. About half of the surveys (Turkey 2003, Philippines 2003, Moldova 2005, Kazakhstan 1999, Indonesia 2012, and Armenia 2000 and 2005) include a specific calendar on union status that provides information on union status at pregnancy. In the rest of surveys, union status has been imputed based on current union status and the moment and duration of the first union. Regarding women's age, we use age-groups defined according to the imputed age at birth. The imputed age at birth is equal to the mother's age at birth in pregnancies carried to term, and age at pregnancy plus nine months for terminated pregnancies. These age groups are then comparable to those standard in fertility analysis. Based on calendar data it is not possible to infer intention status for all pregnancies since those questions are only asked for live births and ongoing pregnancies.

Socioeconomic variables used as controls include the level of education, wealth quintile, employment, and place of residence. They are only observed at the time of interview.

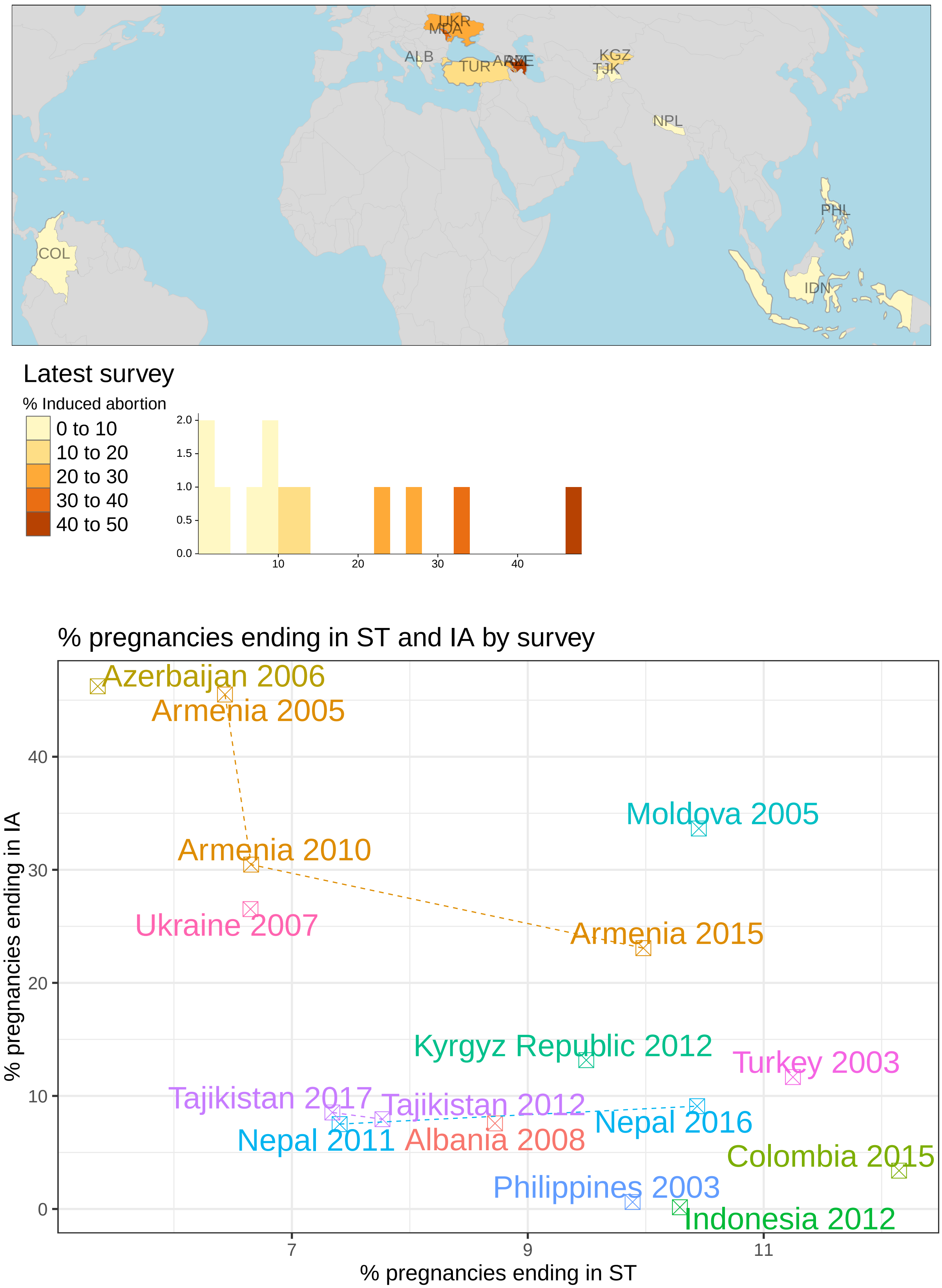


Figure 5: Percentage of pregnancies ending in termination by survey and country.

3.4.2 Methods

A pregnancy ends in birth only if the competing risks of ST and IA do not cause a premature termination. Ignoring the competing nature of risks leads to biased estimates of all risks (Potter, Ford, and Moots 1975, Meister and Schaefer (2008)). In such multiple outcome situations, the multinomial logit model (MNL) provides consistent and efficient estimates when the assumption of independence of irrelevant alternatives (IIA) is met (Cheng and Long 2007). IIA implies that removing an alternative does not alter the relative odds of the rest of alternatives. As a result, removing one outcome would increase the chances of the rest of outcomes. IIA is met in our specific context to the extent that in the absence of IA the biological and behavioral risks for ST would still be there, and that the decision of IA is taken irrespective of the possibility of an ST. STs are generally classified as miscarriages and stillbirths according to the week of pregnancy.[11] While this distinction makes sense from a medical and public health point of view, miscarriages and stillbirths should not be included as separate outcomes in an MNL since they are sequential instead of competing risks. Its inclusion would lead to a violation of the IIA assumption since eliminating stillbirths can only lead to increased likelihood of a birth outcome, leaving IA and miscarriages unaltered. There can also be boundary problems in separating stillbirths from miscarriages (Carlson, Hoem, and Rychtarikova 1999). In our sample miscarriages are much more common than stillbirths: They represent 91.3% of STs. Therefore, the results on ST should be interpreted as referring to miscarriage.

In our analysis, we first look at the conditional probabilities of pregnancy outcomes and binomial logistic regressions for ST and IA using the rest of pregnancy outcomes as the complementary category. Such estimates fail to incorporate competing risks and are biased. We compare them to the consistent and efficient MNL estimates. We estimate survey-specific models that are summarily discussed in the results section and pooled models with data from

[11] WHO recommends 28 weeks as the threshold, https://www.who.int/maternal_child_adolescent/epidemiology/stillbirth/en/, DHS defines stillbirths as occurring in month 7 or later (MacQuarrie et al. 2018).

all the surveys assessed to have no problems of misclassification (see subsection 3.4.3).

For each of the binomial and MNL regressions, a baseline model is estimated. This model only includes our main variable of interest: Contraceptive use at the time of pregnancy. Comparing binomial and MNL estimates provide an idea of biases arising when ignoring the competing risk of pregnancy outcomes. We then estimate four different MNL models. The first model adds age-group to the baseline model. The second model adds the interaction of contraceptive use and age-group to capture the different age-gradients according to contraceptive use. Models 1 and 2 are in line with studies concluding that age is a significant predictor for both IA and ST (Santow and Bracher 1989; Koo et al. 2012). The third model adds women's demographic characteristics like marital status at pregnancy and reproductive history summarized by parity (number of previous live-births at the moment of pregnancy) and the number of previous terminations (the difference between gravidity and the number of deliveries before the current pregnancy). This last variable captures differential risk for women that previously experienced terminations. Since there is little evidence supporting the causality of IA on subsequent ST, our interpretation in the case of ST is a biological predisposition while for IA it would signal the acceptance of IA as a method to avoid unwanted births (Thorp, Hartmann, and Shadigan 2005; Bhattacharya et al. 2012). The fourth model adds socioeconomic variables at the time of the interview. All models include survey-level fixed-effects and controls for recall error (see subsection 3.4.3). All estimations use women weights rescaled to an average of 1 at the survey level. The research is carried out in R (R Core Team 2019) using `multinom` from the `nnet` package for the estimation of MNL models (Venables and Ripley 2002).

Note that MNL estimates both equations simultaneously. Likelihood-ratio tests of significance would only indicate the relevance of a variable without identifying a particular outcome. To test the relevance of a variable for a particular outcome, we use asymptotic Wald tests of joint significance for groups of variables of interest. Note also that in models with interactions, a test of significance for a variable requires a joint test of all terms including that variable.

3.4.3 Addressing data limitations

Contraceptive calendar data includes data for all pregnancies occurring to a woman in the selected period before the interview. It is subject, however, to certain limitations including recall error, omission error, and misclassification of outcomes. We address the potential role of these effects based on current knowledge and devise methods to limit their impact.

Recall error can be present in all retrospective reporting. Still, it is not clear that alternative methods provide more reliable estimates. A comparison of a retrospective survey and continuous population monitoring showed the retrospective survey missing fewer births and fewer terminations than monitoring (Kadobera et al. 2017), and miscarriage rates reported in a recent large-scale prospective cohort study (Ahmed et al. 2018) seem much lower than retrospective survey estimates. Recall error can be identified by a systematic pattern of decline in events registered when going back in time. Different degrees of recall error in DHS terminations have been found using that approach (MacQuarrie et al. 2018). We have taken two actions to mitigate and measure the impact of recall error: First, we do not use all the information in the calendar data, limiting our analysis to pregnancies starting in the 48 months before the interview. This avoids the data with worse deterioration problems together with displacement problems around the cutoff year (Schoumaker 2014). Second, we include a recall error covariate in all models (MacQuarrie et al. 2018). The recall error variable is defined as the distance in years between the month when the pregnancy started and the baseline month of 9 months before the interview. Since this variable is included both in ST and IA regressions, we allow for differential recall error according to outcome.

In our study, there can be omissions regarding pregnancies, their outcomes, or contraceptive use at the time of pregnancy. Regarding pregnancies, there can be different degrees of omission according to the outcome. Miscarriages, particularly those happening early in the pregnancy, can be missing due to ignorance of being pregnant, forgetting, or cultural differences (Cai and Feng 2005). We have found exploratory evidence of this in finding larger differences according to education in first-trimester miscarriages. On the other hand, IA could be either reported as miscarriage (misclassification) or omitted. Intentional omission can be high in contexts where IA is not legal or is not socially accepted (Barreto et al. 1992). There can also be an unintentional omission of medication abortion not being considered as an IA (Jilozian and Agadjanian 2016).

Regarding stillbirths, a DHS-based study evaluated the consistency of DHS calendar data (Bradley, Winfrey, and Croft 2015): Stillbirth rates in some surveys seemed underestimated since they were lower than expected based on levels of early neonatal mortality. Underreporting could be about 50% for countries including full pregnancy history such as those in our sample, and larger for other surveys. The same study evaluated omissions in contraceptive use. In many surveys average contraceptive prevalence estimated from calendar data is lower than rates based on current use from earlier surveys, suggesting underreporting of contraceptive use. Again, in problematic surveys, the discrepancy tends to increase with time since the interview, so that limiting ourselves to pregnancies in the previous four years might help in that respect. Underreporting of contraceptive prevalence could lead to a bias towards zero in our estimates of the effect of contraceptive use at pregnancy since some women reporting no use might have been using.

Concerning misclassification, the biggest concern is misreporting of IA as ST. While this can certainly happen, one advantage of our data is that misclassification can be detected by an abnormal increase of reported ST among contraceptive users. Since they are at higher risk of IA, this would suggest misreporting. Note that many of the surveys in our sample belong to countries with less restrictive laws on IA, where the problem is less likely. The effect seems absent in most surveys, but it can be identified in two particular surveys, Colombia 2015 and the Kyrgyz Republic 2012. We remove those surveys from the pooled sample: While the percentage of pregnancies misclassified is not a large percent of all pregnancies, it can severely bias the estimates regarding ST since a large proportion of reported STs could be

IAs. Estimated effects in the ST equation would be contaminated and resemble the patterns for IA. It does not necessarily affect IA estimates as much since misclassification or omission are captured in a lower survey fixed-effect. The problem would be systematic misclassification or omission according to contraceptive use at pregnancy. While we cannot know if that is the case, it is more likely that misreporting is correlated with socioeconomic and cultural factors that might be captured in the model by wealth, education, and employment variables. In this respect, including these variables in the model makes the estimates of differences according to contraceptive use more robust, while blurring the interpretation of the coefficients of socioeconomic variables.

3.5 Results

Table 3 provides the descriptive characteristics of the pregnancies in our sample, together with their classification according to pregnancy outcome. We provide both unweighted and weighted counts. Sample weights have been defined to have a mean of 1 at the survey level. The outcomes are distributed in 79.1% (n=41,636) live-births, 11.9% (n=6,274) IA, and 8.9% (n=4,706) ST. Pregnancies resulting from contraceptive failure represent 11.7% (n=6,174) of the sample and only 52.3% (n=3,231) of them end in live-birth. The proportion of pregnancies ending in IA was 39.9% (n=2,465) for users compared to only 9.1% (n=4,228) for non-users. In contrast, the proportion of pregnancies ending in ST is smaller for users than non-users.

Table 3: Characteristics of pregnancies and conditional probabilities of outcomes. Probabilities estimated from the weighted sample.

	Total number		Percentage ending in			
				Termination		
	Unweighted	Weighted	Birth	Spontaneous	Induced	p-value
Sample (only included surveys)						
Pregnancies	52,616	52,616	79.1	8.9	11.9	
Surveys						
Included						
Albania 2008	1,150	1,150	83.7	8.7	7.6	< 1e-10

Table 3: Characteristics of pregnancies and conditional probabilities of outcomes. Probabilities estimated from the weighted sample. *(continued)*

	Total number		Percentage ending in			
				Termination		
	Unweighted	Weighted	Birth	Spontaneous	Induced	p-value
Armenia 2005	1,993	1,993	48.1	6.4	45.5	
Armenia 2010	1,634	1,634	62.9	6.7	30.5	
Armenia 2015	1,708	1,708	66.9	10.0	23.1	
Azerbaijan 2006	3,193	3,193	48.4	5.4	46.2	
Indonesia 2012	13,353	13,353	89.6	10.3	0.2	
Moldova 2005	1,974	1,974	55.9	10.5	33.7	
Nepal 2011	4,134	4,134	85.1	7.4	7.5	
Nepal 2016	4,130	4,130	80.5	10.4	9.1	
Philippines 2003	5,276	5,276	89.5	9.9	0.6	
Tajikistan 2012	4,220	4,220	84.3	7.8	7.9	
Tajikistan 2017	4,929	4,929	84.1	7.3	8.5	
Turkey 2003	3,714	3,714	77.1	11.2	11.7	
Ukraine 2007	1,208	1,208	66.8	6.6	26.5	
Excluded due to misclassification						
Colombia 2015	9,013	9,013	84.5	12.1	3.4	
Kyrgyz Republic 2012	3,866	3,866	77.3	9.5	13.2	
Contraceptive use						
Non-users	46,570	46,442	82.7	9.1	8.2	< 1e-10
Users	6,046	6,174	52.3	7.7	39.9	
Union status						
In-union	50,883	50,944	79.0	9.0	12.0	0.001
Not-in-union	1,733	1,672	84.6	7.1	8.3	
Age-group						
< 20	5,780	5,750	86.5	10.1	3.5	< 1e-10
20-24	17,005	17,146	85.0	7.5	7.5	
25-29	14,470	14,606	78.7	8.1	13.3	
30-34	8,780	8,684	73.7	9.0	17.3	
35-39	4,887	4,771	67.3	12.5	20.2	
40-49	1,694	1,659	60.0	16.5	23.5	
Parity						
0	17,005	17,502	88.4	9.8	1.8	< 1e-10
1	14,400	14,752	83.9	8.2	7.9	
2	10,229	10,115	65.9	8.2	25.8	
3	5,201	4,915	66.2	7.6	26.2	
4	2,587	2,384	69.3	9.0	21.7	
5	1,348	1,256	72.3	11.1	16.6	
6+	1,846	1,693	77.1	13.1	9.8	
Previous terminations						
0	38,741	38,796	84.5	9.3	6.2	< 1e-10
1	7,637	7,654	70.3	7.4	22.3	
2	2,979	2,976	59.6	9.6	30.8	
3	1,534	1,507	56.5	9.1	34.3	
4+	1,725	1,683	49.7	7.7	42.7	
Level of education						

Table 3: Characteristics of pregnancies and conditional probabilities of outcomes. Probabilities estimated from the weighted sample. *(continued)*

	Total number		Percentage ending in			
				Termination		
	Unweighted	Weighted	Birth	Spontaneous	Induced	p-value
No education	4,718	4,452	85.4	8.4	6.2	< 1e-10
Primary	10,577	11,018	84.1	10.6	5.3	
Secondary	27,835	28,001	77.0	8.3	14.7	
Higher	9,486	9,145	76.6	9.3	14.1	
Place of residence						
Urban	24,614	23,289	76.2	9.5	14.4	< 1e-10
Rural	28,002	29,327	81.5	8.5	10.0	
Currently working						
No	34,031	34,593	79.9	8.1	12.0	< 1e-10
Yes	18,585	18,023	77.7	10.6	11.7	
Wealth quintile						
Quintile 1	12,880	11,324	80.8	8.4	10.9	< 1e-10
Quintile 2	10,692	10,859	80.6	9.2	10.2	
Quintile 3	10,145	10,690	80.1	8.5	11.4	
Quintile 4	9,845	10,448	78.6	9.3	12.1	
Quintile 5	9,054	9,294	75.0	9.5	15.6	

3.5.1 Detection of misclassification

Before proceeding with the analysis, we assessed potential misclassification problems by looking at changes in the conditional probabilities of outcomes according to use. Misclassification would produce that part (or all) of the increased probability of IA for users would shift to an increased probability of ST. Figure 6 shows that the proportion of pregnancies ending in IA is higher among contraceptive users in all surveys, while in almost all surveys the probability of ST is lower for users as would be expected due to competing risks. Two exceptions stand out: Kyrgyz Republic 2012 and Colombia 2015, where the proportion of pregnancies ending in ST is 5.5 and 2.9 percentage points higher for users, respectively. In these two countries, an explanation in terms of IA reported as SA makes more sense than a significant increase in the risk of ST. As explained in section 3.4.3, we exclude these two surveys from the pooled analysis.

Figure 6: Percentage of pregnancies ending in termination by contraceptive use and survey.

3.5.2 Biases in binomial logistic regressions

Biases in logistic regressions not accounting for competing risks can be detected by comparing the MNL and logit coefficients for contraceptive use at pregnancy in the baseline model that only controls for recall error and survey fixed-effects. Table 4 shows the differences in the pooled sample. MNL estimates that take competing risks into account show users slightly more likely to experience ST than non-users (OR=1.24, p-value=6e-05). In the case of IA, users are much more likely to recur to IA (OR=7.2, p-value<1e-10).

Binomial logistic regression estimates that do not incorporate competing risks are biased downwards. This is particularly extreme in the case of ST, where the OR becomes lower than one (0.83, p-value=3e-04). This means that the competing risks can explain all the observed decline in the conditional probability of ST for contraceptive users. In the case of IA, the estimate is also biased downwards (OR=7.02, p-value<1e-10), but given the intensity of the effects, the order of magnitude is still similar.

Figure 7 explores the survey-specific patterns in individual survey regressions of the baseline model. Solid and hollow points indicate the OR from the MNL and binomial models, respectively. The dotted lines defining a cross around the MNL estimates indicate 95% confidence intervals. We can see that in most countries, particularly those with a higher incidence of IA, the estimates from the logistic regression have a negative bias both for IA and ST detected in the negative slope of the solid line connecting both estimates. In the case of ST, most binomial estimates are lower than one, consistent with the lower proportion of STs among contraceptive users. However, the MNL estimates are mostly higher than 1 indicating a slightly higher risk of ST for users, consistent with lower levels of care. Regarding IA, in all surveys the ORs are higher than 1 for users, corroborating the link between contraceptive failure and IA.

Table 4: Odds ratios (OR) from baseline model.

	Binomial logistic						Multinomial logistic					
	Spontaneous			Induced			Spontaneous			Induced		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Contraceptive use												
Non-users	1.00			1.00			1.00			1.00		
Users	0.83	0.74 - 0.91	3e-04	7.02	6.49 - 7.60	<1e-10	1.24	1.12 - 1.37	6e-05	7.20	6.65 - 7.81	<1e-10
Recall error												
Per year	0.93	0.90 - 0.96	9e-06	0.94	0.91 - 0.97	2e-04	0.93	0.90 - 0.96	2e-06	0.93	0.90 - 0.96	3e-05
Fixed-effect												
Survey			<1e-10			<1e-10			<1e-10			<1e-10

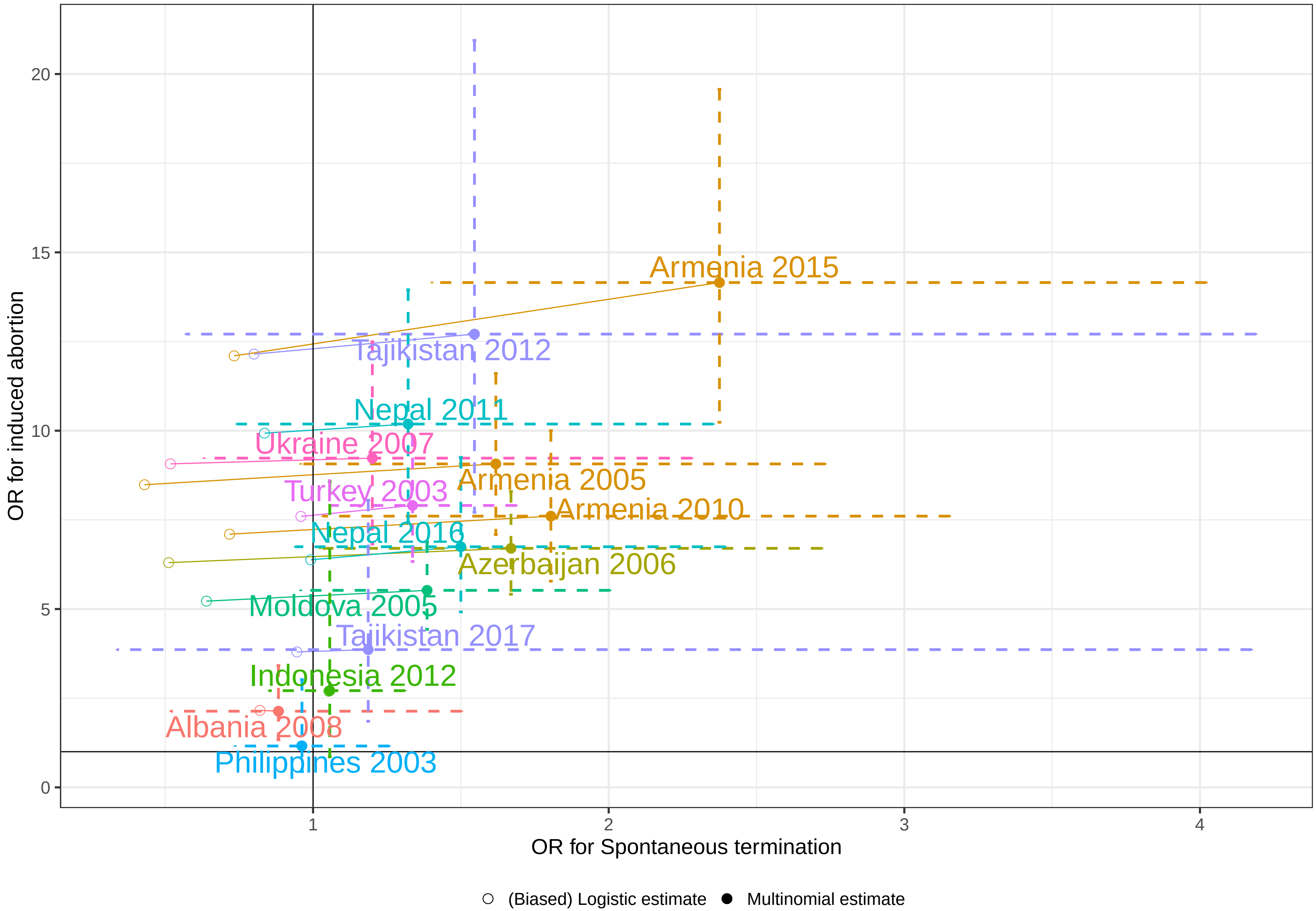


Figure 7: Survey-specific Odds Ratios (OR) for contraceptive use in the multinomial model and logistic estimates. 95% confidence intervals.

3.5.3 Multivariate models accounting for competing risk

Table 5 shows the MNL estimates for models that progressively introduce controls for demographic and socioeconomic variables into the baseline model. Given the general dependence of IA and ST on age, age-group is added in model 1. Models 2 to 4 progressively include interactions between contraceptive use at pregnancy and age, and additional controls for demographic and socioeconomic characteristics. Table 6 provides asymptotic Wald tests of joint significance for the variables on contraceptive use, age, interactions of age and use, and survey-fixed effects. All the tests show a significant effect of both contraceptive use at the time of pregnancy and age on both ST and IA. The interaction of age and use is highly significant for IA and not significant or borderline significant for ST (table 6). This is consistent with combined strategies of contraceptive use and IA by age, whereas the age-gradient for ST might be more connected to biological risk which would have liitle connection with pregnancy intentions. Note that significance tests for individual coefficients are of little interest in interaction models. They only measure the difference to the reference category, in this case `women less than 20 not using contraceptives`.

Table 5: Adjusted odds ratios (AOR) from multinomial logistic regression accounting for competing risk (Birth is the reference).

	Model 1				Model 2				Model 3				Model 4			
	Spontaneous		Induced		Spontaneous		Induced		Spontaneous		Induced		Spontaneous		Induced	
	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value
Contraceptive use																
Non-users	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Users	1.15	0.0085	5.94	<1e-10	1.50	0.069	13.48	<1e-10	1.61	0.032	6.65	<1e-10	1.56	0.045	5.86	<1e-10
Age group																
< 20	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00	
20-24	0.76	3.6e-07	1.57	6e-08	0.76	9e-07	1.74	3e-09	0.79	2e-05	0.68	2e-04	0.76	2e-06	0.59	5e-07
25-29	0.89	0.0248	3.39	<1e-10	0.89	0.043	3.80	<1e-10	0.97	0.568	0.65	3e-05	0.90	0.110	0.49	<1e-10
30-34	1.06	0.2962	5.65	<1e-10	1.07	0.239	6.31	<1e-10	1.20	0.010	0.70	0.001	1.09	0.219	0.46	<1e-10
35-39	1.63	< 1e-10	8.56	<1e-10	1.65	<1e-10	10.72	<1e-10	1.87	<1e-10	1.04	0.734	1.68	1e-10	0.64	3e-04
40-49	2.44	< 1e-10	13.91	<1e-10	2.65	<1e-10	18.89	<1e-10	3.08	<1e-10	1.94	7e-06	2.67	<1e-10	1.23	0.16
Use x Age-group																
Users x < 20					1.00		1.00		1.00		1.00		1.00		1.00	
Users x 20-24					0.84	0.482	0.49	1e-03	0.84	0.493	0.60	0.028	0.86	0.554	0.62	0.04
Users x 25-29					0.77	0.289	0.46	3e-04	0.75	0.244	0.68	0.092	0.77	0.282	0.72	0.16
Users x 30-34					0.76	0.278	0.46	5e-04	0.72	0.184	0.77	0.266	0.73	0.205	0.83	0.44
Users x 35-39					0.75	0.250	0.30	2e-07	0.71	0.171	0.49	0.005	0.73	0.209	0.55	0.02
Users x 40-49					0.46	0.009	0.20	8e-09	0.42	0.004	0.29	3e-05	0.44	0.006	0.31	9e-05
Union status																
Not-in-union									1.00		1.00		1.00		1.00	
In-union									1.34	0.003	0.22	<1e-10	1.34	0.003	0.22	<1e-10
Parity																
0									1.00		1.00		1.00		1.00	
1									0.77	1e-09	4.59	<1e-10	0.77	6e-09	5.17	<1e-10
2									0.89	0.023	18.57	<1e-10	0.92	0.109	25.53	<1e-10
3									0.75	4e-05	23.73	<1e-10	0.79	0.001	39.94	<1e-10
4									0.77	0.003	25.58	<1e-10	0.82	0.029	50.26	<1e-10
5									0.81	0.048	18.58	<1e-10	0.89	0.291	43.80	<1e-10
6+									0.75	0.002	13.58	<1e-10	0.84	0.074	39.78	<1e-10
Previous terminations																
0									1.00		1.00		1.00		1.00	

Table 5: Adjusted odds ratios (AOR) from multinomial logistic regression accounting for competing risk (Birth is the reference). *(continued)*

	Model 1				Model 2				Model 3				Model 4			
	Spontaneous		Induced		Spontaneous		Induced		Spontaneous		Induced		Spontaneous		Induced	
	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value	AOR	p-value
1									0.85	0.001	2.21	<1e-10	0.84	8e-04	2.11	<1e-10
2									1.35	1e-04	2.29	<1e-10	1.34	1e-04	2.08	<1e-10
3									1.28	0.020	2.18	<1e-10	1.31	0.010	2.13	<1e-10
4+									1.11	0.374	2.30	<1e-10	1.16	0.197	2.46	<1e-10
Level of education																
No education													1.00		1.00	
Primary													1.33	4e-05	2.45	<1e-10
Secondary													1.20	0.011	4.36	<1e-10
Higher													1.14	0.126	4.10	<1e-10
Place of residence																
Urban													1.00		1.00	
Rural													0.96	0.246	0.77	1e-08
Wealth quintile																
Quintile 1													1.00		1.00	
Quintile 2													1.13	0.014	1.13	0.03
Quintile 3													1.08	0.154	1.42	4e-09
Quintile 4													1.19	0.001	1.63	<1e-10
Quintile 5													1.22	0.001	2.02	<1e-10
Currently working																
No													1.00		1.00	
Yes													1.36	<1e-10	1.64	<1e-10
Recall error																
Per year	0.93	3.9e-06	0.94	6e-04	0.93	3e-06	0.94	9e-04	0.93	4e-06	0.95	0.003	0.91	4e-08	0.93	2e-04
Fixed-effects																
Survey		< 1e-10		<1e-10		<1e-10		<1e-10		<1e-10		<1e-10		<1e-10		<1e-10

Table 6: Wald test from multinomial logistic regressions.

		Spontaneous		Induced	
Test	df	χ^2	p-value	χ^2	p-value
No contraceptive use					
Baseline model	1	16.1	6e-05	2340	< 1e-10
Model 1	1	6.9	0.008	1773	< 1e-10
Model 2	6	15.0	0.020	1845	< 1e-10
Model 3	6	21.4	0.002	1026	< 1e-10
Model 4	6	19.5	0.003	919	< 1e-10
No age					
Model 1	5	371.0	<1e-10	1642	< 1e-10
Model 2	10	381.0	<1e-10	1680	< 1e-10
Model 3	10	311.7	<1e-10	157	< 1e-10
Model 4	10	265.5	<1e-10	147	< 1e-10
No interaction use - age					
Model 2	5	8.7	0.121	49	2.8e-09
Model 3	5	11.2	0.048	30	1.5e-05
Model 4	5	10.7	0.058	28	3.7e-05
No survey fixed-effects					
Baseline model	13	130.3	<1e-10	3889	< 1e-10
Model 1	13	151.1	<1e-10	3833	< 1e-10
Model 2	13	149.0	<1e-10	3815	< 1e-10
Model 3	13	109.6	<1e-10	3503	< 1e-10
Model 4	13	117.4	<1e-10	2674	< 1e-10

Note:
df = degrees of freedom.

Controlling for age as in model 1 leads to lower estimates of contraceptive use compared to the baseline model for both ST (AOR=1.15, p-value=0.008) and IA (AOR=5.94, p-value<1e-10). Such reduction is consistent with older women being more likely to use contraceptives and more at risk of IA and ST. Age-gradients are highly significant (table 6): U-shaped in the case of ST with a minimum risk at ages 20-24, and increasing with age for IA.

Since IA and contraceptive use provide elements of a combined strategy of fertility control, the age-gradients can be different for contraceptive users and not users. Models 2 to 4 include interaction of age-groups with use. Coefficients for interacted variables in models 2 to 4 are best interpreted collectively as in figure 8 displaying the estimated age-gradients for users and not-users respectively. Model estimates (respect to 0) are shown in the main axis, with AOR in the secondary axis. Only models 2 and 4 are shown due to the similarity of models 3 and

4. Regarding IA, age-profiles are very different for users and not-users, even after controlling for demographic and socioeconomic characteristics. Interactions are highly significant in all models (table 6).

Model 2, with no controls, shows that odds increase sharply with age. In contrast, model 4, with controls, shows relatively flat U-shaped patterns with maximum levels for younger women in the case of users, and sharp U-shaped pattern with minimum levels at ages 30-34 for non-users. The large reduction in the coefficients is mostly connected to the very high effects of parity and union-status. This indicates that the large effect of age without control is due to birth-avoidance of women having 2 children or more (AOR>25 at parities 2 and above compared to nulliparous women in model 4) or not being in union (AOR=0.22 for women in-union compared to those not-in-union). The peak at ages less than 20 in model 4 indicates that these are the women likely to recur to IA at lower parities. The results for individual countries are generally consistent with this idea.

Regarding ST, while the age-patterns are much less marked than for IA, they are always highly significant. They remain as important after controlling for demographic and socio-economic characteristics. In all cases, risks of ST are minimum for women 20-24 and maximum for older women. The interaction between age and use is of borderline significance (p-value=0.058 in model 4) but suggests that the increased risk of ST for users is higher for women in the younger age groups. The effect of parity is not so important for SA, with nulliparous women having the highest risk.

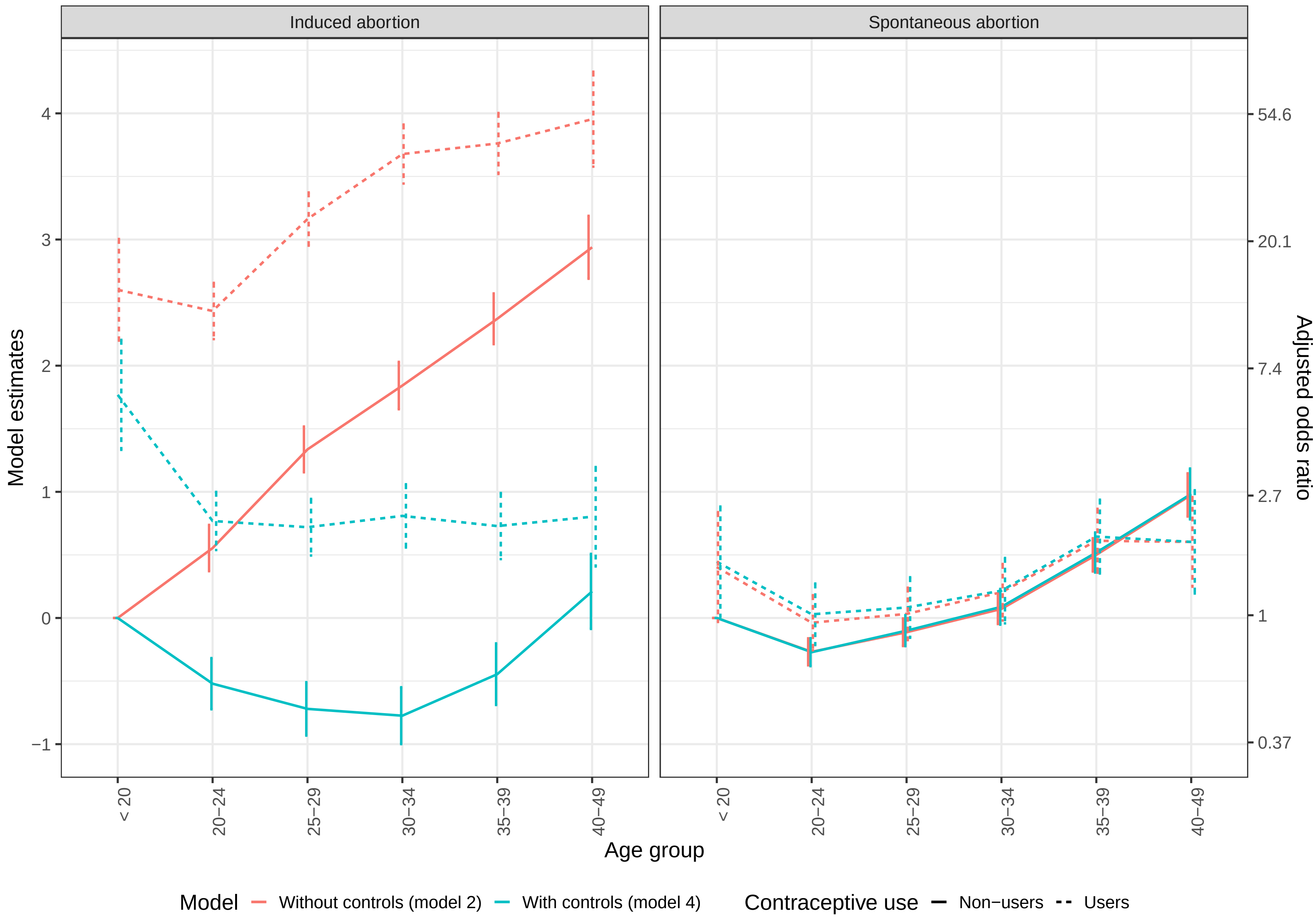


Figure 8: Estimated age-profiles of pregnancy outcomes according to contraceptive use without (model 2) and with (model 4) control for demographic and socioeconomic characteristics. Asymptotic 95% confidence intervals are displayed in vertical.

Regarding the rest of variables in table 5, previous terminations are connected to highly-significant increasing odds for IA in line with the `ready-willing-able` framework, with no apparent pattern for ST. In-union women have higher odds of ST (AOR=1.34, p-value=0.003) in contrast to the lower likelihood of IA. Regarding socioeconomic variables, the odds of ST are surprisingly lower for women with no education compared to the rest. Differences are stronger for IA, with increasing odds with education ranging from AOR of 2.45 (p-value<1e-10) for primary education to an AOR of 4.10 (p-value<1e-10) for women with higher education. Regarding the place of residence, there are no significant differences in ST (p-value=0.25), with a lower likelihood of IA in rural areas (AOR=0.77, p-value=1.5e-08). Wealth quintile patterns indicate that poorest women are more likely to report the lowest levels of both ST and IA. Again, the effects are more prominent in IA, where the AOR at quintile 5 rises to 2.02 (p-value<1e-10) than for ST, with a maximum AOR=1.22 (p-value=0.001). Women currently working are also more likely to experience both IA and ST with stronger effects for IA.

Recall error seems to be present in all cases, with estimates of comparable magnitude for ST and IA.

3.6 Discussion

This study presents original estimates of the differential odds of ST and IA according to contraceptive use at the time of pregnancy while accounting for the competing risk of pregnancy outcomes. It is the first such comparative study making use of the rich information contained in DHS calendar data.

The share of pregnancies not ending in live-birth in our sample is within the ranges reported in the literature. At the survey level, terminated pregnancies range between 10.4% and 51.9%, with the incidence of IA explaining most of the differences (Bradley, Croft, and Rutstein 2011). The incidence of ST ranges from 5.4% to 12.1% of total pregnancies, in line with previous findings (Cai and Feng 2005; Nfii 2017; Nybo-Andersen et al. 2000). In the case of IA, estimates are between 0.2% and 46.2% of total pregnancies (Sedgh et al. 2016).

Our estimates are consistent with previous findings regarding the bond between contraceptive failure and IA using a more extense empirical base. Pregnancies resulting from contraceptive failure are much more likely to end in termination, particularly an IA, but also increase the risk of ST (Bankole, Singh, and Haas 1998; Bradley, Croft, and Rutstein 2011; Marston and Cleland 2004). Even though contraceptive use has been increasing in the last decades, there is still a significant share of pregnancies considered as unintended, mostly due to contraceptive failure (Polis et al. 2016). Both access to and use of contraception are therefore first steps to avoid unwanted pregnancies. Contraceptive failure can be reduced by more efficient contraceptive use and the use of more effective contraceptive methods leading to less unintended pregnancies and fewer abortions (Bongaarts and Westoff 2000).

Regarding ST, since medical studies do not find a causal effect of contraceptive use on miscarriages (Jellesen et al. 2008; Waller et al. 2010), the higher odds of ST could be explained by women being less careful with their pregnancies when resulting from contraceptive failure (Cheng et al. 2009; Guliani, Sepehri, and Serieux 2013; Saad-Haddad et al. 2016). This includes both prenatal care and behavioral factors such as smoking, drinking, or eating patterns. These results are robust when controlling for demographic and socioeconomic variables and are also found in most individual surveys. However, as discussed in the methods section, this result is subject to bias if IAs are misclassified as STs. Excluding suspicious surveys from the pooled sample makes the estimates more robust, but we cannot exclude misclassification in the rest of surveys.

The introduction of demographic and socioeconomic variables, and in particular, separate age-gradients for users and non-users have allowed us to identify combined strategies of contraceptive use and IA in birth prevention. Whereas the age-gradient without further controls shows older women at higher risk of IA, controlling for parity and union-status suggests that parity is more important than age, with women at parities 2 and above or not-in-union, and particularly those using contraceptives, being most likely to abort. In this context, women below the age of 20 are most likely to abort conditional on parity and union status. Working women would also incur a higher opportunity cost from birth and be more likely to abort.

In the case of ST, age-gradients seem more connected to biological factors than to behavioral factors. Age-patterns remain after controlling for other variables: Women 20-24 have the lowest risk of ST. At younger ages, women using contraceptives at pregnancy are more likely to experience ST probably due to lower levels of care, but the present evidence is tentative given the possible contamination of ST coefficients in the presence of misclassification.

Regarding differentials in IA according to the rest of demographic and socioeconomic variables, they are consistent with the `ready, willing, able` framework (Lesthaeghe and Vanderhoeft 2001): more educated women living in urban areas with a higher wealth status could be more likely to recur to IA since they might have better access and be more knowledgeable regarding available options. Such results are in line with others in the literature (Westoff 2005). There is also a possibility that these variables capture differential reporting according to socioeconomic status, with more disadvantaged women less likely to admit an IA. If this is the case, controlling for these variables makes the estimates for contraceptive use more robust.

In the case of ST, while some patterns are consistent with the literature such as the higher risk for nulliparous women or women experiencing previous terminations, the patterns suggest that women in disadvantage (less educated or less wealthy) are less likely to experience ST. While studies based on good quality data show less likelihood of ST with higher socioeconomic status (Carlson, Hoem, and Rychtarikova 1999; Norsker et al. 2012; Zheng et al. 2017), a negative gradient has also been found in other retrospective surveys (Cai and Feng 2005). We have already hinted at alternative explanations: A first one, differential reporting of

ST according to socioeconomic status, with more disadvantaged women being less able to identify or remember a previous ST. A second possibility is contamination from the estimated equation for IA due to misclassification.

On the methodological side, our results confirm the importance of adequately capturing the competing risks between IA and ST (Potter, Ford, and Moots 1975). Not accounting for the competing outcomes would lead to wrongly conclude that the risk of ST is lower for women using contraceptives in contrast to the MNL estimates suggesting a higher risk. It would also underestimate the association between contraceptive failure and IA. The multinomial logit model of pregnancy outcomes conditional on pregnancy proposed here is new in the literature. It is a simple way to adequately control for the competing risks while keeping the results interpretable. It requires the assumption of independence of irrelevant alternatives (Cheng and Long 2007), something that can be defended on a-priori grounds to the extent that miscarriages and stillbirths are grouped together. Analysis of the separate determinants for miscarriages and stillbirths would require taking into account the sequential (not competing) nature of those terminations. Note also that we are focusing on the understudied topic of pregnancy outcomes according to contraceptive use at the time of pregnancy. This is only one part of the overall impact of contraceptive use on birth outcomes: since the main reason why contraceptives are used is that they make unintended pregnancies much less likely, this reduction in the probability of conception leads to a lower number of conceptions and fewer abortions. We focus on what happens in the event of a contraceptive failure. Note also that we have not explored differential patterns according to the contraceptive method used. We believe that the main impact of using more effective methods is avoiding pregnancy. Once a contraceptive failure happens, it is not so relevant why it happened but what is done about it.

Regarding data issues, our sample is biased towards countries where laws regarding IA are less restrictive. This makes recourse to IA more likely. It would be interesting to carry out a similar analysis for countries where IA is illegal or heavily restricted. That study cannot be done using the DHS as a source to the extent that only the surveys in our sample report the nature of the termination, whether it is IA or ST. For other DHS surveys, terminations are registered but not classified. Furthermore, misreporting and omission are more likely in those contexts. We have found problems of misclassification in two surveys identified by an abnormal increase of reported ST among contraceptive users. We have excluded those surveys from the pooled estimates. We have also addressed recall error and omission error by limiting our sample to the most recent 48 months of contraceptive calendar data and including a recall error covariate defined by time since the baseline period.

On the policy side, our research has implications regarding methods for estimating the impact of contraceptive use on abortion and pregnancy outcomes. A first implication is that contraceptive use and IA are dependent strategies. Therefore, methods based on independence such as the residual methods of estimating IA or the Spectrum model are not realistic (Rossier 2003; Stover and Winfrey 2017). Second, since IA and ST are competing risks, scenarios that change one probability while keeping the other constant are not realistic. That is the case of many aggregate models partly due to little evidence on ST. Our research fills a gap in that sense suggesting that ST is much less dependent on contraceptive use than IA, but that still, due to competing risks, there will be a lower probability of ST in high abortion contexts.

4 Reported patterns of pregnancy termination from Demographic and Health Surveys[12][13]

4.1 Resumen

Motivación: Las Encuestas Demográficas y de Salud, ampliamente usadas para la estimación de fecundidad e indicadores de salud reproductiva en países en desarrollo, son subutilizadas para el estudio de terminaciones de embarazos. Esto se debe parcialmente a que muchas de las encuestas no diferencias el tipo de terminación, ya sea espontánea o inducida. Los datos del calendario reproductivo hacen posible analizar los patrones de terminación de acuerdo con el uso de anticonceptivos al momento del embarazo. Fallos en el uso de anticonceptivos aumentan la probabilidad de aborto inducido lo que contribuye a explicar los patrones de terminación.

Metodología: Se utiliza información individual a partir del calendario reproductivo de 623,966 embarazos para analizar los niveles y diferenciales de los patrones reportados de terminación por edad, estado civil y uso de anticonceptivos en 107 encuestas DHS de 50 países. A partir de las estimaciones de la probabilidad de terminación, se calculan indicadores de salud reproductiva brindando indicios de lo que contribuye a las diferencias, y comparando con aquellas encuestas que sí incluyen el tipo de terminación.

Resultados: Las terminaciones reportadas son más altas entre las mujeres que usan anticonceptivos, lo que es consistente con lo esperado, pero dichos niveles son bastante bajos en las encuestas DHS, indicando que las terminaciones reportadas son en su mayoría espontáneas. La diferencia en los patrones aparece cuando se hace análisis por clúster y por regiones, mostrando probabilidades más altas de terminación en función de la incidencia del aborto inducido, principalmente en países de la ex Unión Soviética y Asiáticos con leyes de aborto

[12] Una versión previa de este capítulo fue presentada en la 2018 European Population Conference en Bruselas, Bélgica.

[13] Este capítulo se encuentra enviado a una revista internacional de alto impacto.

más flexibles. La mayoría de los países con leyes de aborto restrictivas tienen niveles bajos de terminaciones reportadas. Mientras que la probabilidad crece con la edad, las tasas de terminación son mayores a edades más jóvenes debido a tasas de embarazo más altas.

Discusión: Este es el primer estudio comparativo de gran escala sobre los patrones reportados de terminaciones en las encuestas DHS. Aunque se han explorado las diferencias entre terminaciones espontáneas e inducidas, se necesita más investigación en cuanto a lo que determina que se reporte una terminación o no.

4.2 Abstract

Background: Demographic and Health Surveys, widely used for estimation of fertility and reproductive health indicators in developing countries, remain underutilized for the study of pregnancy termination. This is partly due to most surveys not reporting the type of pregnancy termination, whether spontaneous or induced. Reproductive calendar data makes it possible to examine termination patterns according to contraceptive use at the time of pregnancy. Contraceptive failure is expected to increase the likelihood of induced abortion helping in the interpretation of reported termination patterns.

Methods: We use individual-level calendar data regarding 623,966 pregnancies to analyze levels and differentials in reported patterns of pregnancy termination by age, union status, and contraceptive use in 107 DHS surveys from 50 countries. From the estimates of the probability of pregnancy termination, we compute derived reproductive health indicators providing an assessment of what is driving the differences by comparison to the few surveys reporting the type of pregnancy termination.

Results: Reported pregnancy termination is higher among women using contraceptives, consistent with expectations, but levels of reported termination are very low in most DHS surveys indicating that most reported terminations are spontaneous. Differential patterns emerging from cluster analysis and regional rates indicate high rates of pregnancy termination

driven by induced abortion in countries from the Former Soviet Union and Asian countries with liberal laws. Most countries with restrictive abortion laws have low levels of reported termination. While the probabilities of pregnancy termination are higher at older ages, termination rates generally peak at younger ages due to higher conception rates.

Discussion: This is the first large comparative study of the patterns of reported pregnancy termination in DHS surveys. While we have explored the extent to which differences arise from spontaneous terminations or induced abortion, more research is needed regarding the determinants of reported pregnancy termination.

4.3 Background

Demographic analysis of fertility focuses on live births, but not all pregnancies are carried to term. A pregnancy ending before live-birth, regardless of the reason, is associated with a pregnancy termination (PT). PT includes both spontaneous terminations (ST) —miscarriage and stillbirth— and induced abortions (IA). The incidence of PT affects fertility levels. For instance, in a sample from 20 low- and middle-income countries, the proportion of PT ranged between 4.9% and 52.0%, mostly depending on the levels of IA (Bradley, Croft, and Rutstein 2011).

Much of what is known regarding fertility levels in developing countries is based on nationally representative demographic surveys. In particular, Demographic and Health Surveys (DHS) are, since 1985, a significant source of information regarding fertility and its proximate determinants like union formation, contraceptive use, and sterility. However, they are rarely used for the estimation of IA or ST (Rossier 2003; Sedgh et al. 2016; Christou, Dibley, and Raynes-Greenow 2017; Bongaarts and Casterline 2018). There are several reasons for this. The first one is connected with data coverage: the majority (but not all) of DHS surveys only classify pregnancy outcomes as live-births or PT without further differentiation. Therefore, some sources only use those surveys reporting the type of termination (Bearak et al. 2019). A second one is a concern regarding the completeness of coverage and possible misclassification of outcomes. The only comparative survey of PT according to outcome based on retrospective survey data dates back to the World Fertility Survey (Casterline 1989). It showed significant differences in the reported incidence of ST among countries and according to sociodemographic variables and generally low reported rates of IA. A recent DHS technical report has analyzed comparative levels of PT to check the consistency of reporting according to time since the interview (MacQuarrie et al. 2018). This research finds signs of underreporting of PT when going back in time, particularly in some countries such as in sub-Saharan Africa. Probably due to these concerns and, in particular, low levels of reported IA in countries where abortion is illegal or heavily restricted, international monitoring efforts that use DHS and related surveys in monitoring reproductive health outcomes, prefer to use regional and subregional estimates derived from other indirect sources to impute the incidence of IA at the country-level in those countries (Sedgh et al. 2016; Singh et al. 2018; Bearak et al. 2019). In the period 2010-2014, subregional estimates of IA ranged between 12% and 39% of pregnancies (Sedgh et al. 2016).

While we share the concern regarding the completeness of coverage, we feel that data on PT has been dismissed as useless before studying it and we pretend to fill this data gap by analyzing the available information on DHS surveys on PT in order to identify patterns in reported PT. In particular, we make use of the information contained in DHS surveys on contraceptive use at the time of pregnancy. Since pregnancies arising from contraceptive failure are unintended, they are more likely to end in an IA (Marston and Cleland 2004; Bradley, Croft, and Rutstein 2011; Cleland and Ali 2004; Polis et al. 2016). We use the few surveys that include details on the type of PT to highlight that differences across surveys in PT are, for the most part, connected to different levels of IA, but also that there remain important differences in levels of reported ST in countries with low reported IA. Previous studies on the incidence of IA highlight, among others, the effect of age and union status (Chae et al. 2017; Dankwah et al. 2018; Dickson, Adde, and Ahinkorah 2018; Ibisomi and

Odimegwu 2008; Maharana 2017). The likelihood of IA increases with age to the extent that it is used to limit family size. Pregnancies occurring outside of unions, on the other hand, might be more likely to be aborted irrespective of family size. Age is also a relevant predictor of the medical risk of ST with a U-shaped age-gradient (Mosley and Chen 2003; Nybo-Andersen et al. 2000; Zheng et al. 2017). For these reasons, we identify patterns of pregnancy termination according to age, union-status, and contraceptive use at the time of pregnancy.

Regarding the interpretation of differences in reported PT, little is known regarding the drivers of reported ST. It is recognized that cultural factors are important both as drivers of self-perception of ST and recall patterns (Casterline 1989; Cai and Feng 2005). Despite a relevant share of pregnancies ending in miscarriage, a cultural norm of silence surrounds them (Layne 1990; Renner et al. 2000). This could be related to grief after facing a loss and possible stigma (Akker 2011, 2012). Moreover, memory could be affected after traumatic experiences so that events related to grief are forgotten (Kolk and Hart 1991; Hart, Brown, and Kolk 2019). On the other hand, while it might be true that some part of differences in reporting might be due to forgetting in some cultural settings, and that for these reasons we should not expect annual time series derived from DHS to be reliable (MacQuarrie et al. 2018), that is only a small part of the variability in reported termination rates. Reported levels of ST tend to be relatively stable over time (Cai and Feng 2005) and reported differentials according to socio-demographic characteristics tend to agree with medical knowledge (Casterline 1989; Cai and Feng 2005). What remains poorly understood is the connection between reported levels, biological determinants of ST, cultural elements behind self-awareness and recall and the functioning of public health systems. In order to advance in this direction, it is necessary first to put the estimates on the table. Prospective cohort studies of ST and IA are often seen as an alternative, more objective way to measure PT. While large scale prospective cohort studies from developing countries are rare, detected levels of ST and IA in a recent comparative study are much lower than those reported in DHS surveys (Ahmed et al. 2018).

In the case of IA, intentional underreporting is even more likely than for ST (Rossier 2003). In particular, we can fear that women are more reluctant to report an IA in a context where it is illegal. We will, therefore, look at differences in reported PT according to the legal status of IA (Singh et al. 2018). However, women, particularly those from more deprived settings, might not be aware of changes in the law (Yogi, Prakash, and Neupane 2018), and, in any case, we cannot be sure to what extent a relationship between reported PT and abortion-legality status is due to increased levels of underreporting or to a lower probability of IA. Problems in understanding concepts such as termination or induced abortion can also be at stake (Moreau, Bajos, and Bouyer 2004).

Regarding the implications of the study, universal access to Sexual and Reproductive Health by 2030 is part of the Sustainable Development Goals (United Nations 2015b). Also, the Family Planning 2020 global partnership includes as goals, among others, increasing contraceptive prevalence, reducing unintended pregnancies, and averting unsafe abortions (Family Planning 2020 2018). Differences in PT according to contraceptive use highlight the consequences of contraceptive failure. The use of more effective methods of family planning can prevent unintended pregnancies and avoid IA. In this respect, it is important to differentiate between the conditional probability of pregnancy termination that will be of relevance in a medical context, and the underlying termination rates that have public health implications. While we find that the conditional probabilities increase with age, termination rates are generally higher for women at peak reproductive ages given their higher risk of conception (Chae et al. 2017). Combining our estimates of the Total Termination Rate with fertility estimates, we can detect the relationship between modern contraceptive prevalence and the Total Pregnancy Rate.

Our research is also relevant regarding fertility estimation based on the proximate determinants framework (Bongaarts 1978, 2015) at the core of aggregate models of reproductive health such as the Spectrum model (Stover and Winfrey 2017). This model is based on independence among proximate determinants such as union formation, contraceptive use, and abortion. In contrast, we explicitly measure differences in PT according to union status and contraceptive use.

4.4 Data and methods

4.4.1 Data

DHS surveys are a rich source of information, especially regarding fertility and family planning. For most countries, DHS surveys collect information using monthly calendar data going back up to 72 months (The DHS Program 2017). Our goal is to analyze the patterns of pregnancy termination according to contraceptive use at the time of pregnancy and according to age and union status. For this purpose we use three different calendars: The contraceptive use and reproductive history calendar (`cal1`), registers pregnancies, pregnancy outcomes, and contraceptive methods used. It identifies when a pregnancy begins and whether it ends in a live-birth or not. The second calendar (`cal2`) identifies the reasons for discontinuing or changing the contraceptive method used. Among others, `cal2` indicates when a woman "became pregnant while using" so that contraceptive use at the time of pregnancy can be perfectly identified. The third calendar (`cal3`) records marital status. From `cal3` we know if women were in-union or not-in-union at the time of pregnancy.

Unfortunately, not every survey includes the three calendars we need. In surveys where `cal2` is absent, we assume a pregnancy occurred while using when a contraceptive method was being used in the month preceding the pregnancy. For surveys not including `cal3`, we impute union status based on the date of the first union and the duration of that union. On the other hand, some DHS surveys only represent women in union. We use all DHS surveys that include all women irrespective of union status and reporting at least `cal1`. After screening for these conditions, our database consists of 107 DHS surveys from 50 low- and middle-income countries, collected between 1990 and 2017, and includes individual-level information for

1,468,524 women aged 15-49 at the time of the interview (see S-table 7). These surveys belong to Africa, Central and West Asia & Europe, Latin America and South and Southeast Asia.

We analyze all pregnancies that started in the 45 to 9 months preceding the interview. Pregnancies in the eight months preceding the interview are excluded to avoid right censoring. In this way, except for a small number of premature births, we capture all births occurring in the 3-years before the interview. That is the same framework used for fertility estimation in DHS. This allows us to move from probabilities of termination to age-specific termination rates. To ensure that the age-groups are comparable, we assign age according to imputed age at birth. This is equal to age at birth for pregnancies carried to term, and age at pregnancy plus nine months for the rest of pregnancies. We use standard five-year age-groups except for the 40-49 age-group due to the small number of pregnancies at age 40 and above. A few pregnancies with an imputed age at birth of less than 15 are excluded in line with DHS fertility estimation. Our sample includes 623,966 pregnancies, of which 555,908 are live-births (outcome `B`) and 68,058 pregnancy terminations (outcome `PT`) (see table 7). Most DHS surveys do not collect the type of PT. In our case, only 16 DHS surveys identifying the type of PT meet our requirements, mostly from countries where abortion is legal. We use these surveys to assess specific patterns of IA and ST according to contraceptive use, and, most importantly, to shed light on the likely distribution of PT in the surveys not reporting the type of termination.

Pregnancies are further classified according to union status and contraceptive use at the time of pregnancy. According to DHS definitions, married women and those in consensual unions are grouped as `in-union`. Women that are never married, divorced, widowed, or separated are grouped as `not-in-union`. Regarding contraceptive use at pregnancy, users of any method at the time of pregnancy are classified as using. The reason is that, irrespective of the efficacy of the contraceptive method used, the use of any method hints at a desire to avoid pregnancy.

Age-specific termination rates (ASTR) and general termination rates (GTR) for all women are derived from the age-specific probabilities of PT and age-specific fertility rates (ASFR) computed by the DHS program for the three years before the survey. We obtain ASFR, general fertility rates (GFR) and contraceptive prevalence rates from the DHS API webpage using the R package `rdhs` (Watson and Eaton 2019).

Table 7: Sample size. Weighted number of women included in the sample by age and union status and weighted number of pregnancies by outcome.

			Percentage of women								Pregnancies ending in	
Code	Survey	Women	In-union	15-19	20-24	25-29	30-34	35-39	40-49	Pregnancies	Birth	Termination
Africa												
AO	Angola 2015	25,567	65.2	25.2	21.8	17.7	12.3	11.6	11.3	8,880	8,288	592
BF	Burkina Faso 2010	31,132	82.9	21.0	20.1	18.6	14.5	12.0	13.8	10,029	9,530	499
BJ	Benin 2011	29,692	77.6	18.9	20.4	19.8	16.3	12.6	12.1	8,253	7,937	316
BU	Burundi 2010	16,403	65.4	27.4	20.9	16.5	11.6	10.7	12.8	5,428	5,032	396
BU	Burundi 2016	30,485	65.3	23.5	20.7	16.3	14.7	11.3	13.4	9,060	8,321	739
ET	Ethiopia 2005	23,964	68.2	26.7	21.4	17.6	12.4	10.8	11.1	7,078	6,770	308
ET	Ethiopia 2011	29,672	75.1	24.5	21.3	18.5	13.6	11.1	11.0	7,506	7,036	470
ET	Ethiopia 2016	27,528	73.6	24.4	19.1	19.7	14.3	12.2	10.3	7,006	6,636	370
GH	Ghana 2008	8,859	69.6	22.3	19.4	16.7	14.6	12.9	14.2	2,097	1,799	298
GH	Ghana 2014	17,169	69.2	18.6	18.7	17.9	14.8	13.8	16.1	4,390	3,593	797
KE	Kenya 1998	13,636	64.4	25.3	20.6	17.3	14.1	12.1	10.5	3,748	3,540	208
KE	Kenya 2003	14,857	61.2	24.8	21.0	17.7	13.4	10.9	12.2	4,034	3,809	225
KE	Kenya 2008	15,151	70.1	23.0	21.0	17.9	13.8	11.1	13.2	3,895	3,664	231
KM	Comoros 2012	9,059	69.3	26.4	19.1	18.2	13.5	11.8	11.0	2,205	2,038	167
LB	Liberia 2013	16,786	76.3	20.8	18.4	17.8	14.2	13.4	15.4	4,599	4,047	552
LS	Lesotho 2009	13,521	66.6	25.0	21.0	15.9	12.7	10.3	15.1	2,530	2,395	135
LS	Lesotho 2014	11,764	65.3	24.8	20.5	16.9	13.8	10.9	13.1	2,253	2,068	185
MA	Morocco 1992	14,145	67.7	15.6	22.9	17.0	16.7	13.2	14.5	3,445	3,152	293
MA	Morocco 2003	30,068	60.2	21.9	18.9	16.4	12.5	12.2	18.1	4,123	3,636	487
MD	Madagascar 2008	31,458	80.9	23.7	17.4	17.4	14.2	12.7	14.6	8,297	7,690	607
ML	Mali 2012	18,960	85.9	21.6	19.7	21.4	14.8	11.4	11.1	6,392	6,133	259
MW	Malawi 2004	20,692	73.1	25.9	24.4	15.7	13.1	10.1	10.7	7,235	6,877	358
MW	Malawi 2010	41,117	82.5	21.7	21.6	19.2	14.6	11.0	11.9	13,049	12,329	720
MW	Malawi 2015	43,386	77.7	23.8	20.9	18.1	15.8	11.7	9.6	11,077	10,450	627
MZ	Mozambique 2011	24,487	77.8	22.4	20.0	18.0	13.9	12.1	13.6	7,888	7,392	496
NG	Nigeria 2008	61,182	75.6	22.0	20.7	18.8	13.2	11.7	13.6	18,702	17,370	1,332
NG	Nigeria 2013	70,955	75.2	21.8	19.2	18.6	13.7	12.0	14.8	21,249	19,642	1,607
NI	Niger 2012	19,981	88.9	21.2	20.1	21.8	14.3	11.1	11.5	8,955	8,325	630
NM	Namibia 2006	17,254	43.3	23.9	20.1	17.3	14.0	11.9	12.7	3,385	3,205	180
NM	Namibia 2013	16,361	42.1	22.5	19.9	17.1	14.7	12.0	13.8	3,312	3,083	229

Table 7: Sample size. Weighted number of women included in the sample by age and union status and weighted number of pregnancies by outcome. *(continued)*

			Percentage of women								Pregnancies ending in	
Code	Survey	Women	In-union	15-19	20-24	25-29	30-34	35-39	40-49	Pregnancies	Birth	Termination
RW	Rwanda 2010	24,554	61.9	22.4	21.7	18.2	12.9	10.4	14.4	5,835	5,418	417
RW	Rwanda 2014	24,480	61.9	21.0	19.4	18.5	16.0	11.6	13.5	5,556	5,118	438
SL	Sierra Leone 2008	13,396	79.7	20.4	20.8	20.3	15.5	12.0	11.1	3,946	3,697	249
SL	Sierra Leone 2013	28,995	74.8	23.3	18.3	18.0	15.0	12.9	12.5	7,952	7,414	538
SN	Senegal 2012	15,240	71.0	26.6	21.7	17.2	12.6	10.1	11.7	4,419	4,008	411
SN	Senegal 2014	14,926	72.6	25.1	20.9	18.6	13.2	10.5	11.7	4,188	3,839	349
SN	Senegal 2015	15,692	71.9	25.8	19.8	18.9	12.7	11.4	11.5	4,294	3,903	391
SN	Senegal 2016	15,709	72.9	25.4	20.6	17.7	14.0	10.6	11.8	4,115	3,741	374
SN	Senegal 2017	29,760	71.2	25.0	18.7	18.6	14.6	11.6	11.5	7,728	6,930	798
TZ	Tanzania 2004	18,442	67.8	23.1	20.6	18.3	14.5	10.8	12.6	6,052	5,520	532
TZ	Tanzania 2010	18,097	75.0	22.1	19.6	17.1	14.3	12.6	14.3	5,535	5,088	447
TZ	Tanzania 2015	23,887	73.3	23.5	19.1	16.6	13.9	12.7	14.3	6,999	6,314	685
UG	Uganda 2006	15,203	78.2	23.2	20.3	17.8	14.6	11.3	12.8	5,778	5,217	561
UG	Uganda 2011	15,543	75.0	23.7	21.1	18.4	13.5	11.6	11.6	5,572	5,015	557
UG	Uganda 2016	33,314	73.9	24.4	20.7	17.8	13.4	11.4	12.3	10,528	9,375	1,153
ZM	Zambia 2007	12,682	73.8	23.2	22.6	19.1	14.0	10.3	10.7	4,384	4,112	272
ZM	Zambia 2013	29,627	72.3	23.9	18.9	18.2	14.8	12.2	12.0	8,592	8,108	484
ZW	Zimbabwe 1994	10,776	64.9	25.5	20.7	16.7	13.7	11.5	12.0	2,645	2,427	218
ZW	Zimbabwe 1999	9,872	62.5	28.4	23.2	16.9	9.0	10.8	11.6	2,452	2,252	200
ZW	Zimbabwe 2005	15,481	61.1	27.2	22.0	16.9	12.5	9.6	11.8	3,557	3,298	259
ZW	Zimbabwe 2010	16,255	72.0	23.9	21.8	18.5	14.8	10.8	10.2	3,981	3,702	279
ZW	Zimbabwe 2015	17,660	73.2	21.3	19.2	18.5	16.5	12.7	11.8	4,207	3,851	356
Central and West Asia & Europe												
AL	Albania 2008	11,904	69.4	20.4	14.7	11.9	15.5	19.6	18.0	1,049	882	167
AL	Albania 2017	17,926	80.7	9.6	16.4	14.1	15.1	16.1	28.7	1,767	1,604	163
AM	Armenia 2000	11,234	70.3	19.5	15.8	12.4	14.6	16.7	21.0	2,508	932	1,576
AM	Armenia 2005	9,783	75.2	12.6	15.2	14.8	14.3	17.0	26.2	2,035	978	1,057
AM	Armenia 2010	9,427	74.8	11.2	21.7	16.0	14.7	13.8	22.5	1,508	956	552
AM	Armenia 2015	10,568	76.1	8.0	19.2	19.8	17.1	15.3	20.7	1,549	1,048	501
AZ	Azerbaijan 2006	14,366	67.3	20.7	17.5	14.3	14.1	15.9	17.5	3,121	1,491	1,630
KK	Kazakhstan 1999	8,507	65.4	17.8	14.9	16.9	16.4	16.2	17.8	1,613	856	757
KY	Kyrgyz Republic 2012	14,831	73.6	20.1	19.7	15.9	13.1	12.5	18.8	3,436	2,665	771

Table 7: Sample size. Weighted number of women included in the sample by age and union status and weighted number of pregnancies by outcome. *(continued)*

			Percentage of women								Pregnancies ending in	
Code	Survey	Women	In-union	15-19	20-24	25-29	30-34	35-39	40-49	Pregnancies	Birth	Termination
MB	Moldova 2005	13,033	67.5	20.9	16.0	14.4	13.5	12.9	22.2	1,854	1,036	818
TJ	Tajikistan 2012	17,680	69.9	22.8	20.3	15.7	12.6	11.8	16.7	4,111	3,455	656
TJ	Tajikistan 2017	19,554	74.5	20.4	19.5	18.5	13.9	12.1	15.6	4,850	4,079	771
TR	Turkey 1998	13,319	81.3	15.1	18.3	17.5	17.8	14.7	16.5	2,860	2,158	702
TR	Turkey 2003	15,300	94.8	5.6	15.8	19.8	17.8	17.8	23.2	3,200	2,464	736
UA	Ukraine 2007	12,342	76.9	14.3	15.7	16.2	16.0	15.9	21.8	1,061	701	360
Latin America												
BO	Bolivia 1994	15,303	64.5	21.9	18.9	17.4	15.5	12.5	13.7	4,086	3,718	368
BO	Bolivia 2008	31,082	67.9	21.2	17.6	16.9	14.2	13.0	17.2	6,217	5,412	805
BR	Brazil 1996	22,715	63.1	20.2	16.9	17.3	15.8	13.7	16.2	3,386	2,927	459
CO	Colombia 1990	15,418	64.9	22.3	21.5	19.0	14.5	11.1	11.6	2,684	2,348	336
CO	Colombia 1995	20,150	57.8	19.8	19.3	17.7	14.2	13.4	15.6	3,543	3,143	400
CO	Colombia 2000	21,255	54.6	21.0	17.3	16.1	15.3	14.0	16.3	3,350	2,823	527
CO	Colombia 2005	70,147	55.4	19.0	17.6	15.3	14.8	14.3	19.0	10,185	8,374	1,811
CO	Colombia 2010	89,239	70.5	19.5	16.8	16.1	14.5	14.3	18.8	11,639	9,568	2,071
CO	Colombia 2015	66,362	71.3	18.7	16.9	15.6	14.9	13.4	20.5	7,807	6,603	1,204
DR	Dominican Republic 1991	12,546	63.4	25.5	22.5	17.7	14.3	11.0	9.0	2,877	2,463	414
DR	Dominican Republic 1996	14,905	65.3	22.9	20.1	17.2	14.7	12.9	12.3	3,255	2,709	546
DR	Dominican Republic 1999	2,028	62.6	24.1	21.3	19.4	16.9	7.7	10.6	435	340	95
DR	Dominican Republic 2002	41,477	67.7	21.7	18.4	16.6	14.9	13.9	14.4	8,065	6,761	1,304
GU	Guatemala 1995	21,716	70.9	24.3	19.2	14.8	13.6	12.8	15.4	6,179	5,811	368
GU	Guatemala 1998	10,598	71.4	24.7	19.8	15.8	13.3	12.6	13.9	2,988	2,813	175
GU	Guatemala 2014	47,045	68.1	23.1	19.1	16.0	14.2	12.3	15.4	8,300	7,649	651
GY	Guyana 2009	8,916	70.9	20.3	15.6	15.2	14.7	14.8	19.3	1,567	1,225	342
HN	Honduras 2005	36,022	73.7	23.3	19.6	16.4	13.9	11.7	15.0	6,767	6,154	613
HN	Honduras 2011	41,241	72.6	23.2	19.0	16.3	14.3	12.1	15.0	7,120	6,420	700
NC	Nicaragua 1998	23,629	67.4	25.1	19.2	17.3	14.6	12.0	11.7	5,145	4,734	411
PE	Peru 1991	28,575	59.7	23.1	19.8	16.9	14.7	12.4	13.1	5,696	5,114	582
PE	Peru 1996	52,860	63.8	21.5	18.9	17.3	15.1	12.7	14.5	10,459	9,408	1,051
PE	Peru 2000	50,579	62.2	20.7	18.1	16.4	15.5	13.5	15.8	8,027	7,201	826
PE	Peru 2004	34,361	61.3	19.6	17.3	16.3	15.6	14.6	16.6	4,531	4,019	512
PE	Peru 2007	40,992	62.6	18.7	16.7	15.9	15.5	13.2	19.9	5,949	5,116	833

Table 7: Sample size. Weighted number of women included in the sample by age and union status and weighted number of pregnancies by outcome. *(continued)*

			Percentage of women								Pregnancies ending in	
Code	Survey	Women	In-union	15-19	20-24	25-29	30-34	35-39	40-49	Pregnancies	Birth	Termination
PE	Peru 2009	44,210	63.1	18.7	16.5	15.9	15.4	14.7	18.9	6,514	5,599	915
PE	Peru 2010	41,908	62.6	18.5	16.3	15.9	15.7	14.7	19.0	6,115	5,150	965
PE	Peru 2011	40,991	63.2	18.1	16.1	16.0	15.8	14.8	19.2	6,109	5,184	925
PY	Paraguay 1990	10,530	64.6	22.4	19.1	17.5	14.2	12.1	14.6	2,789	2,485	304
South and Southeast Asia												
IA	India 2005	227,719	72.6	21.3	19.4	17.3	15.1	13.0	14.0	38,223	33,576	4,647
ID	Indonesia 2012	84,923	71.9	16.1	15.9	17.1	16.0	15.4	19.5	11,858	10,600	1,258
KH	Cambodia 2010	33,889	69.9	21.2	18.7	18.2	10.1	12.5	19.4	6,514	5,108	1,406
KH	Cambodia 2014	32,230	71.9	18.7	18.4	18.1	16.1	10.3	18.4	5,985	4,555	1,430
NP	Nepal 2011	22,776	78.0	23.1	19.4	16.8	14.4	12.6	13.7	3,848	3,275	573
NP	Nepal 2016	23,046	81.9	22.1	17.1	16.6	14.6	13.0	16.6	3,749	3,008	741
PH	Philippines 1993	26,738	63.7	21.4	18.9	17.6	14.7	13.4	14.0	6,144	5,549	595
PH	Philippines 1998	24,745	64.3	21.3	17.6	17.2	15.2	13.0	15.6	5,229	4,667	562
PH	Philippines 2003	24,282	66.2	19.6	17.9	16.5	15.9	13.5	16.6	4,787	4,288	499
TL	Timor Leste 2009	22,591	67.4	25.5	18.7	12.4	13.9	14.0	15.5	6,225	6,044	181
TL	Timor Leste 2016	21,001	63.0	25.3	17.9	16.6	12.9	10.4	16.9	4,680	4,521	159

4.4.2 Methods

4.4.2.1 Probability of pregnancy termination

We estimate separate conditional probabilities of PT (T) for each combination of age-group, union status, and contraceptive use at the time of pregnancy at the survey level. DHS surveys are complex surveys representative at the national level with a stratified two-stage cluster design. Given unequal probabilities of selection we use women weights (w_i) so that the conditional probability is computed as the ratio of the weighted number of pregnancies ending in termination to the total weighted number of pregnancies irrespective of outcome (p):

$$T_{s,a,m,u} = \frac{\sum w_i \cdot (p = PT)_{s,a,m,u}}{\sum w_i \cdot (p = PT)_{s,a,m,u} + \sum w_i \cdot (p = B)_{s,a,m,u}} \tag{3}$$

The subscripts a, m, and u refer to age-group, union-status, and contraceptive use at the time of pregnancy, respectively. s identifies the particular subpopulation analyzed. It can be a specific survey, a pooled regional sample or the total pooled sample. For surveys reporting the type of pregnancy termination, we follow the same approach to derive the conditional probabilities for each termination type, ST and IA. All calculations are carried out in R (R Core Team 2019) using `tidyverse` packages (Wickham 2017) and purposely written functions for managing DHS reproductive calendar data.

Approximate binomial confidence intervals are derived from the unweighted number of cases using the Wilson method (Agresti and Coull 1998). For this purpose, we use the `binconf` function from R package `Hmisc` (Harrell Jr., Dupont, and others 2018).

4.4.2.2 Clustering

In order to identify common patterns of pregnancy termination at the survey level according to age-group, union-status, and contraceptive use at pregnancy, we use cluster analysis.

Unfortunately, in many surveys sample size is too small for accurate estimation of T, especially among older women not-in-union, or among contraceptive users in countries with low contraceptive prevalence. With the view to minimize the problem, we have regrouped pregnancies to women not-in-union in only two age-groups before performing the cluster analysis: 15-24 and 25-49. There are still some combinations where the probability is based on less than 10 unweighted pregnancies. This happens for 12.1% of the categories. Given the considerable uncertainty involved in those estimates we have preferred to set them as missing data in combination with the use of a variant of the k-means cluster analysis algorithm, k-POD, that allows for missing data while simultaneously imputing the missing data to the cluster average (Chi, Chi, and Baraniuk 2015). k-POD uses a majorization-minimization algorithm to identify a clustering according to the observed data and retains the information without assuming any distribution over the missingness patterns. We have reprogrammed the algorithm in R package `kpodclustr` (Chi and Chi 2014) to use multiple initial values in order to avoid issues of lack of convergence.

Regarding the choice of the number of clusters, we use the `gap statistic` method since it usually outperforms other methods proposed in the literature (Tibshirani, Walther, and Hastie 2001). The optimal number of clusters is 4. The interpretation of the clusters is based on the cluster averages for each of the conditional probabilities, and Principal Component Analysis (PCA) that extracts the linear combinations of variables representing the largest possible variability present in the data (Kassambara 2017). In our case, the first two principal components represent 84.2% of the variance. The computations are carried out using R packages `factoextra` (Kassambara and Mundt 2017) and `FactoMineR` (Lê, Josse, and Husson 2008).

4.4.2.3 Termination and pregnancy rates

Given our choice of the time-window and our use of imputed age-at-birth instead of age-at-pregnancy, T can be combined with reported ASFRs for the 3-years before the survey to derive reproductive health indicators like $ASTR$, GTR, and the total termination rate (TTR). While T indicates what happens once the pregnancy takes place, the rates provide an estimate of the likelihood of a woman experiencing a termination in a given year. TTR can be interpreted as the expected number of terminations throughout the reproductive years in a synthetic cohort experiencing current $ASTRs$.

$ASTR$ for a particular sub-group i can be defined as

$$\text{ASTR}_a = \frac{PT_a}{N_a} \tag{4}$$

where PT_a represents the number of terminated pregnancies in the subgroup of women of age a, and N_a is the number of woman-years of exposure. $ASFR_a$ is defined equivalently as $\frac{B_a}{N_a}$ where B_a represents the number of births. Since T_a represents the probability of pregnancy termination, $1 - T_a$ represents the probability of a pregnancy ending in live-birth. Thus, we can estimate $ASTR_a$ as:

$$\text{ASTR}_a = \frac{PT_a}{B_a} \cdot \frac{B_a}{N_a} = \frac{T_a}{1 - T_a} \cdot \text{ASFR}_a \tag{5}$$

A similar calculation can be carried out for the GTR as a function of the GFR

$$\text{GTR} = \frac{T}{1 - T} \cdot \text{GFR} \tag{6}$$

In this case, T is the probability of pregnancy termination based on all pregnancies.

TTR is obtained by aggregation of the respective $ASTR$s. In the case of 5-year age-groups, it is given by:

$$\text{TTR} = \sum_a 5 \cdot \text{ASTR}_a \tag{7}$$

This is a parallel definition to that of the Total Fertility Rate (TFR). An estimate of the number of lifetime pregnancies expected over a woman's reproductive ages, the Total Pregnancy Rate (TPR), can be computed as the sum of TFR and TTR:

$$\text{TPR} = \text{TFR} + \text{TTR} \tag{8}$$

Note that TPR should conceptually include pregnancies ending in ST as in our case. Other investigators have used an estimate of TPR only including pregnancies resulting in birth or IA (Bongaarts and Casterline 2018).

4.4.2.4 Tentative separation of terminations as induced or spontaneous

While DHS surveys do not provide information on the type of PT for most surveys, it is possible to use the information contained in those few surveys that report it for a tentative separation of terminations in induced and spontaneous. Based on the 16 DHS surveys with information on the type of outcome, we have estimated logistic regression models for the probability of IA conditional on termination. The simple idea is that higher values of T will be associated with a higher proportion of IA among PT. Since IA is expected to be more frequent among women who were using contraceptives at the time of pregnancy, we use the conditional probabilities according to contraceptive use providing a total of 32 data points. We estimate two models (see table 8).

The first model includes independent variables T and contraceptive use. The second model only T. Since contraceptive use is not statistically significant in the first model and its AIC value is higher, we keep the second model. We, then, compute a tentative probability of IA by multiplying the predicted values of the model by T. ST is the difference between T and the probability of IA. This simple approach provides an educated guess at what the relative proportions of IA and ST are in those surveys reporting all terminations together. While a simple approximation, it is complex enough to capture that the probabilities of ST decline

Table 8: Model estimates of the probability of induced abortion from the probability of pregnancy termination (T).

	Model 1	**Model2**
Intercept	-1.635^{*}	-1.632^{**}
	(0.836)	(0.826)
T	7.582^{**}	6.733^{**}
	(3.220)	(2.796)
$use = 1$	-0.584	
	(1.007)	
AIC	29.716	28.028
BIC	34.113	30.959
Log Likelihood	-11.858	-12.014
Num. obs.	32	32

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

when IA is very high due to the competing nature of both risks since women undergoing an IA are no longer at risk of ST (Potter, Ford, and Moots 1975).

4.5 Results

4.5.1 Patterns of pregnancy termination

Levels of T at the survey level vary significantly between surveys and according to demographic characteristics (see table 9). The lower panel of figure 9 displays the overall percentage of terminated pregnancies, T, for the 107 surveys. For those surveys that report the type of outcome, the bars display the respective contribution of IA and ST to all terminations. A first pattern emerges: High values of T are connected with a high prevalence of IA, with ST levels not increasing or even decreasing in countries with high proportions of terminated pregnancies. We also see that most countries reporting the type of PT are high abortion countries except for Indonesia 2012 and Philippines 2003. However, most of the surveys not reporting the type of outcome have low proportions of PT suggesting that in those countries most reported terminations are spontaneous.

Table 9: Weighted number of pregnancies (P) and probability of termination (T) included in the sample by contraceptive use, union status, and age-group.

					Contraceptive use				Union status				Age-group					
			Total		Using		Not using		In-union		Not-in-union		15-24		25-34		35-49	
Code	Survey	Cluster	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Africa																		
AO	Angola 2015	1	8,880	6.7	38	23.7	8,842	6.6	6,507	6.4	2,374	7.3	4,240	6.6	3,324	5.6	1,316	9.6
BF	Burkina Faso 2010	1	10,029	5.0	65	13.8	9,965	4.9	9,687	4.8	342	9.6	4,171	5.4	4,248	4.2	1,610	6.1
BJ	Benin 2011	1	8,253	3.8	39	10.3	8,215	3.8	7,434	3.6	819	6.1	3,180	3.9	4,001	3.5	1,072	5.0
BU	Burundi 2010	1	5,428	7.3	95	7.4	5,333	7.3	5,157	7.3	271	7.4	2,104	7.3	2,272	5.2	1,052	11.8
BU	Burundi 2016	1	9,060	8.2	151	6.0	8,909	8.2	8,463	8.3	598	5.5	3,051	7.8	4,310	6.5	1,699	12.9
ET	Ethiopia 2005	1	7,078	4.4	62	24.2	7,016	4.2	6,935	4.3	143	7.7	2,941	4.1	3,013	3.7	1,124	6.8
ET	Ethiopia 2011	1	7,506	6.3	373	7.2	7,133	6.2	7,315	6.2	191	7.9	3,074	6.5	3,288	4.3	1,144	11.2
ET	Ethiopia 2016	1	7,006	5.3	70	14.3	6,936	5.2	6,851	5.2	155	10.3	2,692	4.2	3,219	4.9	1,095	8.9
GH	Ghana 2008	2	2,097	14.2	162	17.3	1,935	14.0	1,811	11.8	286	29.4	811	15.5	931	12.5	355	15.8
GH	Ghana 2014	2	4,390	18.2	201	29.9	4,190	17.6	3,671	14.7	719	36.2	1,474	20.6	2,072	15.8	844	19.7
KE	Kenya 1998	1	3,748	5.5	326	4.9	3,422	5.6	3,069	5.2	679	7.1	1,837	5.2	1,487	5.4	424	7.5
KE	Kenya 2003	1	4,034	5.6	324	6.8	3,710	5.5	3,419	5.7	616	5.0	1,950	5.8	1,602	4.3	482	8.7
KE	Kenya 2008	1	3,895	5.9	495	5.7	3,400	6.0	3,249	6.4	647	3.7	1,818	4.0	1,584	5.7	493	13.6
KM	Comoros 2012	1	2,205	7.6	26	3.8	2,180	7.6	2,103	7.5	102	8.8	796	5.2	1,037	7.3	372	13.4
LB	Liberia 2013	2	4,599	12.0	91	37.4	4,507	11.5	3,498	11.9	1,101	12.2	2,154	10.1	1,765	12.6	680	16.5
LS	Lesotho 2009	1	2,530	5.3	228	7.0	2,301	5.2	1,962	5.5	568	4.9	1,359	5.1	906	4.9	265	8.3
LS	Lesotho 2014	1	2,253	8.2	260	6.2	1,992	8.5	1,696	8.5	556	7.6	1,181	6.4	820	9.6	252	11.9
MA	Morocco 1992	1	3,445	8.5	435	11.3	3,010	8.1	3,430	8.5	15	6.7	1,034	7.5	1,660	8.3	751	10.4
MA	Morocco 2003	1	4,123	11.8	868	13.4	3,255	11.4	4,091	11.8	33	15.2	1,374	9.3	1,935	10.2	814	19.8
MD	Madagascar 2008	1	8,297	7.3	517	13.2	7,780	6.9	7,533	6.8	763	12.3	3,909	6.9	3,109	7.1	1,279	8.9
ML	Mali 2012	1	6,392	4.1	9	11.1	6,383	4.0	6,084	4.0	308	5.2	2,680	4.0	2,838	3.6	874	5.5
MW	Malawi 2004	1	7,235	4.9	240	3.8	6,995	5.0	6,651	4.9	584	5.1	3,932	4.8	2,474	4.4	829	7.0
MW	Malawi 2010	1	13,049	5.5	945	3.9	12,103	5.6	12,080	5.3	969	8.5	6,257	5.1	5,072	5.3	1,720	7.7
MW	Malawi 2015	1	11,077	5.7	225	6.2	10,853	5.6	9,652	5.4	1,426	7.4	5,612	5.8	4,167	5.1	1,298	6.9
MZ	Mozambique 2011	1	7,888	6.3	58	19.0	7,830	6.2	6,872	5.6	1,016	11.0	3,648	6.9	3,045	5.3	1,195	6.9
NG	Nigeria 2008	1	18,702	7.1	909	12.9	17,794	6.8	17,311	6.2	1,392	18.0	7,470	7.2	8,253	5.8	2,979	10.5
NG	Nigeria 2013	1	21,249	7.6	501	17.6	20,748	7.3	20,002	7.0	1,247	16.1	8,451	6.9	9,410	7.0	3,388	10.9
NI	Niger 2012	1	8,955	7.0	32	6.2	8,923	7.0	8,785	7.1	171	6.4	3,758	5.9	3,906	6.6	1,291	11.7
NM	Namibia 2006	1	3,385	5.3	309	4.2	3,076	5.4	1,705	7.1	1,680	3.5	1,486	3.6	1,385	5.3	514	10.5
NM	Namibia 2013	1	3,312	6.9	327	4.6	2,985	7.2	1,455	8.1	1,857	6.0	1,414	4.5	1,388	8.1	510	10.4
RW	Rwanda 2010	1	5,835	7.1	248	9.7	5,587	7.0	5,199	7.3	635	6.0	2,036	6.9	2,729	5.5	1,070	12.0
RW	Rwanda 2014	1	5,556	7.9	370	11.6	5,186	7.6	4,747	8.2	809	5.9	1,803	6.9	2,794	7.0	959	12.3

Table 9: Weighted number of pregnancies (P) and probability of termination (T) included in the sample by contraceptive use, union status, and age-group. *(continued)*

					Contraceptive use				Union status				Age-group					
			Total		Using		Not using		In-union		Not-in-union		15-24		25-34		35-49	
Code	Survey	Cluster	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
SL	Sierra Leone 2008	1	3,946	6.3	94	9.6	3,853	6.2	3,502	6.1	444	8.1	1,685	6.1	1,687	6.1	574	7.7
SL	Sierra Leone 2013	1	7,952	6.8	104	21.2	7,848	6.6	6,790	6.5	1,163	8.5	3,373	6.4	3,332	6.2	1,247	9.1
SN	Senegal 2012	1	4,419	9.3	33	12.1	4,386	9.3	4,209	9.4	209	6.7	1,773	9.4	1,886	7.9	760	12.6
SN	Senegal 2014	1	4,188	8.3	28	10.7	4,159	8.3	3,915	8.4	273	7.0	1,570	7.4	1,913	8.4	705	10.2
SN	Senegal 2015	1	4,294	9.1	55	14.5	4,239	9.1	4,066	9.3	229	5.7	1,567	7.0	1,947	7.6	780	17.1
SN	Senegal 2016	1	4,115	9.1	91	9.9	4,024	9.1	3,930	8.9	185	12.4	1,523	7.6	1,898	8.1	694	15.0
SN	Senegal 2017	1	7,728	10.3	63	6.3	7,665	10.4	7,326	10.5	402	7.7	2,754	8.8	3,558	8.7	1,416	17.4
TZ	Tanzania 2004	1	6,052	8.8	255	13.7	5,796	8.6	5,288	8.3	764	12.3	2,765	7.5	2,492	8.1	795	15.5
TZ	Tanzania 2010	1	5,535	8.1	309	4.2	5,226	8.3	4,938	8.3	597	6.0	2,392	7.3	2,251	6.8	892	13.5
TZ	Tanzania 2015	1	6,999	9.8	368	12.2	6,631	9.7	6,053	9.7	946	10.5	3,121	8.5	2,719	9.3	1,159	14.5
UG	Uganda 2006	1	5,778	9.7	328	11.6	5,450	9.6	5,291	9.5	487	12.3	2,586	8.9	2,332	7.7	860	17.4
UG	Uganda 2011	1	5,572	10.0	253	9.9	5,319	10.0	5,040	9.6	532	13.5	2,587	9.4	2,187	8.1	798	17.0
UG	Uganda 2016	2	10,528	11.0	422	17.3	10,106	10.7	9,152	10.8	1,376	11.8	5,025	9.9	4,064	9.6	1,439	18.4
ZM	Zambia 2007	1	4,384	6.2	468	6.4	3,917	6.2	3,828	6.1	556	7.0	1,957	6.0	1,814	6.2	613	6.9
ZM	Zambia 2013	1	8,592	5.6	536	5.0	8,056	5.7	7,181	5.6	1,411	6.0	3,819	5.3	3,522	4.8	1,251	9.0
ZW	Zimbabwe 1994	1	2,645	8.2	279	9.7	2,366	8.1	2,231	8.2	414	8.2	1,295	8.2	992	6.5	358	13.4
ZW	Zimbabwe 1999	1	2,452	8.2	222	8.6	2,230	8.1	2,027	8.2	425	8.2	1,349	8.2	808	6.6	295	12.2
ZW	Zimbabwe 2005	1	3,557	7.3	358	6.4	3,199	7.4	3,028	7.4	529	6.6	1,940	6.9	1,274	6.0	343	14.3
ZW	Zimbabwe 2010	1	3,981	7.0	283	6.7	3,698	7.0	3,404	7.1	578	6.6	1,987	6.2	1,599	7.8	395	7.6
ZW	Zimbabwe 2015	1	4,207	8.5	346	7.2	3,860	8.6	3,634	8.4	572	9.1	1,879	9.0	1,805	6.2	523	14.3
Central and West Asia & Europe																		
AL	Albania 2008	2	1,049	15.9	221	18.6	828	15.3	996	16.6	53	3.8	372	10.2	580	15.3	97	41.2
AL	Albania 2017	1	1,767	9.2	82	22.0	1,686	8.6	1,665	9.6	103	2.9	591	7.3	994	7.8	182	23.1
AM	Armenia 2000	4	2,508	62.8	1,080	85.2	1,428	45.9	2,495	62.8	13	61.5	988	40.1	1,096	74.0	424	87.0
AM	Armenia 2005	4	2,035	51.9	586	83.3	1,449	39.3	1,991	51.9	43	53.5	830	31.1	960	62.7	245	80.4
AM	Armenia 2010	3	1,508	36.6	276	67.4	1,232	29.7	1,487	36.9	20	15.0	690	22.8	677	46.1	141	58.9
AM	Armenia 2015	3	1,549	32.3	220	75.5	1,328	25.3	1,522	32.4	27	29.6	571	21.9	838	36.8	140	48.6
AZ	Azerbaijan 2006	4	3,121	52.2	664	82.4	2,457	44.1	3,069	52.6	52	32.7	1,234	31.4	1,382	60.6	505	80.4
KK	Kazakhstan 1999	4	1,613	46.9	374	78.3	1,238	37.6	1,458	45.5	154	61.0	653	35.2	746	51.3	214	67.3
KY	Kyrgyz Rep. 2012	3	3,436	22.4	213	50.2	3,222	20.6	3,317	22.4	119	23.5	1,458	17.6	1,543	24.4	435	31.7
MB	Moldova 2005	4	1,854	44.1	536	67.9	1,318	34.4	1,713	43.3	141	53.2	869	35.4	790	46.7	195	72.3
TJ	Tajikistan 2012	3	4,111	16.0	74	54.1	4,037	15.3	4,034	15.9	77	16.9	2,003	11.2	1,707	17.6	401	32.4
TJ	Tajikistan 2017	2	4,850	15.9	41	39.0	4,809	15.7	4,771	15.9	80	13.8	2,462	10.5	2,027	18.7	361	36.8

Table 9: Weighted number of pregnancies (P) and probability of termination (T) included in the sample by contraceptive use, union status, and age-group. *(continued)*

					Contraceptive use				Union status				Age-group					
			Total		Using		Not using		In-union		Not-in-union		15-24		25-34		35-49	
Code	Survey	Cluster	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
TR	Turkey 1998	3	2,860	24.5	615	45.7	2,244	18.8	2,849	24.5	10	30.0	1,316	17.6	1,233	25.9	311	48.9
TR	Turkey 2003	3	3,200	23.0	851	37.6	2,350	17.7	3,199	22.9	2	100.0	1,393	15.7	1,398	23.8	409	45.0
UA	Ukraine 2007	3	1,061	33.9	264	65.2	797	23.6	974	34.5	87	27.6	447	20.4	502	41.0	112	56.2
Latin America																		
BO	Bolivia 1994	1	4,086	9.0	776	13.8	3,310	7.9	3,651	9.2	435	7.6	1,625	6.9	1,806	10.4	655	10.5
BO	Bolivia 2008	1	6,217	12.9	1,522	15.5	4,695	12.1	5,150	13.1	1,067	12.0	2,618	10.6	2,578	13.3	1,021	18.1
BR	Brazil 1996	2	3,386	13.6	697	16.8	2,689	12.7	2,699	13.0	687	15.7	1,658	12.5	1,326	11.7	402	24.1
CO	Colombia 1990	2	2,684	12.5	521	17.1	2,163	11.4	2,312	13.1	372	8.6	1,344	10.5	1,079	13.1	261	20.7
CO	Colombia 1995	1	3,543	11.3	965	14.5	2,578	10.1	2,867	11.6	675	9.9	1,751	10.0	1,420	11.7	372	15.9
CO	Colombia 2000	2	3,350	15.7	1,119	16.9	2,230	15.2	2,489	15.2	861	17.1	1,613	13.3	1,353	15.7	384	26.0
CO	Colombia 2005	2	10,185	17.8	2,937	21.5	7,248	16.3	7,425	16.7	2,760	20.7	5,200	16.2	3,746	17.4	1,239	25.8
CO	Colombia 2010	2	11,639	17.8	2,543	21.0	9,096	16.9	8,714	18.2	2,925	16.7	5,995	15.8	4,303	17.8	1,341	26.5
CO	Colombia 2015	2	7,807	15.4	1,582	19.3	6,224	14.4	5,908	15.3	1,899	15.7	3,913	13.2	3,099	16.5	795	22.3
DR	Dominican Rep. 1991	2	2,877	14.4	327	21.7	2,549	13.5	2,722	14.4	155	14.2	1,534	10.7	1,145	17.9	198	22.7
DR	Dominican Rep. 1996	2	3,255	16.8	398	19.1	2,857	16.5	2,933	15.9	322	25.2	1,818	15.4	1,234	17.2	203	26.6
DR	Dominican Rep. 1999	2	435	21.8	60	20.0	375	22.1	394	18.5	41	53.7	224	18.3	181	24.9	30	30.0
DR	Dominican Rep. 2002	2	8,065	16.2	1,044	21.6	7,021	15.4	7,094	14.6	971	27.9	4,557	15.3	2,969	16.3	539	22.4
GU	Guatemala 1995	1	6,179	6.0	245	11.0	5,934	5.7	5,845	6.0	334	4.8	2,952	5.1	2,355	5.6	872	9.7
GU	Guatemala 1998	1	2,988	5.9	197	11.2	2,791	5.4	2,736	5.7	252	7.1	1,451	4.5	1,125	6.7	412	8.5
GU	Guatemala 2014	1	8,300	7.8	935	10.8	7,365	7.5	7,313	8.0	987	6.8	4,193	6.3	3,179	8.2	928	13.7
GY	Guyana 2009	2	1,567	21.8	195	34.9	1,372	20.0	1,254	22.2	313	20.1	768	15.5	583	25.2	216	35.2
HN	Honduras 2005	1	6,767	9.1	1,053	12.5	5,713	8.4	6,241	9.0	526	10.1	3,417	7.1	2,545	8.8	805	18.1
HN	Honduras 2011	1	7,120	9.8	757	14.3	6,363	9.3	6,281	10.2	838	6.8	3,709	8.1	2,658	9.8	753	18.5
NC	Nicaragua 1998	1	5,145	8.0	469	12.4	4,677	7.5	4,860	7.8	285	10.9	2,781	7.3	1,828	8.2	536	10.8
PE	Peru 1991	1	5,696	10.2	1,643	13.1	4,053	9.0	4,993	10.2	703	10.4	2,342	6.8	2,473	11.0	881	17.0
PE	Peru 1996	1	10,459	10.0	3,037	12.4	7,422	9.1	9,026	10.0	1,433	10.1	4,453	7.9	4,347	10.6	1,659	14.4
PE	Peru 2000	1	8,027	10.3	1,976	13.9	6,052	9.1	6,565	10.0	1,462	11.5	3,310	7.8	3,406	10.8	1,311	15.1
PE	Peru 2004	1	4,531	11.3	1,249	14.7	3,282	10.0	3,667	11.0	864	12.6	1,813	9.7	1,917	10.4	801	17.0
PE	Peru 2007	2	5,949	14.0	1,810	17.6	4,139	12.4	4,762	14.0	1,187	14.1	2,385	12.0	2,548	13.1	1,016	20.9
PE	Peru 2009	2	6,514	14.0	2,026	17.8	4,488	12.3	5,239	12.9	1,275	18.6	2,513	12.8	2,839	12.8	1,162	19.8
PE	Peru 2010	2	6,115	15.8	1,906	21.2	4,209	13.3	4,930	14.8	1,185	19.8	2,419	12.6	2,606	15.5	1,090	23.4
PE	Peru 2011	2	6,109	15.1	1,963	20.2	4,146	12.7	4,905	14.0	1,204	19.8	2,297	13.3	2,709	14.2	1,103	21.3
PY	Paraguay 1990	1	2,789	10.9	414	19.8	2,375	9.3	2,453	11.3	336	8.3	1,088	8.4	1,212	11.1	489	16.0

Table 9: Weighted number of pregnancies (P) and probability of termination (T) included in the sample by contraceptive use, union status, and age-group. *(continued)*

					Contraceptive use				Union status				Age-group					
			Total		Using		Not using		In-union		Not-in-union		15-24		25-34		35-49	
Code	Survey	Cluster	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
South and Southeast Asia																		
IA	India 2005	2	38,223	12.2	1,591	27.9	36,632	11.5	38,134	12.1	89	22.5	23,470	11.0	13,046	13.5	1,707	18.1
ID	Indonesia 2012	1	11,858	10.6	843	11.6	11,016	10.5	11,369	10.8	489	6.1	4,052	8.3	5,788	9.9	2,018	17.3
KH	Cambodia 2010	3	6,514	21.6	409	49.1	6,105	19.7	6,359	21.7	155	17.4	2,545	15.1	2,859	20.4	1,110	39.5
KH	Cambodia 2014	3	5,985	23.9	584	53.3	5,401	20.7	5,863	23.9	122	24.6	2,401	17.2	2,860	23.7	724	47.0
NP	Nepal 2011	2	3,848	14.9	191	40.3	3,657	13.6	3,807	14.9	41	14.6	2,158	10.9	1,401	19.2	289	23.9
NP	Nepal 2016	3	3,749	19.8	187	41.7	3,563	18.6	3,713	19.9	36	5.6	2,196	14.9	1,358	24.0	195	44.6
PH	Philippines 1993	1	6,144	9.7	749	12.1	5,395	9.3	5,842	9.8	302	7.3	2,143	8.0	2,939	8.5	1,062	16.2
PH	Philippines 1998	1	5,229	10.7	1,007	11.4	4,221	10.6	4,910	10.9	319	8.2	1,770	9.1	2,544	9.2	915	18.1
PH	Philippines 2003	1	4,787	10.4	655	10.8	4,133	10.4	4,414	10.8	373	5.6	1,747	8.7	2,183	9.2	857	17.0
TL	Timor Leste 2009	1	6,225	2.9	31	6.5	6,194	2.9	6,109	2.8	117	6.8	2,041	2.8	2,728	2.5	1,456	3.7
TL	Timor Leste 2016	1	4,680	3.4	16	0.0	4,664	3.4	4,449	3.4	231	2.6	1,616	4.0	2,340	2.7	724	4.3

The upper panel of figure 9 introduces the differences in the type of outcome according to contraceptive use at the time of pregnancy for those 16 surveys reporting the type of PT. Graph A contains the same information of the lower panel whereas graphs B and C refer to not-users and users of contraception respectively, the latter experiencing contraceptive failure. We can see that, consistent with our expectations, the probabilities of termination are much higher for women that were using contraceptives, indicating that they were not willing to get pregnant. The reason behind is a higher level of IA resulting in countries where most pregnancies occurring while using do not end in a live-birth. Indeed, those countries with an extremely high prevalence of IA have, if something, lower levels of ST probably due to the competing nature of the risks. Whereas women using have the highest rates of IA, and therefore T, countries with a high incidence of abortion among users tend also to have higher abortion rates among not users.

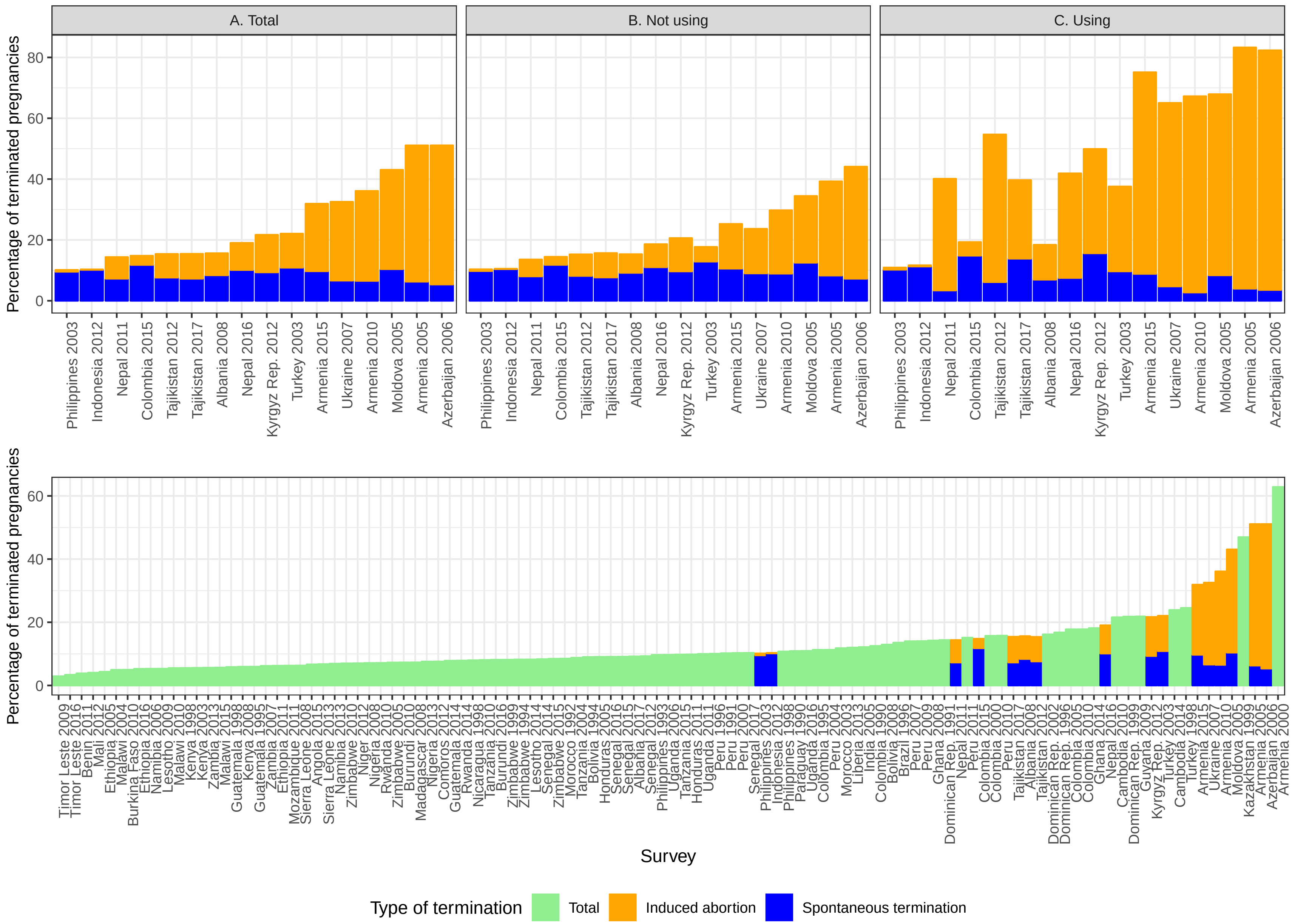


Figure 9: Probability of pregnancy termination by survey.

Figure 10 shows the relation between T of users and non-users in all surveys using a logarithmic scale. Almost all surveys are above the black diagonal (x = y). This means that women experiencing contraceptive failure are more likely to report terminations than women not using contraceptives. Given the patterns found in figure 9 for surveys with information on the type of outcome, the most likely explanation is that contraceptive users are more likely to recur to IA. While the probability of termination is higher among users than not users, a positive association is observed in consonance with the results for the countries reporting the type of PT. This means that countries with relatively high levels of PT among users also tend to have high T for non-users. Regional differences can also be inspected by looking at color. Countries in Central and West Asia & Europe tend to have the highest levels of T both for users and non-users. Latin American countries tend to have medium levels of termination for both groups. All African countries have relatively low levels of T with relatively high variance in the differences according to contraceptive use. South and Southeast Asia is very heterogeneous with countries like Cambodia and Nepal having high reported termination rates, whereas Timor Leste reports the lowest levels for both users and not-users. Lines connect surveys of the same country and labels are placed in the point of the earliest survey. Ascending lines tend to predominate indicating that termination rates move together for users and non-users, but there are exceptions, mostly in countries with low levels of T, like in Africa or Asia. Regarding trends over time, there are countries with increasing termination rates like Ghana or Nepal with others like Armenia experiencing declining rates.

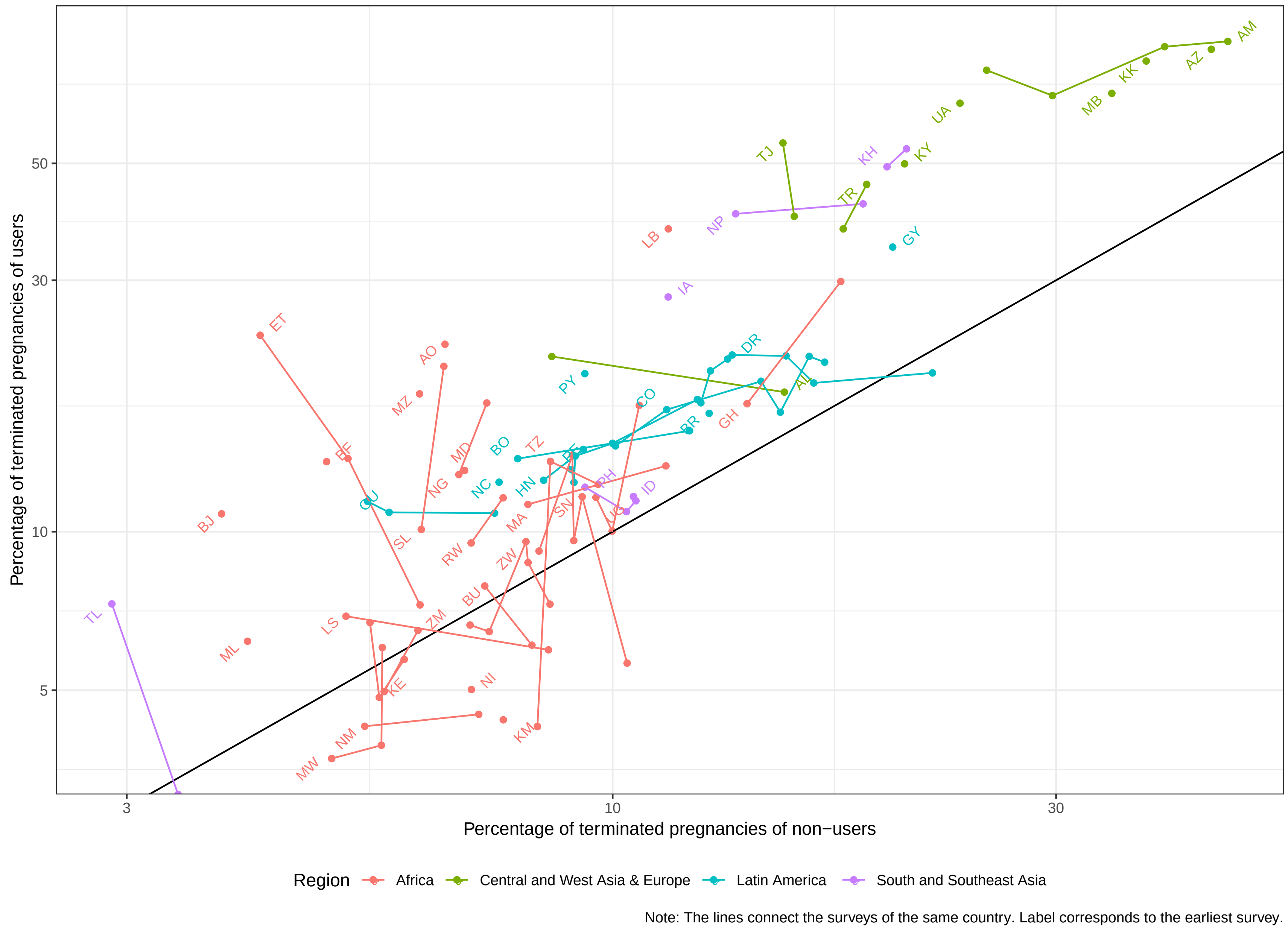


Figure 10: Probability of pregnancy termination by contraceptive use at pregnancy.

Overall patterns of PT by age and union status are shown in the upper panel of figure 11. We can see that contraceptive users are more likely to experience terminations for all combinations of age and union status confirming that contraceptive failure points to a more likely use of IA. The overall percentages of T are 20.9% and 9.8%, respectively. Regarding the patterns according to age, in the case of contraceptive users, the likelihood of termination increases monotonically with age irrespective of union status. This is consistent with the use of IA at older ages to limit family size. In the case of non-users in-union, the largest group, T is minimal for the age-group 20-24 increasing monotonically at older ages. This is consistent with medical evidence on a minimum risk of ST at peak fertility ages. Irrespective of union status, the minimum risk of PT is reached at ages 20-24 (9.3% of terminated pregnancies) reaching a maximum of 20.4% at ages 40-49. Regarding union status, and for all combinations of use and age, women not in union are at a slightly higher risk of termination. On average, T is 10.8% for in-union women and 12% for those not-in-union.

Results by region tend to share the same demographic patterns. In general terms, T increases with age beyond the 20-24 age-group, and it is higher for not-in-union women and women experiencing contraceptive failure (lower panel of figure 11). Nevertheless, there are sharp regional differences in the likelihood of PT and the relative importance of these variables. Africa has the lowest average T in our sample, 7.4%. Also, it shows the least differences among contraceptive users and not-users suggesting very low reported IA, with one exception: Women 15-29 not-in-union using contraception report somewhat higher termination rates suggesting some use of IA to avoid births outside of an union. In contrast to Africa, Central and West Asia & Europe has the highest estimates of T in our sample, 30.7%, and the highest differences according to contraceptive use: 64.9% of terminated pregnancies for users compared to 23.9% for not-users. This, again, suggests a high incidence of IA. Latin America lies in middle-ground compared to the previous two regions with an average T of 12.7%. This region presents an increasing trend by age from 10.5% at ages 15-19 to 24.5% at 45-49. Also, there are differences in T by union status and contraceptive use, 12.2% and 15.1% for in-union and not-in-union women, and 17.1% and 11.5% for users and not-users. In the case of South and Southeast Asia, we notice large confidence intervals for women not-in-union due to a combination of almost universal marriage and low fertility outside of marriage. The average T is similar to Latin America with an average T of 12.4%. We find a higher probability of PT as women ages, going from 10% at ages 20-24 to 24.2% at 40-49. However, the difference by union status is unclear due to the scarcity of cases for not-in-union women. According to contraceptive use at pregnancy, T is 23.8% and 11.6% for users and not-users, respectively.

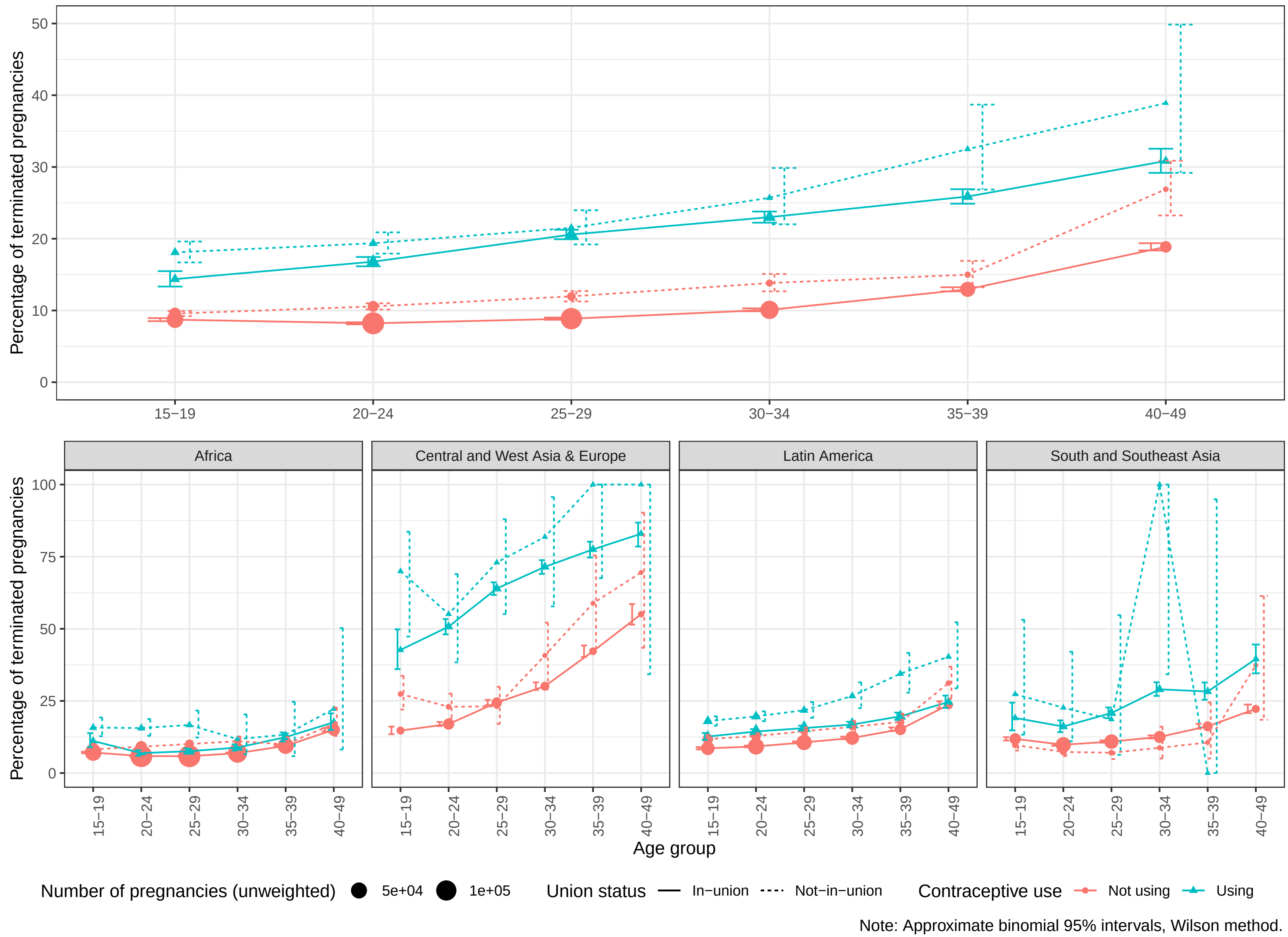
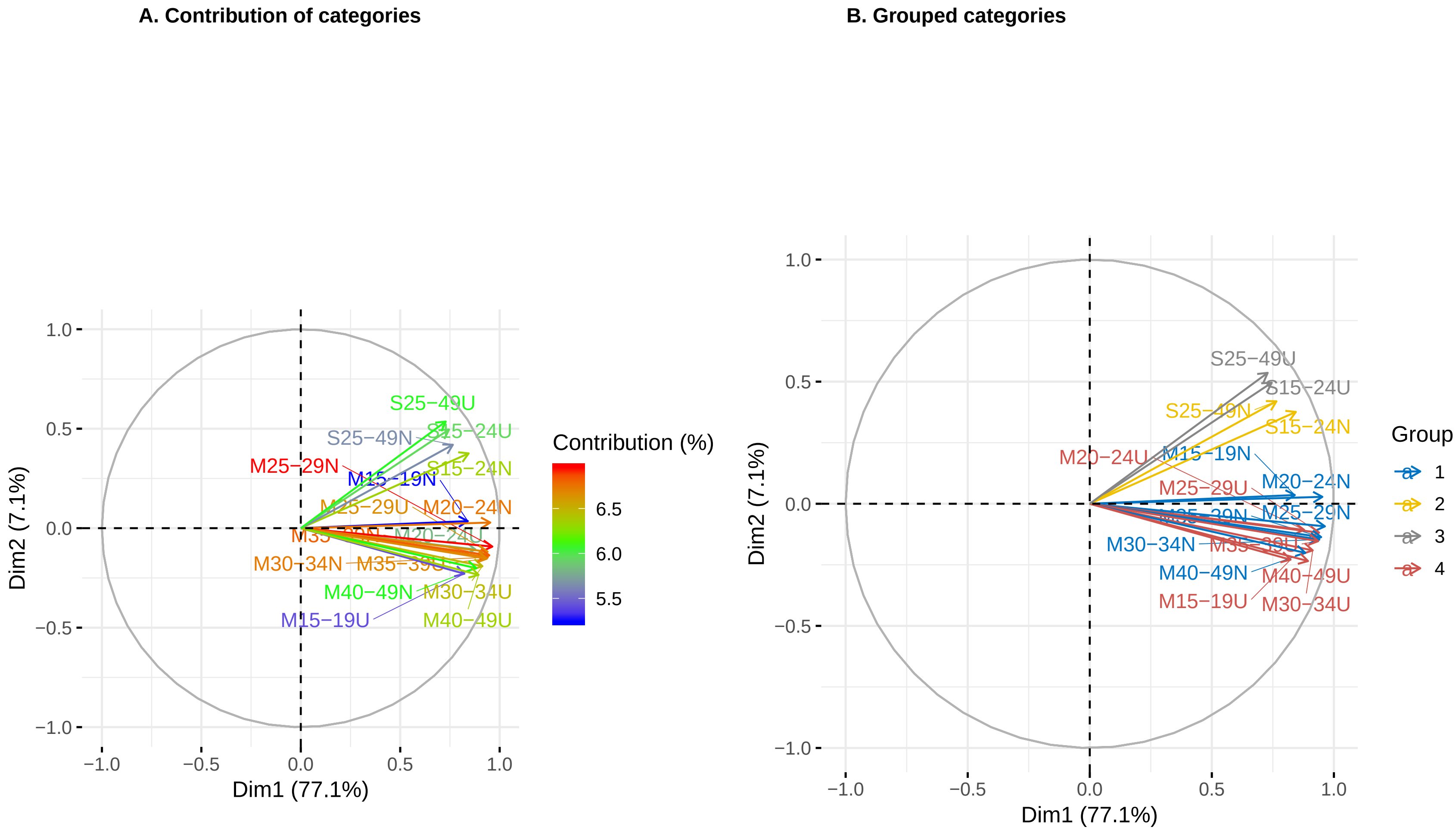


Figure 11: Probability of pregnancy termination according to age, union status, and contraceptive use at pregnancy.

We identified earlier that some regions, and in particular Africa and South and Southeast Asia, are heterogeneous in terms of the risk of PT and the relative differences according to contraceptive use. Cluster analysis can help in characterizing more homogeneous groups. Given the low number of pregnancies in some categories of age and union-status at the country level, and as described in the methods section, we group women not-in-union in two large age-groups: 15-24 and 25-49. For the cluster analysis, each survey is characterized by 16 conditional probabilities: 8 for contraceptive users and 8 for non-users, for 6 age-groups in the case of women in-union and 2 age-groups for women not-in-union. Four clusters emerge that have been labeled 1 to 4 in increasing order of T. These four clusters also have specific differentials according to age-group, union status, and contraceptive use at pregnancy. Such differential patterns are highlighted in the PCA. Figure 12 displays the surveys plotted according to the two first PCA dimensions. Principal component 1, capturing 77.1% of the variance, gives positive weight to all conditional probabilities providing a summary measure of terminations levels. Principal component 2 highlights differential patterns according to age, contraceptive use and union status, in particular, whether women not-in-union using contraceptives have higher T and the respective ages at which the risk of termination starts to increase (figure 13 displays the analysis by variable).

Figure 12: Principal components analysis by survey.



Note: The category name has the following structure: The first letter is the union status (M=in−union or S=not−in−union). Then, the age−group. The last letter refers to using (U) or not using (N) contraceptives.

Figure 13: Principal components analysis by categories.

Graph A of figure 12 shows surveys according to region whereas in graph B they are grouped according to cluster. Clusters are much more homogeneous than the regions, that overlap to a certain extent. This confirms that relatively homogeneous groups of countries can be found that are ranked according to the overall level of termination as suggested by dimension 1, but that also differ qualitatively according to dimension 2, as is the case of cluster 3. To better interpret the clusters, figure 14 displays a map identifying the cluster to which the country belongs in the latest survey. Also, figure 15 displays the cluster means for the different combinations of age-groups, union status, and contraceptive use. We notice how in all cases higher clusters have higher conditional probabilities of PT, but they differ in the relative differences from cluster to cluster. Cluster 1, red color, shows the lowest values of T with small differences according to union status. It is composed mainly of sub-Saharan Africa and insular Southeast Asia, but it also includes Central America, Bolivia, Paraguay, and Albania 2017. These would be countries reporting very few IA and very low levels of ST as well. In this cluster, reported pregnancies do not increase monotonically with age for women in-union. The minimum is observed at age 20-24 for not-users and 25-29 for contraceptive users. The only group that might be reporting some IA are contraceptive users not-in-union. Cluster 2, blue color, includes the rest of Latin American countries, South Asia, and some countries in sub-Saharan Africa (Ghana, Liberia, and Uganda 2016) with higher probabilities of termination than cluster 1. Minimum termination probabilities are observed in the youngest age group. Although termination rates are much lower than in cluster 3, particularly for in-union women using contraception, the differences disappear in the case of women not-in-union. Cluster 3, green color, includes some surveys from Europe and Asia characterized by high termination rates for women in-union with a large differential according to contraceptive use, and low probabilities of termination for women not-in-union. It includes Kyrgyzstan, Tajikistan, Turkey, Ukraine, Cambodia, Nepal 2016, and the latest Armenian surveys. Finally, cluster 4, purple color, includes surveys having high levels of T and large differentials according to age and contraceptive use. It includes countries in the Former-Soviet

Union with a traditionally high incidence of IA like earlier Armenia, Azerbaijan, Kazakhstan, and Moldova. Both cluster 3 and 4 share high differentials in T according to age for women in-union suggesting the use of IA to limit family size.

It is interesting to document the few countries that change cluster over time since these tend to be associated with profound changes. Three countries are moving over time to a cluster with lower T: Armenia, from 4 to 3; Tajikistan, from 3 to 2; and Albania from 2 to 1. In contrast, there are also three countries moving upwards: Uganda from 1 to 2 in 2016, Peru from 1 to 2 in 2007, and Nepal from 2 to 3 in 2016. Colombia belongs in all six surveys to cluster 2 except for a temporary decline to cluster 1 in 1995.

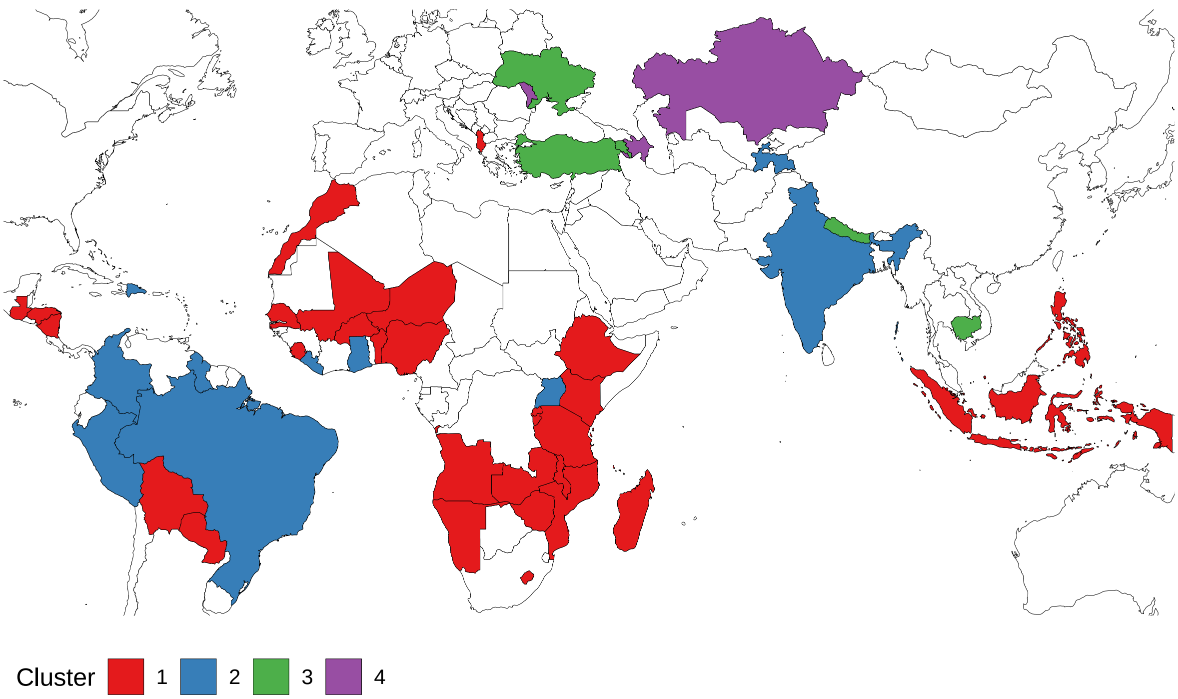


Figure 14: Countries by cluster in the latest DHS survey.

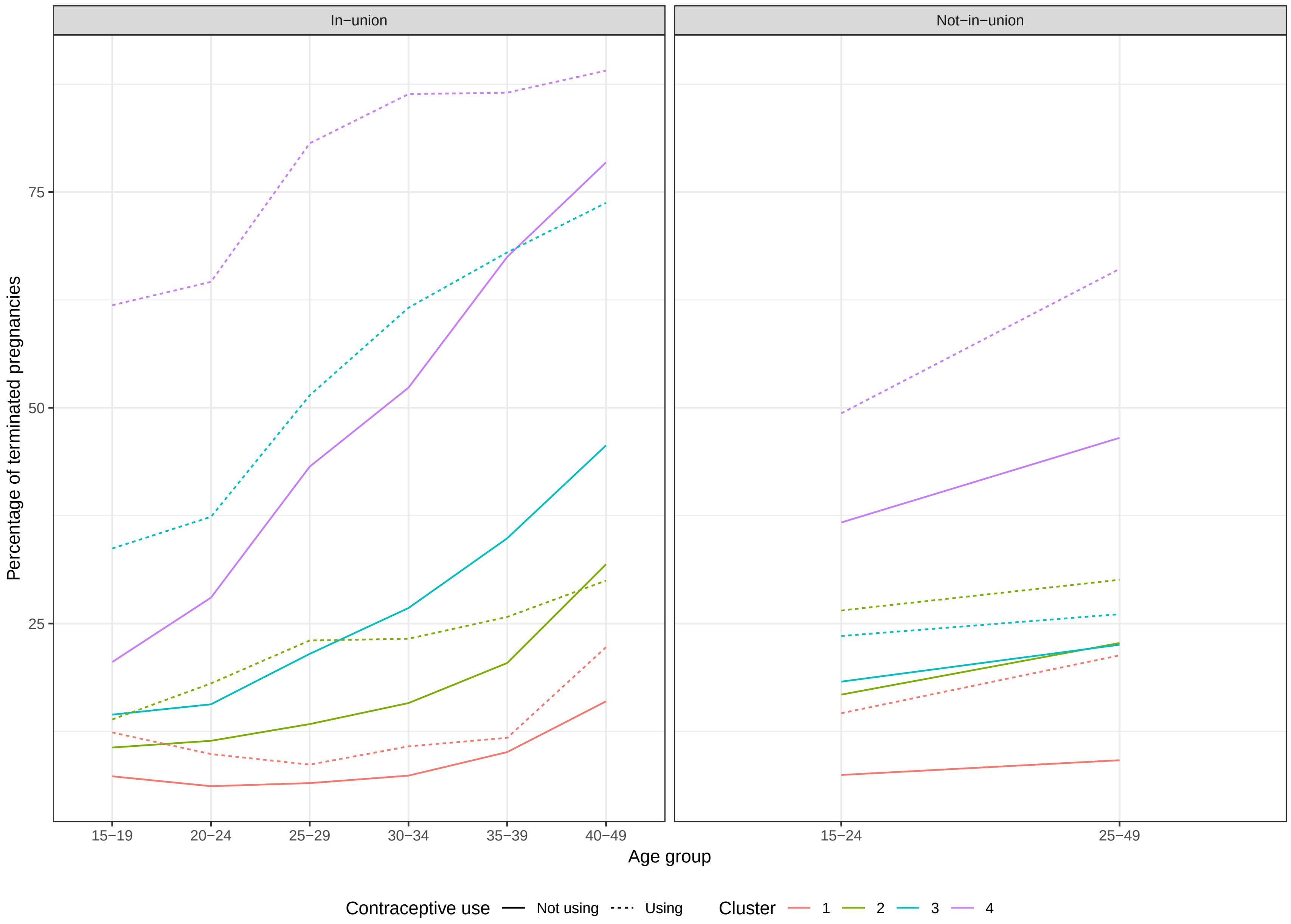


Figure 15: Cluster means by age, union status, and contraceptive use.

Regarding possible explanations for the patterns found, we assess differences according to the legal status of abortion. Figure 16 displays violin plots of overall probabilities of termination in log-scale according to the cluster and how restrictive was the abortion law at the time of the survey. We see that all surveys in contexts of restrictive laws belong to clusters 1 and 2 of low termination. This suggests that in all countries with restrictive laws there are low reported levels of IA. As a result, differences in levels of reported ST must be behind the proportionally large differences in T, many of them too low even as estimates of ST only. While even in these countries with low reported terminations the magnitude and direction of differentials seem consistent, we cannot be sure based only on this evidence whether restrictive laws lead to low IA levels, or to underreporting of IA, due to concerns regarding legal implications. On the other hand, countries with less restrictive abortion laws are very heterogeneous, including countries belonging to all 4 clusters: Albania and Tajikistan are countries where abortion is legal but reporting low levels of termination. This suggests that a more liberal law does not necessarily mean high levels of IA. While underreporting might also be present here, there seems to be less rationale for the intentional omission of IA. At the other end of the spectrum, all the countries with a high incidence of termination driven by IA in clusters 3 and 4 are characterized by liberal abortion laws. Note that reported probabilities of termination can be extremely high, particularly for older women in-union using contraception.

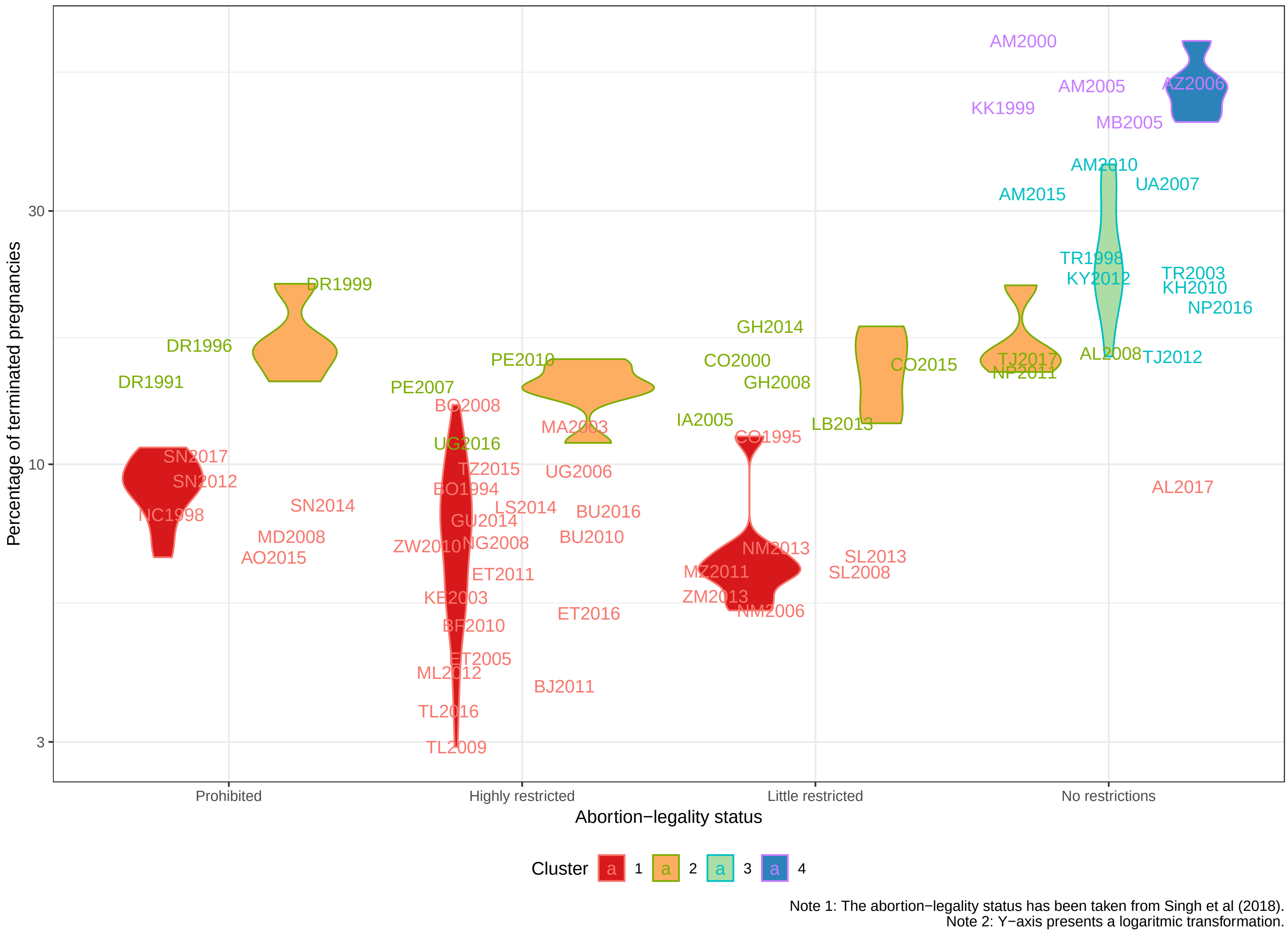


Figure 16: Probability of pregnancy termination by cluster and abortion-legality status.

There are also some countries with surveys that differ according to whether the type of PT is reported or not. It is the case of the Philippines, Colombia, Albania, Armenia, and Turkey. There does not seem to be systematic differences in reporting according to this dimension. In the Philippines, Colombia, and Turkey reported T are very similar in both cases indicating that this dimension does not drive the differences. In Albania, T is lower in the later survey not reporting the type of PT, but this is consistent with external evidence on the declining incidence of IA (Merdani et al. 2016). In the case of Armenia, the lower rates of T in later surveys including information on the type of outcome are internally consistent in pointing to declining abortion rates, although qualitative evidence points that there might be underreporting in later surveys connected with the growing importance of self-administered medication abortion (Jilozian and Agadjanian 2016).

The survey-level variability at the cluster level can be appreciated in figure 17, and it is reported in table 10 and table 11. Although each cluster includes only similar surveys, there are some outliers for a given age-group and union status. In particular, there are instances of countries with low overall levels of T in clusters 1 and 2 but having very large probabilities of IA for women not-in-union like Nigeria, Ghana, or the Dominican Republic. Albania belongs to the low termination clusters but shows relatively high termination rates for women in-union at ages 40-49. In clusters 1 and 2, the more considerable variability of probabilities for not-contraceptive users has to do with smaller numbers, therefore, showing more erratic patterns.

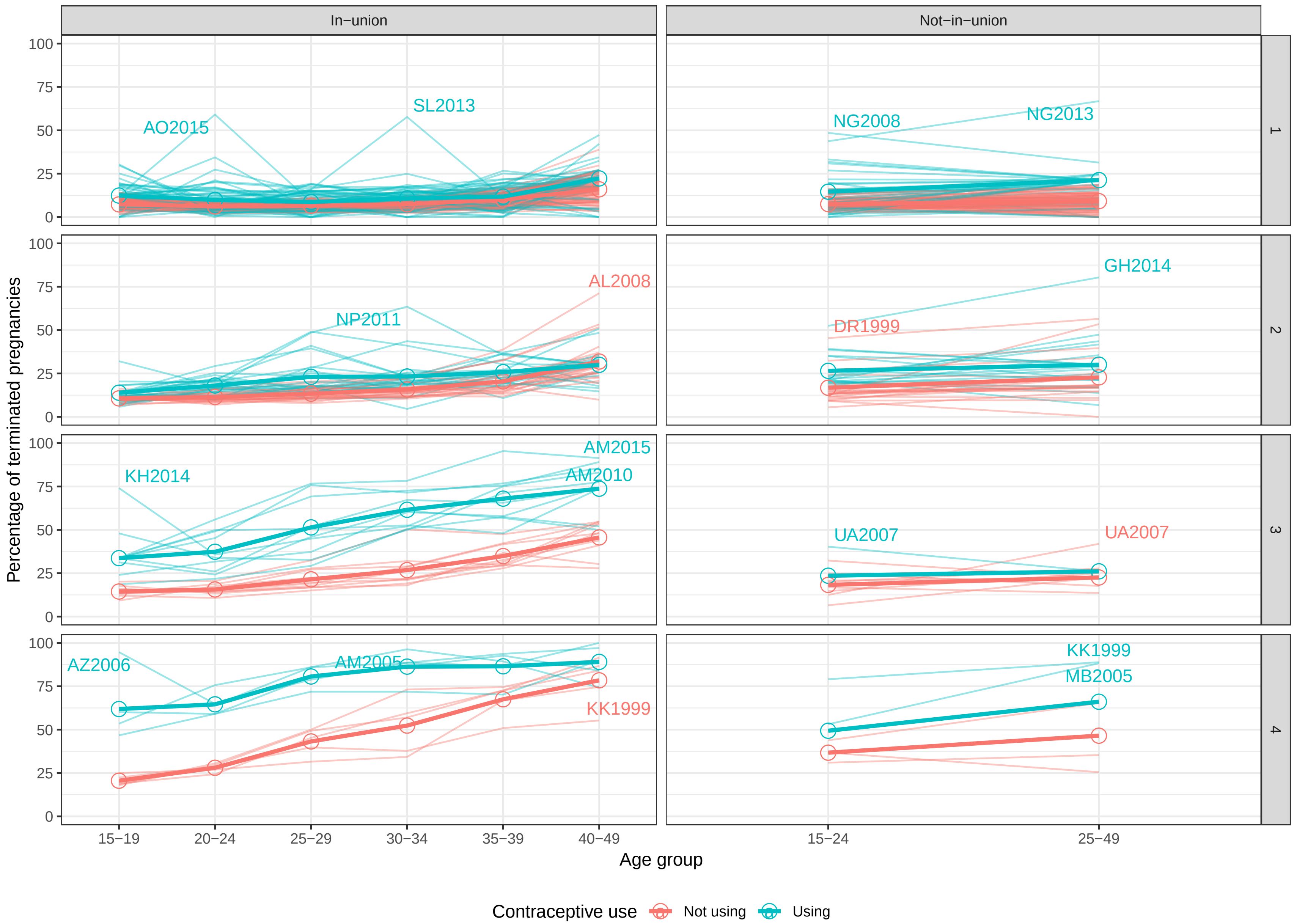


Figure 17: Probabilities of pregnancy termination by cluster and union status, according to age and contraceptive use prior to pregnancy.

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data.

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Africa							
Angola 2015							
Using	0.0	36.8	0.0	0.0	0.0		
Not using	6.7	6.2	5.3	6.3	7.3	15.7	15.7
All	6.6	6.5	5.2	6.3	7.3	15.7	15.7
ASTR	12.0	18.0	15.0	16.0	15.0	17.0	4.0
Burkina Faso 2010							
Using	2.6	22.8	6.1	18.5	20.1		
Not using	7.2	4.3	3.7	4.7	4.7	9.0	9.0
All	7.2	4.4	3.7	4.8	4.8	9.0	9.0
ASTR	10.0	12.0	10.0	12.0	10.0	9.0	2.0
Benin 2011							
Using	0.0	9.8	0.0	23.3	0.0	60.3	60.3
Not using	4.5	3.6	3.1	4.0	5.5	3.4	3.4
All	4.5	3.6	3.1	4.1	5.4	4.0	4.0
ASTR	4.0	9.0	8.0	9.0	7.0	3.0	1.0
Burundi 2010							
Using	0.0	11.1	0.0	2.8	0.0	42.2	42.2
Not using	10.8	6.1	4.4	6.9	8.8	18.1	18.1
All	10.8	6.1	4.3	6.8	8.6	19.0	19.0
ASTR	8.0	18.0	14.0	20.0	21.0	24.0	7.0
Burundi 2016							
Using	0.0	4.9	0.0	6.4	13.0	15.6	15.6
Not using	8.6	7.6	6.5	6.7	10.8	16.9	16.9
All	8.6	7.6	6.4	6.7	10.9	16.8	16.8
ASTR	5.0	18.0	18.0	18.0	23.0	20.0	4.0
Ethiopia 2005							
Using	6.5	28.9	15.9	17.5	21.9	81.3	81.3
Not using	3.2	4.4	3.2	4.1	4.9	9.1	9.1
All	3.2	4.7	3.3	4.1	5.2	9.6	9.6
ASTR	3.0	11.0	8.0	10.0	9.0	9.0	4.0
Ethiopia 2011							
Using	2.9	6.3	6.2	9.1	3.8	59.3	59.3
Not using	6.5	6.5	3.3	5.6	8.8	15.9	15.9
All	6.4	6.5	3.4	5.7	8.6	16.9	16.9
ASTR	5.0	14.0	8.0	12.0	14.0	14.0	6.0
Ethiopia 2016							
Using	41.4	3.8	18.7	12.1	4.1		
Not using	5.0	3.7	4.5	5.3	6.7	14.8	14.8
All	5.3	3.7	4.7	5.4	6.7	14.8	14.8
ASTR	4.0	8.0	10.0	11.0	10.0	12.0	4.0
Ghana 2008							
Using	20.0	20.8	20.0	9.4	19.0	0.0	0.0
Not using	17.1	14.2	9.9	15.0	13.8	20.7	20.7
All	17.3	14.7	10.8	14.6	14.3	19.7	19.7
ASTR	14.0	30.0	25.0	30.0	20.0	14.0	2.0

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Ghana 2014							
Using	10.3	46.4	40.5	15.8	21.6	23.7	23.7
Not using	19.5	20.1	14.5	15.9	18.4	22.7	22.7
All	19.2	21.3	15.7	15.9	18.5	22.8	22.8
ASTR	18.0	44.0	37.0	37.0	31.0	15.0	5.0
Kenya 1998							
Using	9.2	0.9	4.9	2.9	26.0	0.0	0.0
Not using	6.0	5.0	5.7	5.5	5.3	10.5	10.5
All	6.2	4.6	5.6	5.2	6.6	9.5	9.5
ASTR	7.0	12.0	13.0	10.0	8.0	5.0	2.0
Kenya 2003							
Using	12.1	6.9	2.5	5.0	10.6	4.0	4.0
Not using	6.2	5.3	3.7	5.4	8.2	9.7	9.7
All	6.6	5.4	3.6	5.4	8.5	9.3	9.3
ASTR	8.0	14.0	9.0	11.0	11.0	6.0	2.0
Kenya 2008							
Using	3.2	7.0	5.5	4.1	4.2	15.7	15.7
Not using	3.1	4.2	6.3	5.2	12.4	18.8	18.8
All	3.1	4.5	6.2	5.0	11.3	18.4	18.4
ASTR	3.0	11.0	14.0	9.0	15.0	11.0	3.0
Comoros 2012							
Using	0.0	0.0	2.8	0.0	0.0	100.0	100.0
Not using	5.3	5.1	7.9	6.6	12.0	18.1	18.1
All	5.3	5.0	7.9	6.4	11.9	18.8	18.8
ASTR	4.0	9.0	17.0	14.0	18.0	15.0	7.0
Liberia 2013							
Using	29.6	37.5	38.9	56.4	36.4	45.1	45.1
Not using	8.2	10.8	12.2	11.7	11.8	27.0	27.0
All	8.7	11.2	12.9	12.2	12.6	27.4	27.4
ASTR	14.0	28.0	30.0	25.0	19.0	19.0	5.0
Lesotho 2009							
Using	4.4	8.6	2.8	6.2	10.5	29.7	29.7
Not using	4.4	5.2	4.3	5.9	10.0	4.0	4.0
All	4.4	5.5	4.1	5.9	10.1	5.6	5.6
ASTR	4.0	10.0	7.0	7.0	8.0	2.0	0.0
Lesotho 2014							
Using	13.9	1.3	3.1	11.3	6.5	6.2	6.2
Not using	6.3	6.8	9.8	10.5	12.7	12.8	12.8
All	7.0	6.2	9.0	10.6	11.6	12.0	12.0
ASTR	7.0	12.0	14.0	13.0	9.0	7.0	1.0
Morocco 1992							
Using	11.1	4.6	9.0	9.4	13.4	25.5	25.5
Not using	9.0	7.2	7.6	8.6	8.9	8.5	8.5
All	9.1	7.0	7.8	8.7	9.7	11.7	11.7
ASTR	4.0	10.0	15.0	17.0	15.0	11.0	5.0
Morocco 2003							

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Using	18.1	11.1	10.2	12.3	15.8	21.8	21.8
Not using	10.1	8.5	8.4	11.7	16.9	29.8	29.8
All	10.7	8.9	8.8	11.8	16.6	27.2	27.2
ASTR	4.0	10.0	12.0	17.0	15.0	10.0	2.0
Madagascar 2008							
Using	18.9	9.2	14.2	12.4	10.8	21.1	21.1
Not using	7.0	6.2	6.5	6.8	7.5	11.4	11.4
All	7.5	6.4	7.1	7.2	7.8	11.8	11.8
ASTR	12.0	16.0	16.0	13.0	11.0	8.0	2.0
Mali 2012							
Using		0.0	11.5	0.0	0.0		
Not using	4.4	3.7	3.8	3.4	4.6	7.2	7.2
All	4.4	3.7	3.8	3.4	4.6	7.2	7.2
ASTR	8.0	10.0	11.0	8.0	8.0	7.0	3.0
Malawi 2004							
Using	14.9	0.6	0.0	7.5	6.0	5.1	5.1
Not using	5.8	4.3	4.1	5.0	7.2	6.9	6.9
All	5.9	4.2	4.0	5.1	7.1	6.7	6.7
ASTR	10.0	13.0	11.0	12.0	12.0	6.0	3.0
Malawi 2010							
Using	5.3	2.4	3.1	5.8	5.5	4.5	4.5
Not using	7.3	3.9	5.5	5.4	5.3	13.1	13.1
All	7.3	3.7	5.3	5.4	5.3	12.6	12.6
ASTR	12.0	10.0	13.0	12.0	9.0	12.0	5.0
Malawi 2015							
Using	7.8	2.5	8.0	10.0	3.3	0.0	0.0
Not using	6.5	5.4	5.4	4.3	5.7	10.0	10.0
All	6.5	5.3	5.4	4.5	5.7	9.9	9.9
ASTR	9.0	12.0	11.0	7.0	7.0	6.0	2.0
Mozambique 2011							
Using	20.4	41.1	3.8	0.0	17.7	19.5	19.5
Not using	8.4	5.4	5.8	4.5	6.1	8.6	8.6
All	8.5	5.7	5.8	4.5	6.1	8.7	8.7
ASTR	16.0	16.0	16.0	10.0	11.0	8.0	3.0
Nigeria 2008							
Using	28.5	17.4	6.9	9.5	14.8	10.0	10.0
Not using	6.8	6.6	5.1	6.5	9.9	11.3	11.3
All	7.5	7.1	5.2	6.7	10.2	11.3	11.3
ASTR	10.0	17.0	15.0	17.0	18.0	11.0	6.0
Nigeria 2013							
Using	39.5	21.5	12.0	8.0	26.7	20.8	20.8
Not using	7.1	6.3	6.6	7.3	9.3	13.0	13.0
All	7.5	6.5	6.7	7.3	9.8	13.2	13.2
ASTR	10.0	16.0	18.0	19.0	17.0	12.0	4.0
Niger 2012							
Using	22.0	0.0	8.5	0.0	0.0		

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Not using	9.0	3.8	5.8	7.9	9.5	17.3	17.3
All	9.0	3.8	5.8	7.9	9.4	17.3	17.3
ASTR	20.0	13.0	20.0	24.0	23.0	21.0	10.0
Namibia 2006							
Using	3.4	1.4	5.1	4.3	4.6	27.6	27.6
Not using	3.1	4.1	4.4	6.4	8.6	14.5	14.5
All	3.2	3.9	4.5	6.2	8.4	15.3	15.3
ASTR	3.0	7.0	7.0	10.0	10.0	8.0	1.0
Namibia 2013							
Using	2.7	2.5	7.5	5.5	6.8	6.7	6.7
Not using	3.5	5.4	9.3	7.0	7.8	17.9	17.9
All	3.4	5.1	9.1	6.8	7.7	17.0	17.0
ASTR	3.0	9.0	17.0	11.0	9.0	9.0	2.0
Rwanda 2010							
Using	52.3	4.0	3.2	11.8	12.4	17.7	17.7
Not using	4.5	7.4	5.5	5.2	8.1	17.7	17.7
All	4.8	7.4	5.4	5.6	8.4	17.7	17.7
ASTR	2.0	15.0	13.0	12.0	14.0	19.0	4.0
Rwanda 2014							
Using	0.0	3.7	8.6	11.1	17.5	17.1	17.1
Not using	6.4	7.2	5.9	7.9	9.9	16.0	16.0
All	6.3	7.1	6.0	8.2	10.9	16.1	16.1
ASTR	3.0	14.0	14.0	17.0	16.0	13.0	2.0
Sierra Leone 2008							
Using	47.1	6.4	8.2	0.0	0.0	100.0	100.0
Not using	6.1	5.8	6.2	6.1	6.3	10.1	10.1
All	6.5	5.8	6.2	6.0	6.2	11.2	11.2
ASTR	10.0	14.0	14.0	12.0	10.0	9.0	5.0
Sierra Leone 2013							
Using	21.5	12.0	13.3	52.5	11.2	59.7	59.7
Not using	6.8	5.9	6.1	5.8	8.2	10.7	10.7
All	7.0	6.0	6.2	6.2	8.3	11.4	11.4
ASTR	9.0	14.0	15.0	12.0	13.0	8.0	4.0
Senegal 2012							
Using		7.7	0.0	11.4	0.0	41.0	41.0
Not using	11.5	8.3	8.2	7.3	10.4	17.2	17.2
All	11.5	8.3	8.2	7.4	10.3	17.6	17.6
ASTR	10.0	19.0	22.0	18.0	21.0	21.0	4.0
Senegal 2014							
Using		0.0	19.2	0.0	0.0	0.0	0.0
Not using	6.8	7.7	6.5	11.0	10.5	10.3	10.3
All	6.8	7.6	6.6	11.0	10.5	10.2	10.2
ASTR	7.0	16.0	17.0	26.0	18.0	11.0	2.0
Senegal 2015							
Using	0.0	0.0	48.0	0.0	14.6	23.1	23.1
Not using	8.8	6.2	5.9	9.7	15.5	20.8	20.8

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
All	8.7	6.1	6.3	9.5	15.5	20.8	20.8
ASTR	8.0	12.0	15.0	22.0	30.0	22.0	4.0
Senegal 2016							
Using		4.7	0.0	16.6	6.6	36.6	36.6
Not using	7.0	7.9	6.2	10.6	14.1	17.5	17.5
All	7.0	7.9	6.1	10.8	13.7	17.9	17.9
ASTR	5.0	16.0	15.0	24.0	23.0	17.0	5.0
Senegal 2017							
Using	0.0	0.0	7.5	4.3	10.7	0.0	0.0
Not using	9.9	8.1	8.0	9.7	15.7	21.1	21.1
All	9.9	8.1	8.0	9.6	15.6	20.8	20.8
ASTR	9.0	16.0	19.0	22.0	27.0	21.0	6.0
Tanzania 2004							
Using	0.0	11.1	18.3	12.9	7.6	31.2	31.2
Not using	9.4	6.2	7.1	8.5	11.1	23.2	23.2
All	9.3	6.3	7.8	8.7	10.9	23.5	23.5
ASTR	14.0	19.0	21.0	21.0	19.0	24.0	6.0
Tanzania 2010							
Using	0.0	3.3	3.2	5.8	7.5	4.4	4.4
Not using	7.0	7.8	6.8	7.1	12.8	17.1	17.1
All	6.8	7.6	6.6	7.0	12.5	15.9	15.9
ASTR	9.0	21.0	18.0	16.0	23.0	14.0	4.0
Tanzania 2015							
Using	23.5	5.9	13.9	11.5	10.2	15.5	15.5
Not using	8.8	8.1	9.3	8.6	12.0	20.1	20.1
All	9.2	8.0	9.6	8.8	11.9	19.7	19.7
ASTR	13.0	21.0	25.0	19.0	20.0	18.0	4.0
Uganda 2006							
Using	14.0	8.9	8.7	7.7	25.1	29.2	29.2
Not using	11.5	7.1	6.5	9.3	13.9	23.5	23.5
All	11.6	7.2	6.6	9.2	14.6	23.6	23.6
ASTR	20.0	24.0	22.0	26.0	33.0	29.0	8.0
Uganda 2011							
Using	3.3	10.9	5.7	4.4	18.2	55.6	55.6
Not using	13.0	7.3	8.2	8.6	12.9	25.3	25.3
All	12.7	7.5	8.1	8.3	13.1	26.6	26.6
ASTR	19.0	25.0	25.0	21.0	26.0	27.0	8.0
Uganda 2016							
Using	12.9	18.4	13.6	17.2	27.3	17.7	17.7
Not using	10.4	9.3	8.3	10.9	14.9	25.7	25.7
All	10.4	9.6	8.6	11.2	15.5	25.2	25.2
ASTR	15.0	28.0	23.0	26.0	27.0	23.0	5.0
Zambia 2007							
Using	11.3	6.1	4.9	10.9	2.3	0.0	0.0
Not using	6.8	5.3	6.5	5.3	6.0	11.2	11.2
All	7.0	5.4	6.3	6.0	5.5	10.1	10.1

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
ASTR	11.0	16.0	18.0	15.0	11.0	10.0	3.0
Zambia 2013							
Using	3.2	2.6	3.4	2.6	14.6	3.0	3.0
Not using	5.6	5.3	4.6	5.4	6.8	13.9	13.9
All	5.6	5.2	4.5	5.2	7.6	12.7	12.7
ASTR	8.0	13.0	11.0	11.0	12.0	10.0	2.0
Zimbabwe 1994							
Using	4.4	6.0	10.2	9.6	14.2	22.8	22.8
Not using	8.2	8.6	5.6	6.4	7.8	23.7	23.7
All	7.9	8.3	6.1	6.7	8.9	23.5	23.5
ASTR	9.0	19.0	13.0	12.0	11.0	16.0	4.0
Zimbabwe 1999							
Using	13.9	15.0	5.0	0.0	4.1	12.7	12.7
Not using	8.6	7.1	7.0	6.8	11.2	18.0	18.0
All	8.8	7.9	6.8	5.9	10.4	17.5	17.5
ASTR	11.0	17.0	13.0	9.0	13.0	10.0	3.0
Zimbabwe 2005							
Using	26.3	2.2	4.9	2.6	6.7	22.6	22.6
Not using	8.4	5.8	7.5	4.3	12.4	18.5	18.5
All	9.3	5.4	7.2	4.1	11.8	19.0	19.0
ASTR	10.0	12.0	13.0	6.0	12.0	10.0	3.0
Zimbabwe 2010							
Using	24.2	5.4	3.2	11.2	5.8	0.0	0.0
Not using	7.8	5.2	7.5	8.5	7.9	7.6	7.6
All	8.0	5.2	7.2	8.8	7.7	6.5	6.5
ASTR	10.0	12.0	15.0	14.0	9.0	2.0	1.0
Zimbabwe 2015							
Using	0.0	4.1	8.3	9.7	11.8	10.0	10.0
Not using	9.9	9.1	4.9	7.3	11.0	26.6	26.6
All	9.6	8.6	5.2	7.6	11.1	24.7	24.7
ASTR	12.0	19.0	11.0	12.0	13.0	11.0	2.0
Central and West Asia & Europe							
Albania 2008							
Using	0.0	22.9	14.6	19.9	23.9		
Not using	12.0	7.0	10.4	22.2	38.4	71.3	71.3
All	11.2	9.9	11.4	21.5	35.8	71.3	71.3
ASTR	2.0	10.0	16.0	18.0	8.0	2.0	0.0
Albania 2017							
Using	0.0	19.4	16.3	24.9	39.9	72.2	72.2
Not using	5.8	7.0	7.0	7.4	19.5	38.9	38.9
All	5.6	7.6	7.5	8.3	20.2	41.2	41.2
ASTR	1.0	7.0	10.0	8.0	7.0	2.0	0.0
Armenia 2000							
Using	53.4	75.7	86.0	88.6	93.7	97.1	97.1
Not using	19.1	30.7	50.3	73.0	74.6	86.7	86.7
All	23.1	45.3	68.8	81.3	85.3	91.9	91.9

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
ASTR	15.0	123.0	194.0	152.0	93.0	34.0	0.0
Armenia 2005							
Using	44.7	67.9	86.0	96.4	89.3	74.3	74.3
Not using	19.4	24.1	44.2	59.1	72.3	85.0	85.0
All	20.4	33.2	57.8	73.7	79.8	80.8	80.8
ASTR	8.0	74.0	147.0	104.0	63.0	17.0	
Armenia 2010							
Using	6.1	49.1	69.2	72.7	75.5	89.1	89.1
Not using	20.9	20.4	32.0	50.2	47.1	54.6	54.6
All	20.7	23.3	40.7	57.2	54.4	68.8	68.8
ASTR	7.0	42.0	70.0	56.0	29.0	11.0	
Armenia 2015							
Using	75.2	56.0	76.7	78.3	95.5	91.8	91.8
Not using	14.9	19.1	27.7	31.8	29.8	53.5	53.5
All	16.1	22.8	34.8	40.9	43.8	68.1	68.1
ASTR	5.0	37.0	62.0	38.0	19.0	9.0	2.0
Azerbaijan 2006							
Using	94.7	64.9	78.8	88.6	86.7	100.0	100.0
Not using	20.2	29.2	49.0	56.7	72.6	84.1	84.1
All	22.6	33.1	55.8	67.3	77.5	89.2	89.2
ASTR	10.0	84.0	142.0	124.0	86.0	33.0	
Kazakhstan 1999							
Using	66.9	58.1	80.9	86.1	93.2	85.2	85.2
Not using	29.2	31.1	40.1	38.1	55.2	59.6	59.6
All	34.8	35.4	51.2	51.9	66.3	68.9	68.9
ASTR	21.0	91.0	111.0	69.0	47.0	20.0	
Kyrgyz Rep. 2012							
Using	17.0	48.4	51.9	52.6	48.0	81.5	81.5
Not using	9.5	17.8	22.4	21.7	29.8	30.0	30.0
All	9.8	19.2	24.5	24.3	31.4	31.9	31.9
ASTR	5.0	51.0	67.0	48.0	37.0	13.0	0.0
Moldova 2005							
Using	56.8	59.4	72.1	72.5	71.5	90.0	90.0
Not using	27.6	28.9	33.3	35.6	67.2	75.4	75.4
All	33.3	36.2	45.2	49.0	69.0	80.6	80.6
ASTR	17.0	75.0	78.0	55.0	38.0	12.0	
Tajikistan 2012							
Using		26.0	52.0	67.3	65.6	70.2	70.2
Not using	13.0	10.6	15.0	19.5	27.9	41.1	41.1
All	13.0	10.7	16.0	20.8	29.4	42.7	42.7
ASTR	8.0	30.0	41.0	36.0	29.0	14.0	1.0
Tajikistan 2017							
Using		21.7	41.0	78.4	40.3	100.0	100.0
Not using	10.2	10.5	16.1	22.8	32.4	51.7	51.7
All	10.2	10.6	16.4	23.2	32.6	51.8	51.8
ASTR	6.0	36.0	41.0	37.0	27.0	12.0	0.0

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Turkey 1998							
Using	48.0	33.9	32.7	50.0	71.3	77.5	77.5
Not using	13.5	14.4	17.7	26.8	29.4	48.3	48.3
All	17.4	17.7	21.0	33.0	44.1	61.4	61.4
ASTR	13.0	35.0	40.0	46.0	33.0	21.0	2.0
Turkey 2003							
Using	18.6	21.8	29.3	50.6	57.5	52.0	52.0
Not using	17.8	13.3	16.9	18.4	36.7	30.3	30.3
All	17.9	15.0	20.3	30.1	46.0	41.0	41.0
ASTR	10.0	24.0	34.0	34.0	32.0	8.0	1.0
Ukraine 2007							
Using	52.3	41.0	75.4	71.5	77.4	85.6	85.6
Not using	12.9	15.6	28.5	30.0	36.5	53.8	53.8
All	19.4	20.5	40.6	41.6	53.2	68.2	68.2
ASTR	6.0	24.0	42.0	27.0	15.0	6.0	0.0
Latin America							
Bolivia 1994							
Using	14.6	8.5	14.0	17.0	13.7	19.8	19.8
Not using	6.6	6.1	8.1	10.1	10.5	6.4	6.4
All	7.7	6.5	9.2	11.8	11.1	9.4	9.4
ASTR	8.0	16.0	23.0	25.0	17.0	7.0	2.0
Bolivia 2008							
Using	8.3	15.0	15.7	16.1	18.8	24.3	24.3
Not using	10.3	9.8	11.2	14.4	16.8	18.0	18.0
All	9.9	11.0	12.3	14.9	17.4	19.4	19.4
ASTR	10.0	22.0	24.0	22.0	20.0	10.0	2.0
Brazil 1996							
Using	19.7	20.6	11.6	11.0	23.2	30.6	30.6
Not using	11.2	10.6	12.2	11.2	21.0	31.7	31.7
All	12.3	12.6	12.1	11.1	21.5	31.4	31.4
ASTR	12.0	22.0	17.0	10.0	13.0	7.0	1.0
Colombia 1990							
Using	20.9	15.0	14.8	24.7	12.1	26.2	26.2
Not using	9.9	9.3	10.8	13.4	19.0	35.1	35.1
All	11.1	10.2	11.7	15.9	16.9	32.4	32.4
ASTR	9.0	19.0	20.0	18.0	13.0	9.0	1.0
Colombia 1995							
Using	13.3	13.8	15.0	14.4	12.0	28.1	28.1
Not using	8.1	9.3	10.0	11.1	11.7	23.8	23.8
All	9.1	10.4	11.5	12.1	11.8	25.3	25.3
ASTR	9.0	20.0	19.0	14.0	7.0	8.0	1.0
Colombia 2000							
Using	13.1	16.4	13.0	18.6	26.4	28.5	28.5
Not using	10.8	13.7	15.6	16.2	24.6	27.0	27.0
All	11.5	14.6	14.7	17.0	25.3	27.6	27.6
ASTR	11.0	24.0	22.0	20.0	17.0	6.0	1.0

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Colombia 2005							
Using	17.1	22.4	17.9	22.1	33.9	24.0	24.0
Not using	14.7	14.7	15.8	17.3	21.0	30.4	30.4
All	15.3	16.8	16.4	18.8	25.1	28.2	28.2
ASTR	16.0	27.0	23.0	18.0	15.0	6.0	1.0
Colombia 2010							
Using	15.4	22.6	18.1	26.5	22.1	32.9	32.9
Not using	12.8	16.4	15.8	18.3	23.8	34.6	34.6
All	13.4	17.7	16.3	20.1	23.4	34.2	34.2
ASTR	13.0	26.0	20.0	18.0	12.0	6.0	1.0
Colombia 2015							
Using	17.7	16.5	23.8	20.6	19.4	16.6	16.6
Not using	10.0	13.7	16.3	13.3	19.5	36.2	36.2
All	11.6	14.3	17.9	14.4	19.5	31.5	31.5
ASTR	10.0	19.0	20.0	11.0	9.0	4.0	0.0
Dominican Rep. 1991							
Using	7.1	17.9	25.5	18.4	36.5	100.0	100.0
Not using	10.7	9.9	15.3	20.1	17.4	24.3	24.3
All	10.4	10.8	16.8	19.9	20.0	30.8	30.8
ASTR	10.0	25.0	35.0	29.0	14.0	5.0	5.0
Dominican Rep. 1996							
Using	15.0	16.7	15.0	24.9	48.7	66.7	66.7
Not using	16.7	14.2	18.5	14.1	24.9	22.5	22.5
All	16.6	14.6	18.0	15.7	26.7	29.0	29.0
ASTR	22.0	34.0	35.0	21.0	14.0	6.0	0.0
Dominican Rep. 1999							
Using	13.8	10.1	35.4	3.6	0.0	29.0	29.0
Not using	18.1	20.3	22.8	26.8	21.6	73.6	73.6
All	17.6	19.0	25.3	24.6	20.4	53.0	53.0
ASTR	21.0	36.0	44.0	31.0	13.0	9.0	1.0
Dominican Rep. 2002							
Using	20.1	23.3	14.9	24.7	26.5	49.2	49.2
Not using	13.6	14.7	14.5	18.3	16.0	43.4	43.4
All	14.3	16.0	14.6	19.1	17.5	44.0	44.0
ASTR	19.0	36.0	25.0	23.0	9.0	6.0	1.0
Guatemala 1995							
Using	0.0	19.4	2.8	13.7	5.4	16.5	16.5
Not using	4.5	4.9	5.2	5.9	7.6	15.4	15.4
All	4.4	5.6	5.1	6.2	7.5	15.5	15.5
ASTR	6.0	15.0	13.0	13.0	11.0	10.0	2.0
Guatemala 1998							
Using	11.7	5.9	14.1	3.5	0.4	73.5	73.5
Not using	5.7	3.7	6.1	6.4	4.5	13.3	13.3
All	6.0	3.8	6.9	6.2	4.2	17.2	17.2
ASTR	7.0	11.0	18.0	12.0	6.0	12.0	1.0
Guatemala 2014							

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Using	8.9	9.9	9.0	9.9	16.3	22.2	22.2
Not using	7.4	5.0	7.5	8.6	9.7	21.3	21.3
All	7.4	5.5	7.7	8.8	10.8	21.5	21.5
ASTR	7.0	10.0	12.0	11.0	8.0	7.0	1.0
Guyana 2009							
Using	17.6	24.9	48.0	41.4	30.3	20.6	20.6
Not using	12.5	16.5	20.6	21.5	30.9	52.4	52.4
All	12.7	17.7	25.2	24.9	30.9	51.1	51.1
ASTR	15.0	35.0	39.0	34.0	25.0	14.0	4.0
Honduras 2005							
Using	6.8	11.8	16.3	8.3	20.0	16.9	16.9
Not using	6.8	6.6	6.9	9.3	14.0	26.9	26.9
All	6.8	7.4	8.5	9.1	15.1	25.2	25.2
ASTR	7.0	13.0	14.0	12.0	13.0	11.0	2.0
Honduras 2011							
Using	13.4	11.6	12.7	13.3	18.5	45.7	45.7
Not using	8.0	7.3	8.7	10.6	14.0	27.3	27.3
All	8.5	7.7	9.1	10.9	14.6	29.8	29.8
ASTR	9.0	13.0	14.0	12.0	11.0	8.0	1.0
Nicaragua 1998							
Using	12.9	15.3	13.4	5.2	7.2	17.0	17.0
Not using	4.7	8.3	8.3	7.2	11.7	9.1	9.1
All	5.4	9.0	8.9	7.1	11.4	9.4	9.4
ASTR	7.0	19.0	16.0	9.0	10.0	3.0	1.0
Peru 1991							
Using	8.4	7.4	12.7	13.8	21.8	26.2	26.2
Not using	5.7	6.9	8.8	11.8	13.6	14.3	14.3
All	6.3	7.0	10.0	12.5	16.3	18.6	18.6
ASTR	4.0	13.0	20.0	21.0	19.0	10.0	3.0
Peru 1996							
Using	14.1	8.6	11.9	15.2	11.9	18.4	18.4
Not using	6.4	7.4	7.9	11.3	12.9	18.9	18.9
All	8.1	7.7	9.1	12.6	12.6	18.7	18.7
ASTR	7.0	15.0	16.0	20.0	14.0	10.0	2.0
Peru 2000							
Using	13.6	7.3	15.1	14.3	19.3	21.8	21.8
Not using	8.8	6.6	7.9	11.4	12.4	15.0	15.0
All	9.6	6.7	9.7	12.2	14.5	17.1	17.1
ASTR	7.0	10.0	14.0	16.0	13.0	7.0	1.0
Peru 2004							
Using	16.9	14.5	13.2	11.2	16.7	24.7	24.7
Not using	8.8	7.2	10.1	9.2	12.0	26.3	26.3
All	10.6	9.2	11.0	9.8	13.4	25.8	25.8
ASTR	7.0	13.0	15.0	12.0	11.0	9.0	2.0
Peru 2007							
Using	17.7	14.3	18.5	18.1	18.9	23.2	23.2

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Not using	11.5	10.0	10.4	11.4	15.5	31.3	31.3
All	13.3	11.3	12.9	13.4	16.7	28.8	28.8
ASTR	10.0	16.0	18.0	15.0	13.0	11.0	2.0
Peru 2009							
Using	18.7	18.7	15.2	18.2	20.6	14.2	14.2
Not using	7.7	11.3	10.5	12.0	16.9	29.1	29.1
All	11.4	13.8	11.9	13.9	17.9	24.0	24.0
ASTR	9.0	19.0	17.0	18.0	15.0	9.0	1.0
Peru 2010							
Using	16.3	16.9	22.9	22.4	27.2	31.5	31.5
Not using	10.2	11.2	11.5	13.6	17.6	28.1	28.1
All	12.2	13.0	14.7	16.4	20.7	29.1	29.1
ASTR	9.0	18.0	21.0	19.0	17.0	12.0	1.0
Peru 2011							
Using	15.0	17.9	20.2	20.2	23.2	36.0	36.0
Not using	12.3	11.1	10.2	13.1	13.9	29.4	29.4
All	13.2	13.3	13.2	15.2	17.0	31.7	31.7
ASTR	9.0	19.0	19.0	19.0	15.0	12.0	1.0
Paraguay 1990							
Using	14.5	21.3	17.9	18.8	20.9	33.7	33.7
Not using	7.8	6.0	10.0	9.2	13.9	15.8	15.8
All	8.4	8.3	11.3	10.8	15.1	18.2	18.2
ASTR	9.0	19.0	27.0	24.0	25.0	16.0	3.0
South and Southeast Asia							
India 2005							
Using	13.4	20.5	28.2	43.6	37.0	48.4	48.4
Not using	12.2	10.0	11.2	15.0	17.3	9.9	9.9
All	12.2	10.4	12.0	17.0	19.3	13.6	13.6
ASTR	13.0	24.0	19.0	13.0	6.0	1.0	0.0
Indonesia 2012							
Using	29.0	5.6	3.3	12.4	19.9	17.5	17.5
Not using	9.1	7.9	9.0	11.7	15.5	21.2	21.2
All	9.4	7.8	8.7	11.7	16.1	20.7	20.7
ASTR	5.0	12.0	14.0	14.0	12.0	5.0	1.0
Cambodia 2010							
Using	26.9	31.7	37.9	60.2	57.9	74.6	74.6
Not using	16.7	14.2	16.7	21.6	32.5	44.2	44.2
All	16.9	14.5	18.3	25.2	35.2	47.9	47.9
ASTR	9.0	29.0	37.0	41.0	39.0	26.0	4.0
Cambodia 2014							
Using	74.1	35.7	44.8	52.6	75.1	83.1	83.1
Not using	15.9	16.1	19.7	20.9	31.4	55.0	55.0
All	17.2	17.1	22.6	25.4	39.3	59.4	59.4
ASTR	12.0	34.0	44.0	35.0	33.0	25.0	6.0
Nepal 2011							
Using	42.2	18.5	48.5	63.5	35.6	11.1	11.1

Table 10: Probability of pregnancy termination and age-specific termination rate from reported data. *(continued)*

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Not using	11.4	10.2	16.5	16.8	22.9	23.1	23.1
All	11.7	10.4	18.4	20.9	24.7	21.3	21.3
ASTR	11.0	22.0	28.0	19.0	12.0	4.0	1.0
Nepal 2016							
Using	30.8	24.2	46.0	60.9	56.8	50.0	50.0
Not using	13.3	15.3	19.0	28.5	41.7	48.0	48.0
All	13.8	15.6	20.5	31.3	42.9	48.5	48.5
ASTR	14.0	32.0	32.0	27.0	14.0	6.0	2.0
Philippines 1993							
Using	13.9	7.8	12.7	10.3	12.4	27.1	27.1
Not using	10.3	7.2	8.1	8.0	13.5	21.9	21.9
All	10.5	7.3	8.7	8.3	13.3	22.7	22.7
ASTR	6.0	15.0	21.0	16.0	18.0	15.0	2.0
Philippines 1998							
Using	11.9	9.0	5.8	15.3	13.5	32.4	32.4
Not using	13.0	7.6	8.2	10.1	15.7	25.1	25.1
All	12.9	7.8	7.7	11.3	15.2	26.5	26.5
ASTR	7.0	15.0	18.0	20.0	20.0	14.0	3.0
Philippines 2003							
Using	16.3	6.5	8.0	14.9	11.1	17.6	17.6
Not using	9.0	8.6	8.2	9.9	13.4	26.6	26.6
All	9.5	8.4	8.1	10.8	13.1	25.0	25.0
ASTR	6.0	16.0	17.0	17.0	14.0	14.0	2.0
Timor Leste 2009							
Using	0.0	0.0	0.0	14.4	13.7		
Not using	4.7	2.3	2.6	2.4	2.7	5.3	5.3
All	4.7	2.3	2.6	2.5	2.8	5.3	5.3
ASTR	3.0	5.0	7.0	7.0	6.0	5.0	3.0
Timor Leste 2016							
Using			0.0	0.0	0.0	0.0	0.0
Not using	5.4	3.5	2.9	2.6	4.8	3.6	3.6
All	5.4	3.5	2.8	2.6	4.7	3.6	3.6
ASTR	2.0	7.0	7.0	5.0	6.0	2.0	1.0

Note: Cells left in blank correspond to categories with less than 10 unweighted pregnancies.

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering.

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
Africa								
Angola 2015								
Using	*12.4*	59.1	*8.7*	*10.8*	*11.8*	*22.3*	0	*21.3*
Not using	6.3	5.5	5.1	5.5	7.6	15.6	7.3	7.8
All	6.3	6	5.1	5.5	7.6	15.6	7.2	7.8
Burkina Faso 2010								
Using	*12.4*	17.2	6.2	18.5	*11.8*	*22.3*	*14.6*	*21.3*
Not using	7	4.1	3.6	4.7	4.7	9	8.5	18.5
All	7	4.2	3.6	4.8	4.8	9	8.7	18.5
Benin 2011								
Using	*12.4*	*9.9*	0	*10.8*	*11.8*	*22.3*	*14.6*	*21.3*
Not using	3.8	3.5	2.8	3.8	5.1	3.5	4.9	10.2
All	3.8	3.6	2.8	3.8	5.1	3.6	4.9	10.3
Burundi 2010								
Using	*12.4*	13.5	0	2.8	0	42.2	*14.6*	*21.3*
Not using	11.4	5.9	4.4	7	8.9	18.2	8.7	1.8
All	11.4	6	4.3	6.9	8.7	19	8.8	1.8
Burundi 2016								
Using	*12.4*	5.1	0	6.4	13	*22.3*	*14.6*	*21.3*
Not using	10.3	7.7	6.6	6.7	10.9	16.9	5.7	4.9
All	10.3	7.7	6.5	6.7	10.9	17	5.7	4.9
Ethiopia 2005								
Using	0	27.4	14.5	17.5	21.9	*22.3*	*14.6*	*21.3*
Not using	3	4.2	3.3	4.2	5	9.1	10.8	0
All	3	4.5	3.4	4.2	5.3	9.2	10.9	1.1
Ethiopia 2011								
Using	1.6	6.1	6.2	9.3	3.8	*22.3*	13.8	*21.3*
Not using	6.1	6.6	3.3	5.5	8.9	15.9	8.4	3.3
All	6	6.5	3.5	5.7	8.6	16	8.7	3.8
Ethiopia 2016								
Using	*12.4*	0	19.1	12.5	4.1	*22.3*	*14.6*	*21.3*
Not using	4.5	3.5	4.4	5.2	6.7	14.8	9.9	12.3
All	4.5	3.5	4.6	5.3	6.7	14.8	10	12.5
Ghana 2008								
Using	*13.9*	10	17.7	4.6	19	*30*	39.2	*30.1*
Not using	9.4	10.7	8.5	14.5	13.2	20.7	26.8	34
All	9.7	10.6	9.3	13.9	13.8	21.2	28.1	33.4
Ghana 2014								
Using	*13.9*	25.3	23.4	15.8	22.8	*30*	52.5	80.4
Not using	11.4	13.7	11.7	14.8	17.3	22.6	32.4	39.6
All	11.5	14.1	12.1	14.9	17.5	22.8	33.7	42.7
Kenya 1998								
Using	5.4	1.3	5.3	3	12.5	0	5	24.2
Not using	4.5	5.1	5.4	5.4	5.5	9.6	6.6	8.3

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
All	4.5	4.8	5.4	5.1	5.9	8.6	6.4	9.7
Kenya 2003								
Using	17.9	6.9	1.3	5.3	11.1	*22.3*	7	7.4
Not using	7.6	5.4	3.9	5.3	8.2	8.2	4.3	6.1
All	8.1	5.5	3.7	5.3	8.6	9.2	4.5	6.2
Kenya 2008								
Using	6	8	5.5	4.1	4.3	15.7	0	5.1
Not using	3.3	4.4	6.5	4.4	12.5	19	3.1	9
All	3.4	4.8	6.3	4.4	11.4	18.6	2.9	8.3
Comoros 2012								
Using	*12.4*	*9.9*	*8.7*	*10.8*	*11.8*	*22.3*	*14.6*	*21.3*
Not using	5.7	4.6	8.1	5.8	12	18.1	6.6	17.9
All	5.7	4.7	8.1	5.9	12	18.2	6.6	17.9
Liberia 2013								
Using	*13.9*	29.3	39.4	*23.2*	36.4	*30*	38.7	*30.1*
Not using	7.7	8.3	12.4	11.9	11.7	27	11.7	10.9
All	7.8	8.6	13.1	12	12.5	27	12.4	10.9
Lesotho 2009								
Using	7.7	2.7	2.9	6.6	11.1	*22.3*	15.3	*21.3*
Not using	4.3	6	4.6	5.1	9.3	4.1	3.7	7.7
All	4.5	5.7	4.4	5.3	9.6	5.3	4.5	8.6
Lesotho 2014								
Using	22.4	1.2	1.9	11.7	6.8	*22.3*	5	6.9
Not using	9.8	4.8	10.1	10.1	12.4	13.1	7.1	10.5
All	10.7	4.4	9.2	10.3	11.4	14.3	6.9	10
Morocco 1992								
Using	*12.4*	4.6	9.2	9.4	13.6	25.5	*14.6*	*21.3*
Not using	9.1	7.1	7.7	8.6	8.9	8.5	*7.5*	*9.2*
All	9.2	6.9	7.8	8.8	9.7	11.8	7.5	14.4
Morocco 2003								
Using	18.1	11.1	10.2	12.3	15.8	21.8	*14.6*	*21.3*
Not using	10	8.5	8.2	11.7	16.9	29.8	8.6	*9.2*
All	10.7	8.9	8.6	11.9	16.6	27.2	8.9	9.2
Madagascar 2008								
Using	11	8.3	14.3	12	11	21.1	31.8	*21.3*
Not using	5.2	5.7	6.4	6.8	7.6	11.4	11.6	9.2
All	5.4	5.9	7	7.2	7.8	11.8	12.5	10.5
Mali 2012								
Using	*12.4*	*9.9*	*8.7*	*10.8*	*11.8*	*22.3*	*14.6*	*21.3*
Not using	4.5	3.5	3.8	3.4	4.6	7.2	5.7	2.4
All	4.5	3.5	3.8	3.4	4.6	7.2	5.7	2.4
Malawi 2004								
Using	12.5	0.6	0	7.5	6	5.1	*14.6*	*21.3*
Not using	5.8	4.4	4.3	5	7	6.4	5	5.5

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
All	5.9	4.2	4.1	5.1	7	6.3	5	5.6
Malawi 2010								
Using	6.7	2.4	2.5	5.9	5.5	4.5	1.3	*21.3*
Not using	6.8	3.7	5.1	5.4	5.3	13.2	7.9	16.8
All	6.8	3.6	4.9	5.5	5.3	12.7	7.7	17.3
Malawi 2015								
Using	9.4	2.6	8.2	10	3.3	*22.3*	*14.6*	*21.3*
Not using	6.2	4.9	5.3	4.3	5.8	10.2	7.6	6.3
All	6.3	4.8	5.4	4.5	5.7	10.3	7.6	6.5
Mozambique 2011								
Using	*12.4*	34.4	3.8	*10.8*	*11.8*	*22.3*	33.2	*21.3*
Not using	7.7	4.2	5.5	4.4	5.8	8.7	10.7	10.8
All	7.7	4.4	5.5	4.4	5.8	8.8	11.1	10.8
Nigeria 2008								
Using	15.7	6.1	3.9	8	15.2	10	48.5	31.4
Not using	5.2	5.2	4.7	6.2	10	11.3	16.2	13.4
All	5.4	5.3	4.7	6.4	10.3	11.2	19	15.4
Nigeria 2013								
Using	18.6	16.8	7.5	7.4	26.7	20.8	43.7	66.8
Not using	6.3	5.4	6.1	7.2	9.3	13.1	13.7	17
All	6.3	5.6	6.1	7.2	9.9	13.3	15.2	19.3
Niger 2012								
Using	*12.4*	*9.9*	8.5	*10.8*	*11.8*	*22.3*	*14.6*	*21.3*
Not using	9.1	3.8	5.8	7.9	9.5	17.3	6.8	0
All	9.1	3.9	5.9	7.9	9.5	17.3	6.8	0
Namibia 2006								
Using	*12.4*	3.7	6	6.6	3	*22.3*	1.6	4.7
Not using	1.5	6	4.9	7.6	9	16.4	3.3	4
All	1.6	5.8	5	7.5	8.5	16.6	3.1	4.1
Namibia 2013								
Using	*12.4*	4.8	10.1	3.9	10.6	*22.3*	2.4	5
Not using	2.5	5.5	11.5	6	7.9	14.4	4.8	8.5
All	2.8	5.5	11.4	5.8	8.1	15	4.4	8.2
Rwanda 2010								
Using	*12.4*	4	3.2	11.8	12.7	17.7	*14.6*	*21.3*
Not using	5.1	7.6	5.1	5.3	8.3	18.1	5.6	7.1
All	5.1	7.5	5	5.7	8.6	18	5.6	7.2
Rwanda 2014								
Using	*12.4*	4	8.8	10.5	17.5	17.6	*14.6*	*21.3*
Not using	10.5	7.2	5.9	7.7	10	16.2	5.6	6.8
All	10.6	7.1	6.1	8	11	16.4	5.7	7.2
Sierra Leone 2008								
Using	*12.4*	7.7	9.1	0	0	*22.3*	18.9	*21.3*
Not using	5.4	5.1	6.2	6	6.4	10.1	8.5	6.2

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
All	5.4	5.2	6.3	5.8	6.3	10.3	8.8	7.1
Sierra Leone 2013								
Using	*12.4*	3.5	16	57.7	11.2	*22.3*	12.5	*21.3*
Not using	6.2	5.4	5.9	5.7	7.9	10.6	7.9	11.5
All	6.2	5.4	6	6.1	8	10.8	8	11.8
Senegal 2012								
Using	*12.4*	*9.9*	*8.7*	11.4	*11.8*	*22.3*	*14.6*	*21.3*
Not using	11.2	8.7	8.4	7.4	10.4	17.2	8.3	1.1
All	11.2	8.7	8.4	7.5	10.4	17.3	8.5	1.1
Senegal 2014								
Using	*12.4*	*9.9*	19.2	*10.8*	*11.8*	*22.3*	*14.6*	*21.3*
Not using	6.5	7.7	6.7	11.1	10.5	10.1	7.6	4
All	6.5	7.8	6.8	11.1	10.5	10.2	7.6	4
Senegal 2015								
Using	*12.4*	*9.9*	*8.7*	0	*11.8*	*22.3*	*14.6*	*21.3*
Not using	9.2	6.5	6	9.4	15.6	20.8	5	8.2
All	9.2	6.5	6.1	9.2	15.5	20.8	5	8.2
Senegal 2016								
Using	*12.4*	*9.9*	0	16.6	6.6	*22.3*	*14.6*	*21.3*
Not using	5.4	8.1	5.7	10.7	14.1	17.5	11	18.7
All	5.4	8.1	5.6	10.9	13.7	17.6	11	18.7
Senegal 2017								
Using	*12.4*	*9.9*	*8.7*	4.9	10.7	*22.3*	*14.6*	*21.3*
Not using	10.4	8.4	8	9.5	15.7	21.1	6.1	14
All	10.4	8.5	8	9.5	15.6	21.1	6.1	14.2
Tanzania 2004								
Using	*12.4*	8.7	18.7	10.9	2.5	*22.3*	14.5	*21.3*
Not using	8.8	5.7	6.1	8.5	11.2	22.3	10.1	16.2
All	8.8	5.9	6.9	8.6	10.8	22.3	10.2	16.3
Tanzania 2010								
Using	*12.4*	2.5	3.3	6	7.7	4.4	3.9	*21.3*
Not using	8.5	7.2	7.1	7.3	13	17.2	7.3	0.8
All	8.5	7	6.9	7.2	12.7	16	7.2	2.2
Tanzania 2015								
Using	5.5	6.3	15.1	11.5	9.6	15.5	19.5	*21.3*
Not using	9	7.7	8.6	8.7	12.3	20.1	9.3	14.4
All	8.9	7.6	9	8.9	12.1	19.7	9.8	15
Uganda 2006								
Using	25.1	9.7	8.7	7.9	25.1	*22.3*	1.6	*21.3*
Not using	9.4	7.3	6.4	9.2	13.9	23.5	13	13.7
All	10	7.4	6.6	9.1	14.6	23.4	12.2	14
Uganda 2011								
Using	0	12.6	4.1	4.4	18.2	*22.3*	8	*21.3*
Not using	12.9	6.6	8	8.6	12.5	25.5	13.3	17.3

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
All	12.5	6.9	7.8	8.3	12.7	25.3	13.1	17.5
Uganda 2016								
Using	7	15.9	14.1	17.9	27.4	17.7	35.2	*30.1*
Not using	10.3	9.1	7.9	10.5	15	25.5	10.5	18.3
All	10.3	9.4	8.2	10.8	15.7	25	10.9	18.9
Zambia 2007								
Using	6.1	5.2	5	11	2.3	0	15.6	*21.3*
Not using	7.7	5.2	6.2	5.4	6	10.8	5.7	12.4
All	7.6	5.2	6.1	6.1	5.5	9.7	6.4	13.2
Zambia 2013								
Using	4	2.4	3.5	2.6	14.6	3	2.8	*21.3*
Not using	5.6	5.5	4.2	5.3	6.4	13.9	5.2	11.4
All	5.6	5.3	4.1	5.1	7.2	12.7	5.2	11.7
Zimbabwe 1994								
Using	6	5.5	7.2	9.8	14.2	27.3	5.3	24.9
Not using	10.4	8.4	4.9	6	7	24.5	6.6	12.5
All	10	8.1	5.2	6.4	8.3	24.9	6.5	13.6
Zimbabwe 1999								
Using	13.2	16.5	5.5	0	4.2	*22.3*	10	*21.3*
Not using	8.5	7	6.5	7.1	11.6	18.9	8.2	8.2
All	8.8	7.9	6.4	6.2	10.7	19.1	8.3	9.4
Zimbabwe 2005								
Using	30.4	2.3	5.2	2.7	6.9	23.9	5.5	0
Not using	9.4	5.9	7.1	4.6	12.1	18.2	5.8	10.9
All	10.6	5.5	6.8	4.4	11.6	18.8	5.8	10
Zimbabwe 2010								
Using	*12.4*	5	3.3	11.3	5.9	0	21.8	*21.3*
Not using	9.7	5	7.3	8	8.1	7.7	5.4	12.4
All	9.8	5	7	8.4	7.8	6.8	5.7	12.7
Zimbabwe 2015								
Using	0	4	8.5	9.7	11.8	10	*14.6*	*21.3*
Not using	9.4	9.2	5	7.1	11.1	26.6	9.7	6
All	9	8.7	5.4	7.4	11.1	24.7	9.8	6.3
Central and West Asia & Europe								
Albania 2008								
Using	*13.9*	24.1	14.9	20.2	23.9	*30*	*26.5*	*30.1*
Not using	12	6.9	11	22.4	38.8	71.3	9.1	0
All	12.1	10.2	12	21.8	36.1	71.3	11.8	4.2
Albania 2017								
Using	*12.4*	20	16.3	24.9	*11.8*	*22.3*	*14.6*	*21.3*
Not using	6.7	6.9	7.6	7.6	19.6	38.9	5.5	0
All	6.8	7.6	8	8.5	19.3	37.7	5.6	0
Armenia 2000								
Using	53.4	75.7	86	88.6	93.7	97.1	*49.4*	*66.1*

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
Not using	18.5	30.6	50.1	73.1	74.6	86.7	*36.7*	*46.5*
All	22.6	45.3	68.7	81.4	85.3	91.9	36.7	46.5
Armenia 2005								
Using	*61.9*	64.3	86	96.3	89.3	74.3	*49.4*	*66.1*
Not using	19	24.3	45.3	59.5	72.6	91.5	*36.7*	25.5
All	20.7	31.9	58.8	74	80.2	84.5	46.5	28.2
Armenia 2010								
Using	*33.7*	49.1	69.2	72.7	75.5	89.1	*23.6*	*26.1*
Not using	20.2	20.6	32.4	50.2	47.5	54.6	20.8	*22.5*
All	20.4	23.5	41.1	57.2	54.8	68.8	20.8	22.5
Armenia 2015								
Using	*33.7*	56	76.7	78.3	95.5	91.4	*23.6*	*26.1*
Not using	13.7	18.7	27.8	32	29.8	53.5	32.3	*22.5*
All	14	22.5	34.9	41	43.8	67.4	32.3	22.9
Azerbaijan 2006								
Using	94.7	64.9	78.8	88.6	86.7	100	*49.4*	*66.1*
Not using	17.9	29.5	49.3	57	72.6	84.1	31	35.3
All	20.6	33.4	56.2	67.5	77.4	89.2	31	35.3
Kazakhstan 1999								
Using	46.7	59.1	80.5	86.3	92.7	84	79.1	88.9
Not using	22.4	28.8	39.7	37.8	50.9	55.3	49.8	65.2
All	25.2	33.8	50.6	51.6	63.2	67	54	72.5
Kyrgyz Rep. 2012								
Using	*33.7*	49.9	50.5	52.6	48	*73.7*	*23.6*	*26.1*
Not using	9.3	17.5	22.5	21.8	29.8	27.9	19.9	27.7
All	10	19	24.4	24.4	31.4	29.6	20.1	27.6
Moldova 2005								
Using	60.1	59.1	71.9	71.9	70.2	90	53.1	88.3
Not using	25	26.9	31.5	34.3	66.8	74.7	43.8	65.3
All	32.4	34.8	44.1	48.2	68.3	80.5	45.1	70.3
Tajikistan 2012								
Using	*33.7*	26	52	67.3	65.6	*73.7*	*23.6*	*26.1*
Not using	12.1	10.7	15.1	19.2	27.9	41.1	14.7	25
All	12.1	10.8	16	20.4	29.4	42.9	14.7	25
Tajikistan 2017								
Using	*13.9*	21.7	41	*23.2*	*25.8*	*30*	*26.5*	*30.1*
Not using	9.4	10.7	16	22.8	32.5	51.7	11.5	25.1
All	9.4	10.7	16.3	22.8	32.3	51.6	11.5	25.1
Turkey 1998								
Using	48	33.9	32.7	50	71.3	77.5	*23.6*	*26.1*
Not using	13.7	14.4	17.7	26.4	29.1	48.3	*18.3*	*22.5*
All	17.6	17.7	21	32.9	43.9	61.4	18.3	22.5
Turkey 2003								
Using	18.6	21.8	29.3	50.6	57.5	52	23.6	*26.1*

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
Not using	17.8	13.3	16.9	18	36.7	30.3	*18.3*	*22.5*
All	17.9	15	20.3	29.9	46	41		22.5
Ukraine 2007								
Using	*33.7*	45.3	75.9	71.5	76.8	85.6	40.3	*26.1*
Not using	13	15.9	27.1	28.9	42.3	53.8	12.5	41.9
All	15.4	21.2	39.6	41.2	57.4	68.2	20.6	39.1
Latin America								
Bolivia 1994								
Using	12.6	7.6	14.6	17.2	13.7	20	19.9	0
Not using	7.2	6.2	7.9	10	10.6	6.4	5.5	11.1
All	8.1	6.5	9.2	11.8	11.2	9.4	6.9	9.9
Bolivia 2008								
Using	8.7	13.9	15	16.6	18.8	24.3	13.3	18.6
Not using	9.6	10	10.8	14.4	16.7	17.5	10.2	16.8
All	9.4	11	11.8	15	17.3	19.1	10.8	17.3
Brazil 1996								
Using	20.4	20	10.5	11	24.8	33.5	20.6	13.8
Not using	9.7	9.1	11.9	11.1	20.7	30.3	14.3	17
All	10.9	11.1	11.6	11	21.6	31	15.6	16.2
Colombia 1990								
Using	7	16.8	16	25.1	10.8	26.2	21.5	6.7
Not using	11.6	10.3	10.2	13.6	19.2	35.1	5.5	14.5
All	11.1	11.4	11.6	16.3	16.7	32.4	7.5	13
Colombia 1995								
Using	18.6	14.9	15.2	15.6	9.6	26.1	7.7	15.5
Not using	8.6	9.9	9.5	11.1	9.3	23.9	7.1	14.9
All	10.2	11.2	11.1	12.6	9.4	24.7	7.2	15.1
Colombia 2000								
Using	8	14.8	12.9	15.2	25.8	29	19.2	24.5
Not using	8.6	14.2	16.4	16.5	21.1	25.6	13.4	18.4
All	8.5	14.4	15.2	16.1	23	26.9	15.4	20.5
Colombia 2005								
Using	18.3	21	16.6	21.6	33.1	19.3	20.4	27.5
Not using	10.4	13.8	14.3	17	20.6	29	18.8	22.3
All	12.1	15.6	15	18.4	24.8	25.5	19.3	23.8
Colombia 2010								
Using	13	22.1	17.3	27.4	22.3	32.9	20	21.4
Not using	11.7	16.1	15.1	19	25.2	35.1	15.3	16.8
All	12	17.3	15.6	20.8	24.5	34.5	16.4	17.8
Colombia 2015								
Using	11.5	16.6	25.1	21.2	19.5	16.6	19.6	17.1
Not using	7.8	12.3	15.7	13.7	21.6	37.1	14.7	14.7
All	8.5	13.2	17.7	14.8	21.1	32	15.9	15.2
Dominican Rep. 1991								

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
Using	5.7	16.2	26.3	18.4	36.5	*30*	27	*30.1*
Not using	11	9.8	14.8	20.1	18	25.1	9.5	23
All	10.7	10.5	16.6	19.9	20.5	25.5	12.2	23.8
Dominican Rep. 1996								
Using	14.9	15.8	16.7	20.5	*25.8*	*30*	22.8	41.7
Not using	16.2	12.6	18.2	14.2	24.1	19.4	24.3	22.8
All	16.1	13	18	15	24.2	20.2	24.1	27.3
Dominican Rep. 1999								
Using	*13.9*	10.1	28.8	*23.2*	*25.8*	*30*	*26.5*	*30.1*
Not using	13.7	18.2	20.3	22.9	20.5	*31.9*	45.4	56.5
All	13.7	17.1	22	22.9	20.8	30.5	45	53.9
Dominican Rep. 2002								
Using	18.1	21.1	14	25.5	26.9	50.9	35	21.5
Not using	11.7	12.3	13.8	16.8	14.3	40.5	26.5	29.6
All	12.4	13.7	13.8	17.9	15.9	41.7	27.5	28.6
Guatemala 1995								
Using	0	21.3	2.8	13.7	3.2	16.5	*14.6*	*21.3*
Not using	4.8	4.9	5.3	6	7	15.3	4	8.3
All	4.7	5.6	5.2	6.3	6.8	15.3	4.5	8.5
Guatemala 1998								
Using	17.2	7	14.1	3.6	0.6	*22.3*	*14.6*	*21.3*
Not using	6.3	3.2	6	6.5	4.5	13.3	5.6	6.5
All	6.7	3.4	6.9	6.3	4.3	13.6	6.3	9.4
Guatemala 2014								
Using	10.3	10.3	9.4	9.9	16.3	22.2	4.3	0
Not using	7.4	5.2	7.3	8.6	9.6	19.9	5.7	13.3
All	7.6	5.8	7.5	8.8	10.8	20.2	5.6	12.5
Guyana 2009								
Using	*13.9*	21	49	41	30.3	*30*	23.7	43.6
Not using	9.8	16	19.3	21.8	32.8	53.3	17.3	22.5
All	10	16.8	24.1	24.8	32.5	52.4	17.9	26.9
Honduras 2005								
Using	3.9	11.5	15.1	8.4	20	16.9	16.1	*21.3*
Not using	6.5	6.6	6.7	9.2	14.1	26.1	7.3	14
All	6.3	7.4	8.1	9.1	15.2	24.5	8.6	14.9
Honduras 2011								
Using	13.9	12.4	13.1	14.1	17	47.3	10.6	11
Not using	8.6	7.6	9	10.4	14	26.7	5.6	8.5
All	9	8.1	9.5	10.9	14.4	29.5	6.3	8.8
Nicaragua 1998								
Using	13.3	15.9	13.5	5.4	7.2	*22.3*	*14.6*	*21.3*
Not using	4.6	7.9	8.2	6.9	11.7	9.3	10.2	13.3
All	5.3	8.6	8.8	6.7	11.3	9.8	10.4	14.2
Peru 1991								

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
Using	6	5.5	13.1	13.1	21.6	26.7	15.3	16.2
Not using	4.9	6.7	8.9	11.4	13.5	13.9	7.6	12.4
All	5.1	6.4	10.2	12	16.2	18.6	9.3	13.2
Peru 1996								
Using	13.6	8.9	11.1	14.4	12.1	18.1	10.9	21.7
Not using	5.6	7.3	7.8	11.4	12.8	19.3	8	10.3
All	7.4	7.7	8.8	12.4	12.5	18.8	8.7	13.6
Peru 2000								
Using	8.9	6.4	15.1	12.8	17.8	21.6	13.4	24.7
Not using	7.3	6.9	7.8	10.9	12.7	12.1	8.4	13
All	7.5	6.8	9.6	11.5	14.3	15.3	9.6	15.8
Peru 2004								
Using	19.1	14.1	11.9	11.5	16.7	22.2	15.2	20.7
Not using	7	5.9	10	9.1	12	27.3	11.3	10.8
All	9.2	8	10.6	9.8	13.4	25.7	12.4	13.1
Peru 2007								
Using	8.8	11.7	17.8	16.2	17.9	23.8	22	28.8
Not using	11.4	11.1	11	11.3	16.5	31.8	9.3	9.6
All	10.8	11.3	13.2	12.7	17	29.2	13.7	14.9
Peru 2009								
Using	12.5	12.5	13.9	18.5	19.8	14.6	27	21.2
Not using	6.7	9.3	10.5	11.2	16	29.3	13	16.7
All	8.6	10.2	11.4	13.5	17.1	24.4	18.8	17.9
Peru 2010								
Using	12.2	14.4	20.2	19.1	25.4	29	21.3	47.4
Not using	9.3	9.9	10.8	13.2	17	29.4	13.5	17.3
All	10.1	11.2	13.5	15.1	19.7	29.3	16.5	26.1
Peru 2011								
Using	14.1	17	17.7	18.7	20.5	35.9	17.8	35.6
Not using	10.9	8.1	9.6	12.1	13.8	28.7	17.2	17.9
All	11.9	10.9	12	14.1	16.1	31.3	17.4	24
Paraguay 1990								
Using	9.7	20.5	17.3	17.5	19.5	34.5	26.9	*21.3*
Not using	9.1	6.5	10.2	9	14.4	15.7	4.6	10
All	9.2	8.8	11.4	10.4	15.3	18.2	6.4	11.1
South and Southeast Asia								
India 2005								
Using	13.4	20.5	28.2	43.6	37	48.4	*26.5*	*30.1*
Not using	12.2	10	11.1	14.9	17.3	9.9	12.4	53.4
All	12.2	10.4	11.9	16.9	19.2	13.6	12.4	53.4
Indonesia 2012								
Using	29.8	5.6	3.3	12.4	19.9	17.5	*14.6*	*21.3*
Not using	10.2	8.1	9	11.7	15.6	21.1	5.2	9.7
All	10.5	7.9	8.7	11.7	16.2	20.6	5.3	9.8

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
Cambodia 2010								
Using	24	31.7	37.3	60.2	57.9	74.6	*23.6*	*26.1*
Not using	16	14.3	16.8	21.8	32.7	43.9	16.8	13.6
All	16.1	14.7	18.3	25.4	35.4	47.7	17	14.2
Cambodia 2014								
Using	74.1	35.7	44.9	52	75.1	83.1	*23.6*	*26.1*
Not using	15.4	15.8	19.7	21.1	31.5	55	24.9	17.7
All	16.8	16.9	22.5	25.4	39.3	59.4	24.9	18.4
Nepal 2011								
Using	32.1	17.7	48.5	63.5	35.6	*30*	*26.5*	*30.1*
Not using	11.5	10.1	16.5	16.9	22.9	23.1	13.2	*22.7*
All	11.7	10.3	18.4	21	24.7	24.1	13.7	22.7
Nepal 2016								
Using	31.3	24.2	46	60.9	56.8	50	*23.6*	*26.1*
Not using	13.5	15.3	19	28.6	41.7	48	6.5	*22.5*
All	14	15.7	20.5	31.4	42.9	48.5	6.7	22.5
Philippines 1993								
Using	13.9	7.9	12.8	10.3	12.4	27.1	*14.6*	*21.3*
Not using	9.3	7.5	8.3	8.1	13.4	22.1	8.8	3.8
All	9.5	7.5	8.9	8.4	13.3	22.9	8.8	4.1
Philippines 1998								
Using	6.6	7.6	5.9	15.1	13.5	32.4	30.9	*21.3*
Not using	14.2	7.6	8.6	10.3	16	24.9	7.7	2.7
All	13.5	7.6	7.9	11.4	15.4	26.3	9.6	3.5
Philippines 2003								
Using	19.7	6	8.1	14.9	11.3	17.6	8.4	*21.3*
Not using	9.6	9.2	8.5	9.8	13.6	26.7	5.8	5.5
All	10.4	8.8	8.4	10.7	13.2	25	5.9	6
Timor Leste 2009								
Using	*12.4*	*9.9*	*8.7*	14.4	*11.8*	*22.3*	*14.6*	*21.3*
Not using	4.5	2	2.6	2.4	2.8	5.3	8	0
All	4.6	2.1	2.7	2.5	2.8	5.3	8	0
Using	*12.4*	*9.9*	*8.7*	*10.8*	*11.8*	*22.3*	*14.6*	*21.3*
Not using	5.2	3.8	2.9	2.7	4.7	3.6	2.7	2.9
All	5.2	3.8	2.9	2.7	4.8	3.7	2.7	2.9
Cluster means								
Cluster 1								
Using	12.4	9.9	8.7	10.8	11.8	22.3	14.6	21.3
Not using	7.3	6.2	6.5	7.4	10.1	16	7.5	9.2
Cluster 2								
Using	13.9	18.1	23	23.2	25.8	30	26.5	30.1
Not using	10.6	11.4	13.4	15.8	20.4	31.9	16.8	22.7
Cluster 3								
Using	33.7	37.4	51.4	61.6	68	73.7	23.6	26.1

Table 11: Probability of pregnancy termination by age-group, union status, and contraceptive use after the clustering. *(continued)*

	In-union						Not-in-union	
	15-19	20-24	25-29	30-34	35-39	40-49	15-24	25-49
Not using	14.4	15.6	21.5	26.8	34.9	45.6	18.3	22.5
Cluster 4								
Using	61.9	64.6	80.6	86.3	86.5	89.1	49.4	66.1
Not using	20.5	28	43.2	52.3	67.5	78.4	36.7	46.5

Note:
Values in italics correspond to imputed probabilities from the cluster means.

4.5.2 Termination rates and tentative separation of terminations

The analysis of T suggests that PT are more common among older women consistent both with increased risk of ST and higher prevalence of IA to limit family size. However, there are relatively few pregnancies at older ages and many more pregnancies at peak reproductive ages. When $ASTRs$ are computed, we find that termination rates tend to show an inverted U-shaped pattern peaking mostly in the 25-29 age-group for countries with high abortion rates, with more heterogeneity in peak ages for clusters 1 and 2 (see figure 18). Cluster 1 has the lowest $ASTR$ and smooth trends by age with maximum values at ages 30-34, although Senegal and Uganda have the highest peaks at ages 35-39. Cluster 2 has the maximum values between the ages of 20-24 and 25-29, especially Ghana and Tajikistan. This suggests that whereas from a medical perspective we should expect a higher likelihood of termination in older pregnant women, from a public health perspective we should expect women experiencing terminations to be younger. Survey-specific $ASTRs$ are shown together with the age-specific probabilities of termination in figure 19 and printed in table 10.

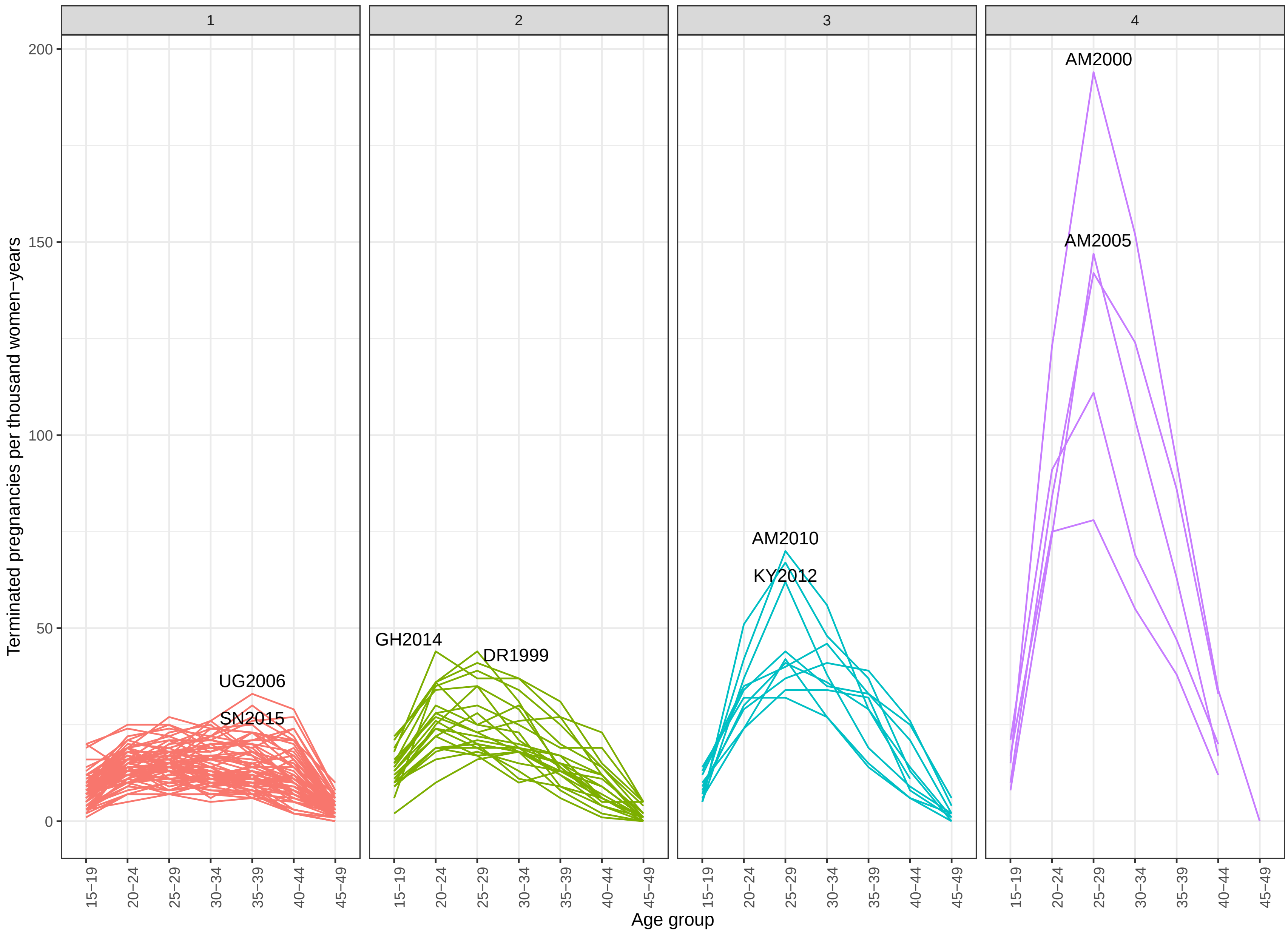


Figure 18: Age-specific termination rate by cluster.

Figure 19: Age−specific termination rate (ASTR) and probability of pregnancy termination (T) by survey.

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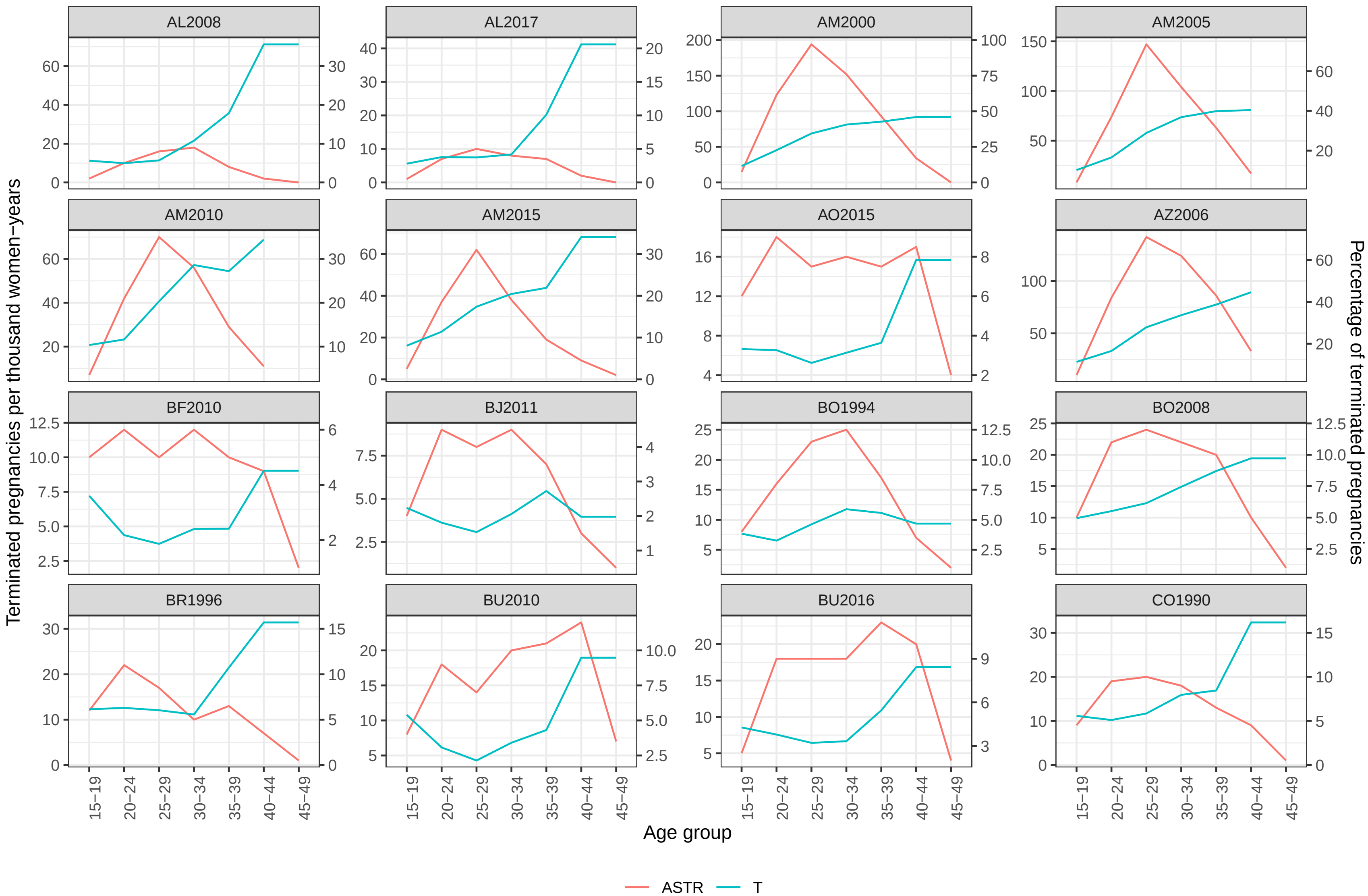

Figure 19: Age−specific termination rate (ASTR) and probability of pregnancy termination (T) by survey.

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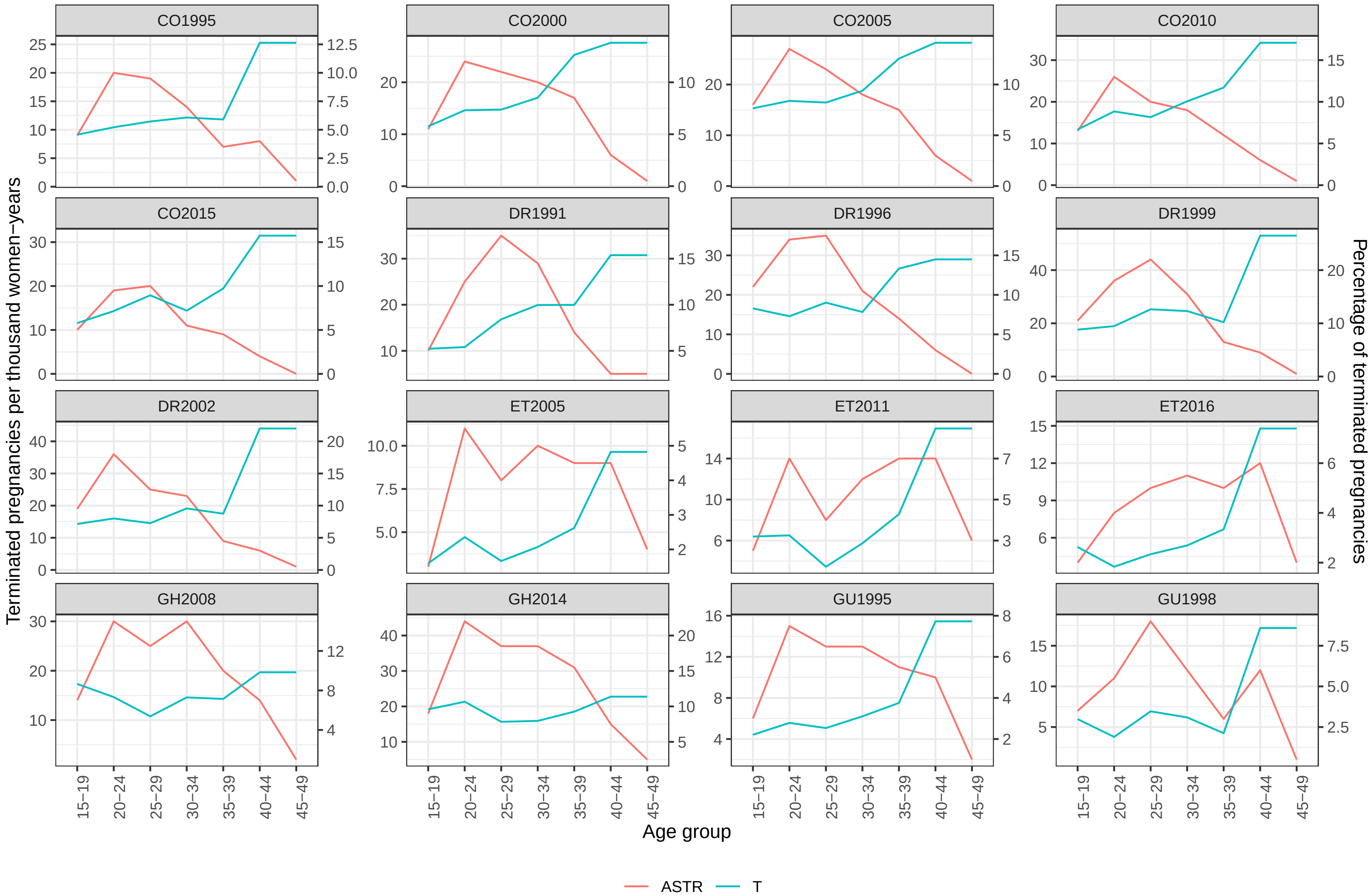

Figure 19: Age−specific termination rate (ASTR) and probability of pregnancy termination (T) by survey.

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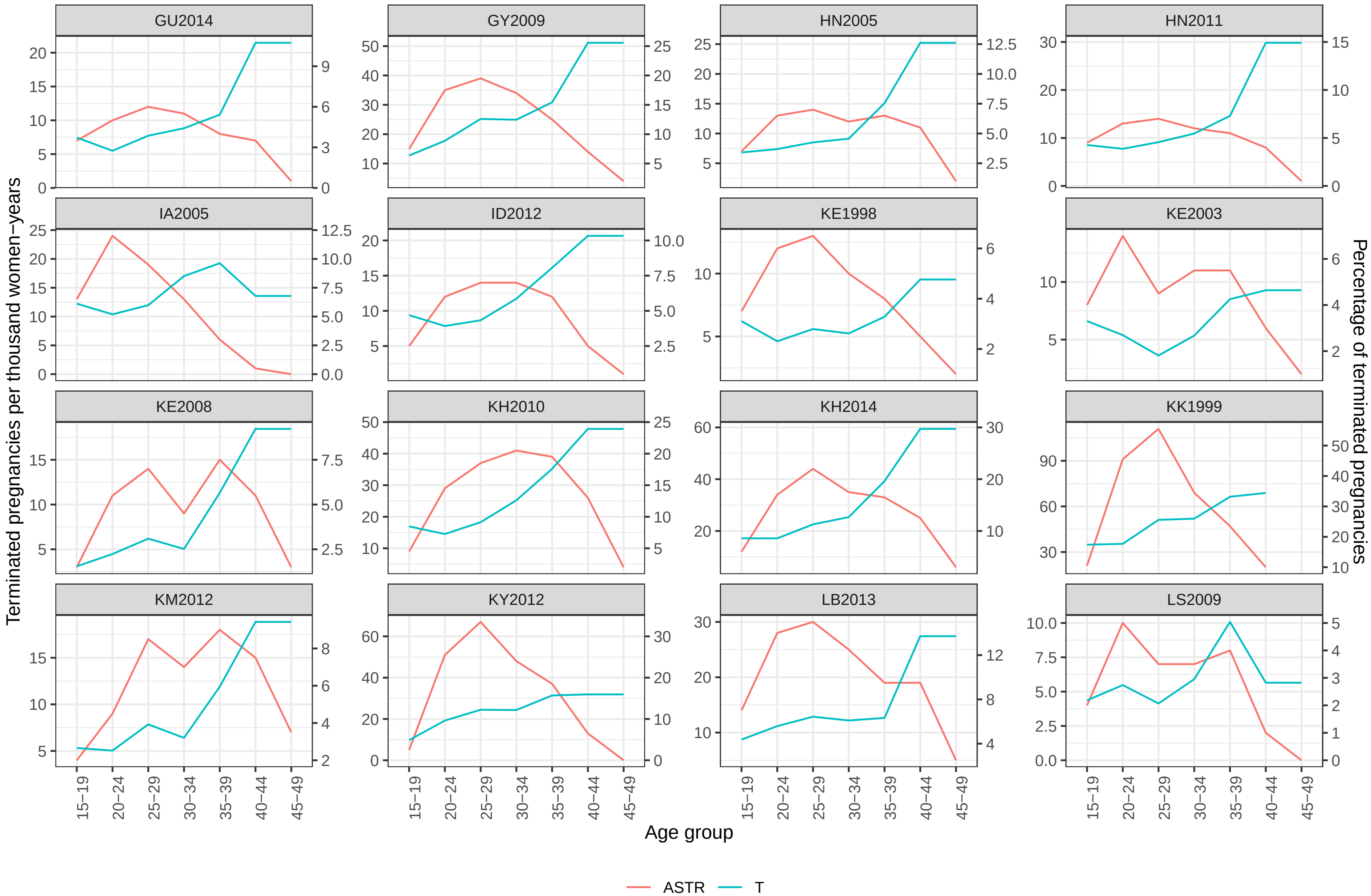

Figure 19: Age−specific termination rate (ASTR) and probability of pregnancy termination (T) by survey.

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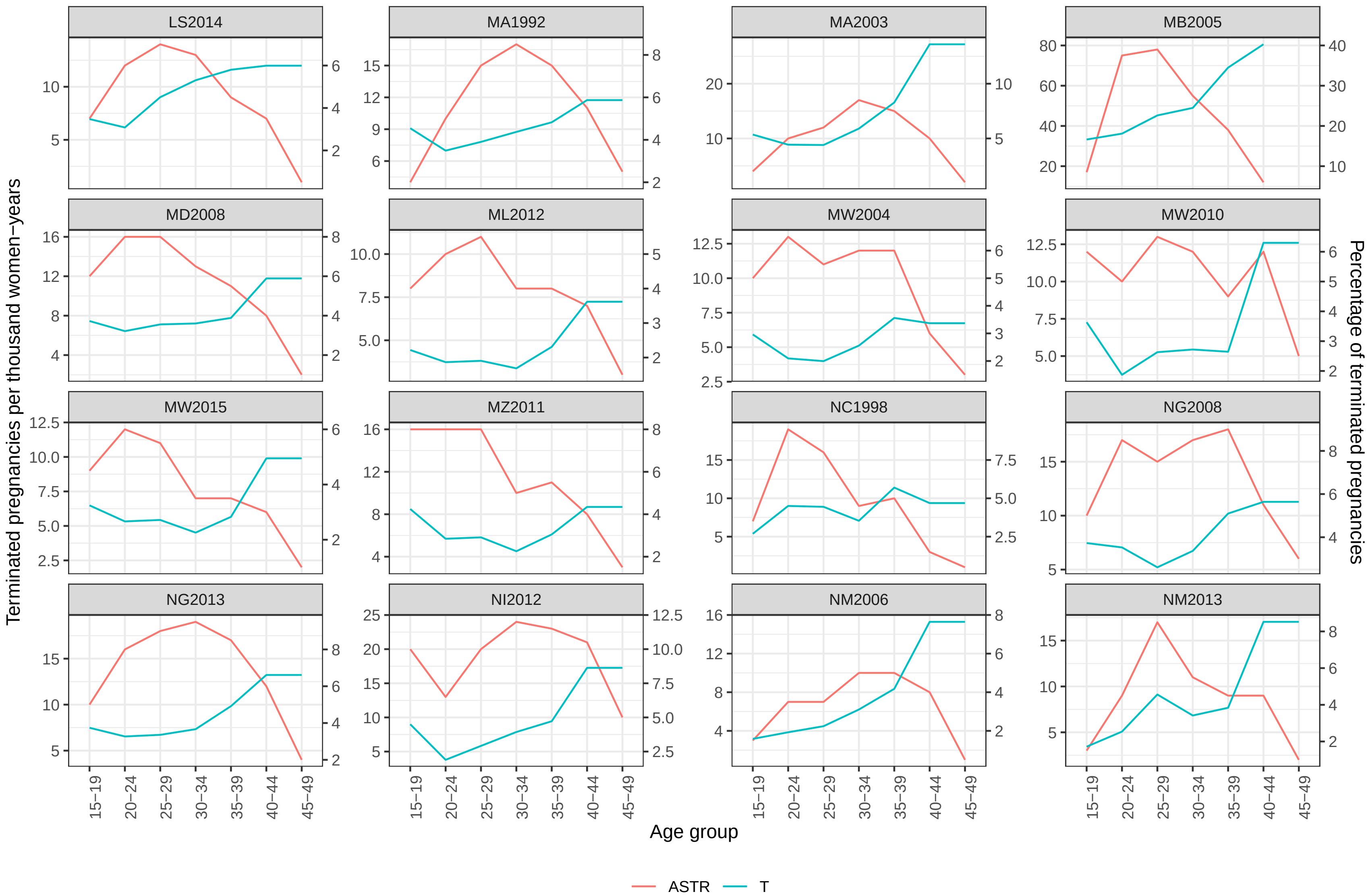

Figure 19: Age−specific termination rate (ASTR) and probability of pregnancy termination (T) by survey.

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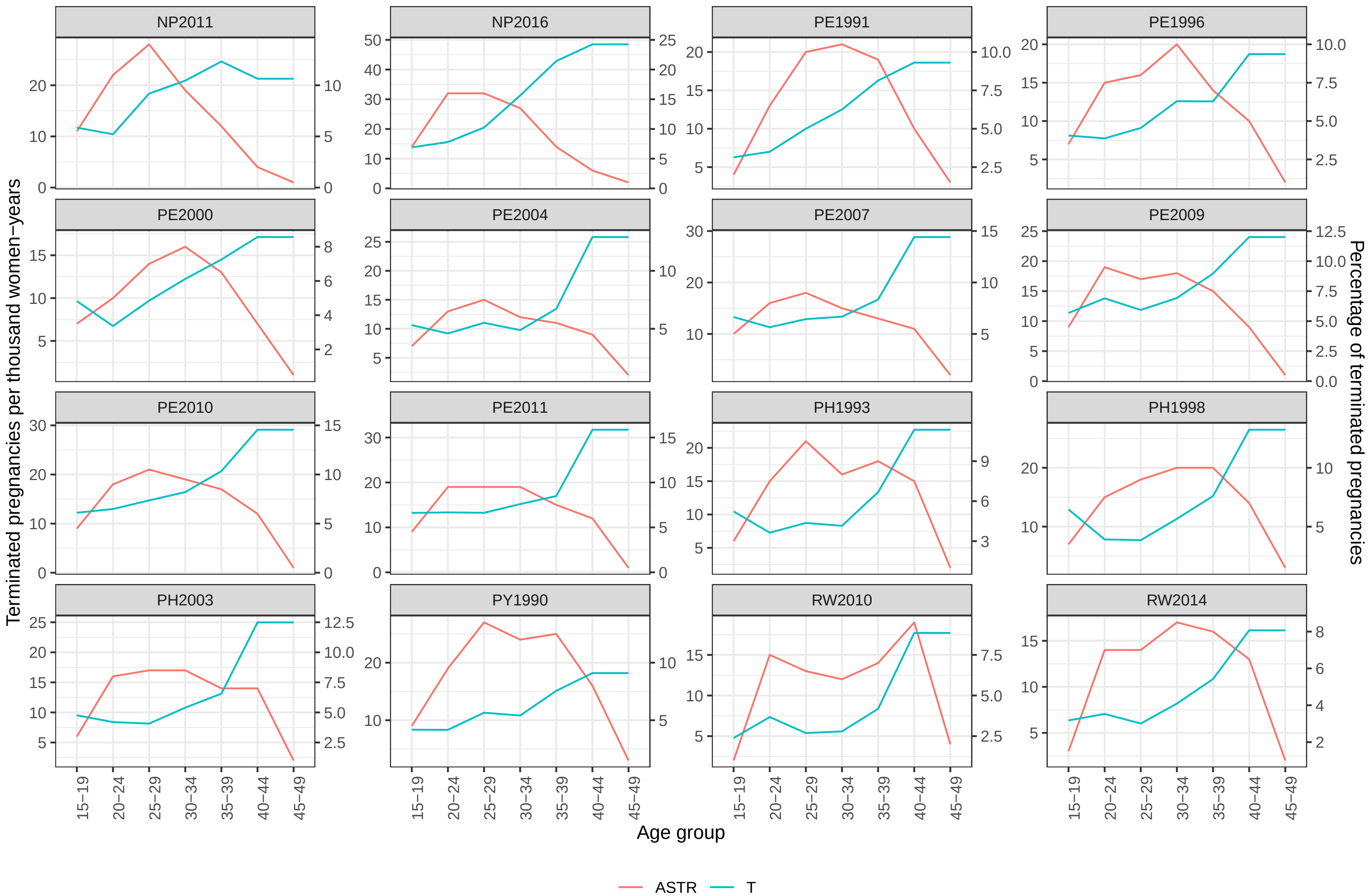

Figure 19: Age−specific termination rate (ASTR) and probability of pregnancy termination (T) by survey.

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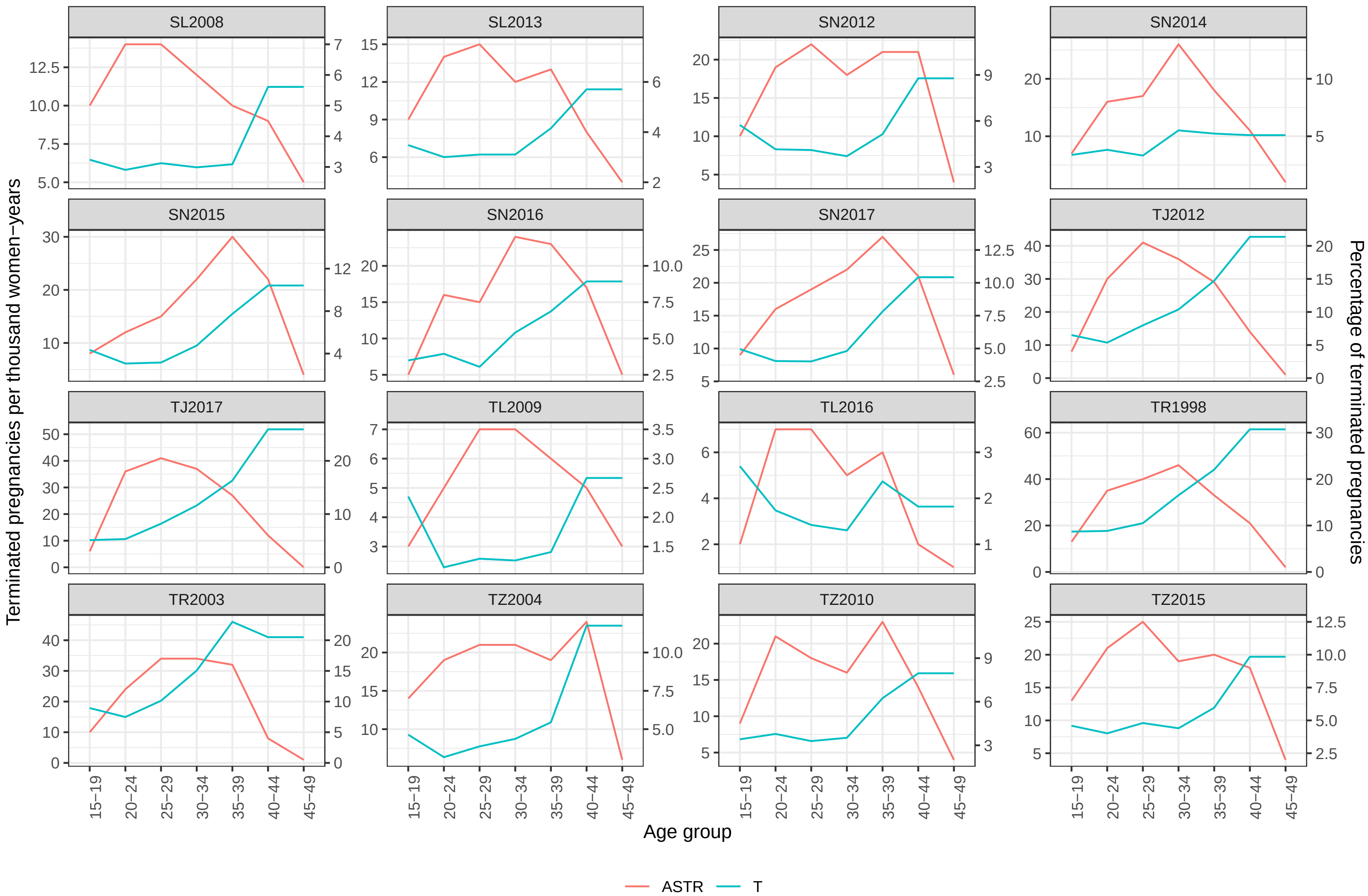

Figure 19: Age−specific termination rate (ASTR) and probability of pregnancy termination (T) by survey.

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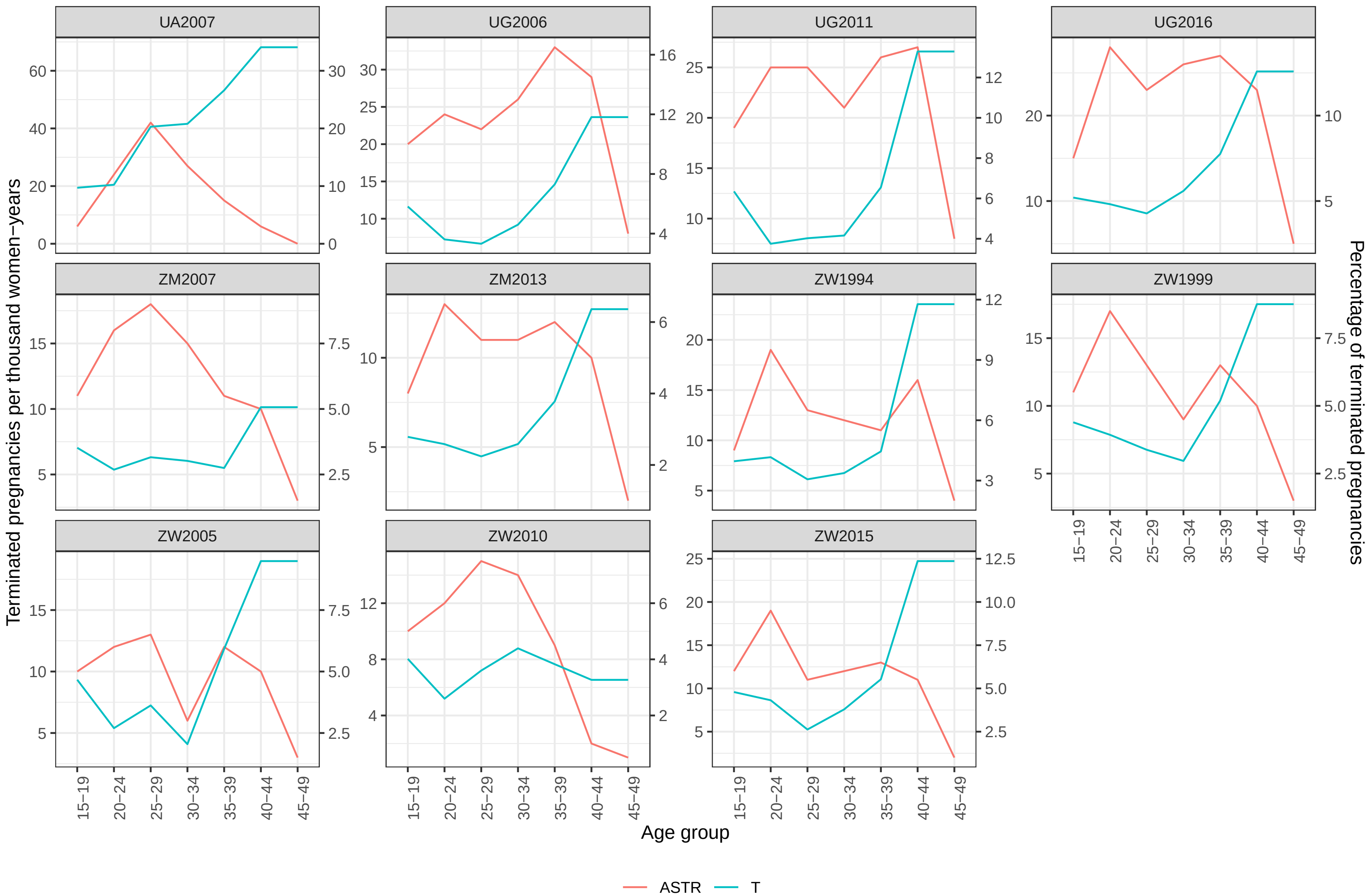

Termination rates provide two alternative indicators of the quantum of PT: TTR and GTR. Figure 20 compares TTR and GTR with T. $TTRs$ indicate that in all countries in clusters 1 and 2, women are expected to experience on average less than one pregnancy loss over their reproductive life. GFR shows that this corresponds to a risk of less than 25 per thousand of experiencing a termination in a given year. In contrast, in high abortion countries, TTR can be higher than two terminations. There is generally a close association between T and both TTR and GTR as captured by the non-parametric regression line. Differences among the three quantum measures are driven by the population structure and the age-structure of women using contraception. TTR is not affected by construction by the age-structure, but might still be affected if the age-structure of contraceptors is different from the overall population of women. Note that we can think of TTR as the sum of a Total Induced Abortion Rate and a Total Spontaneous Termination Rate. TPR can be derived as the sum of TTR and TFR.

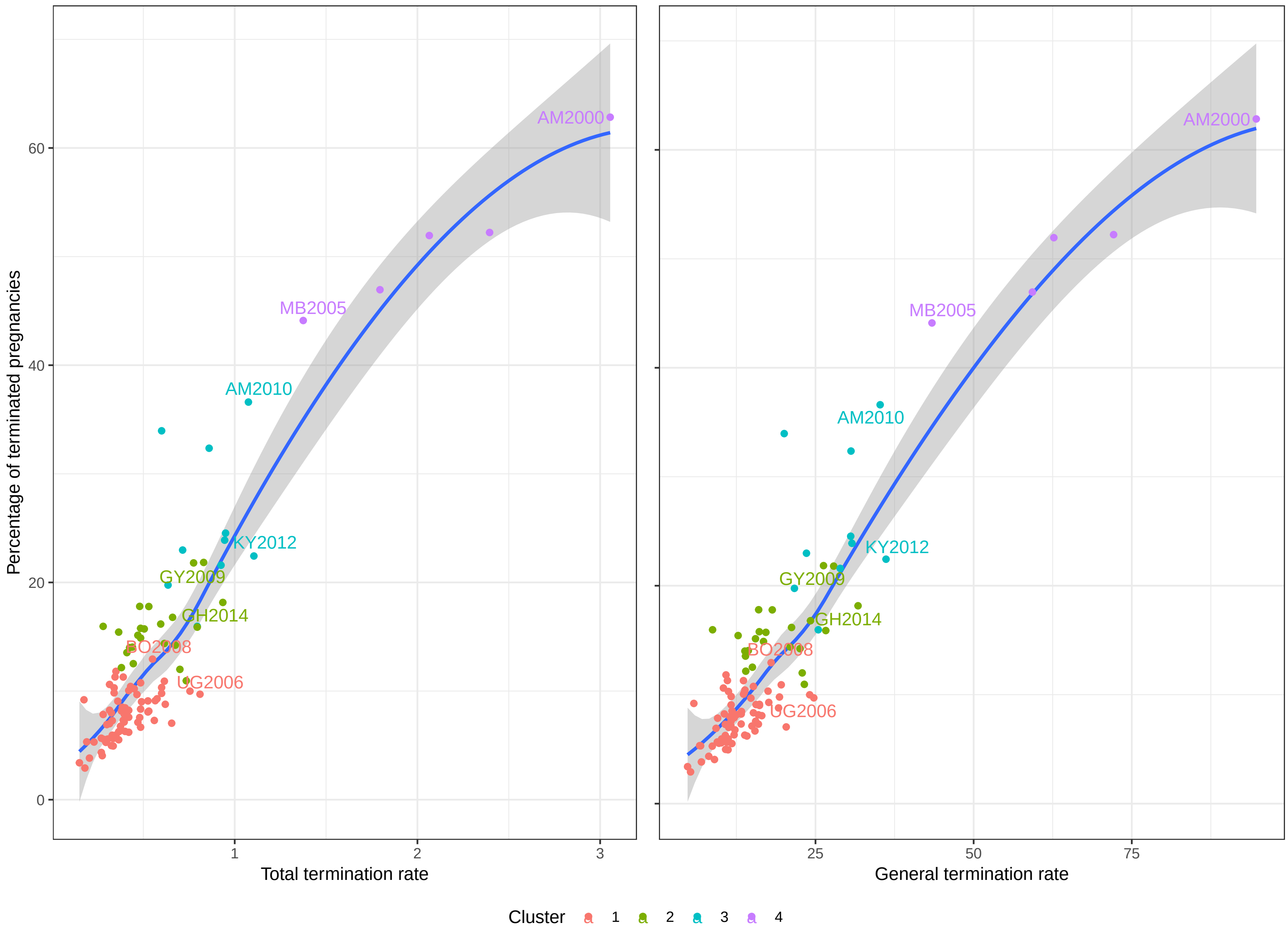

Figure 20: Total termination rate, general termination rate, and probability of pregnancy termination.

From a reproductive health perspective, the implications and determinants of ST and IA are very different, and it would be interesting to obtain separate estimates of the incidence of ST and IA. As presented in figure 9, information from the 16 DHS surveys reporting separately IA and ST suggests that differences in IA are mainly driven by differences in T. That is the idea behind the proposed logistic regression model for the probability of IA conditional on termination as a function of T. Figure 21 presents the resulting IA estimates for all the surveys included in our sample corresponding to model 2. While the model fit is far from perfect, it provides a good approximate indication of the range of likely IA and ST. It suggests that the implicit reported proportion of pregnancies ending in ST increases slowly with T up to a maximum of around 10 percent, declining at very high levels of T due to competing risks. It also suggests a very low proportion of pregnancies reported to end as IA in countries with low T, like in clusters 1 and 2. Note that the gray shadows indicate the observed patterns and the model fits for the surveys reporting the type of outcome. Since there are only two surveys with very low probability of termination, model estimates are driven more by the patterns in surveys with higher values of T. For those two surveys the fitted probabilities of IA are higher than the observed values suggesting that the estimates should be taken as an upper bound for reported IA in countries with low reported T.

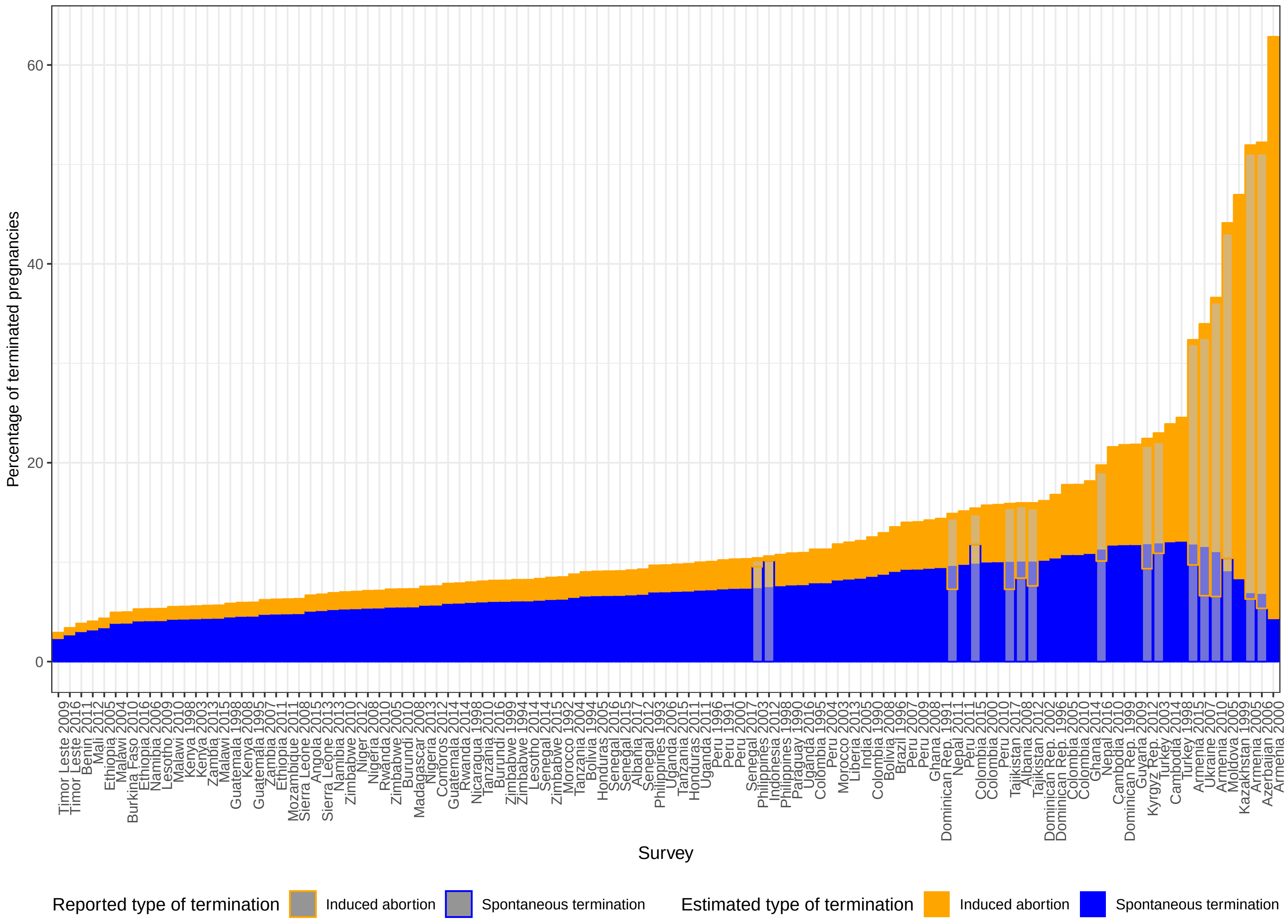

Figure 21: Induced abortion model estimates.

We have finally estimated TPR by adding-up TFR and TTR. Our use of a consistent period for both measures makes this possible. Estimates at the survey level are provided in table 12. We can see in figure 22 that TPR is higher in contexts with lower use of modern contraceptives indicating the role of contraception in preventing pregnancies. Once a pregnancy begins, IA provides a final mean of avoiding childbearing. The relative size of the TFR and TTR in the TPR bars indicates these different ways of managing reproduction. Note that our estimates of TPR also include reported ST. This will make them higher than alternative estimates only including IA and live-births (Bongaarts and Casterline 2018). On the other hand, those estimates combine DHS estimates of fertility with higher estimates of IA produced by the Guttmacher Institute (Sedgh et al. 2016). While overall increasing levels of modern contraceptive prevalence are associated to a lower number of pregnancies the relation is far from perfect. Other proximate determinants such as union-formation and sexual activity are also expected to play a role.

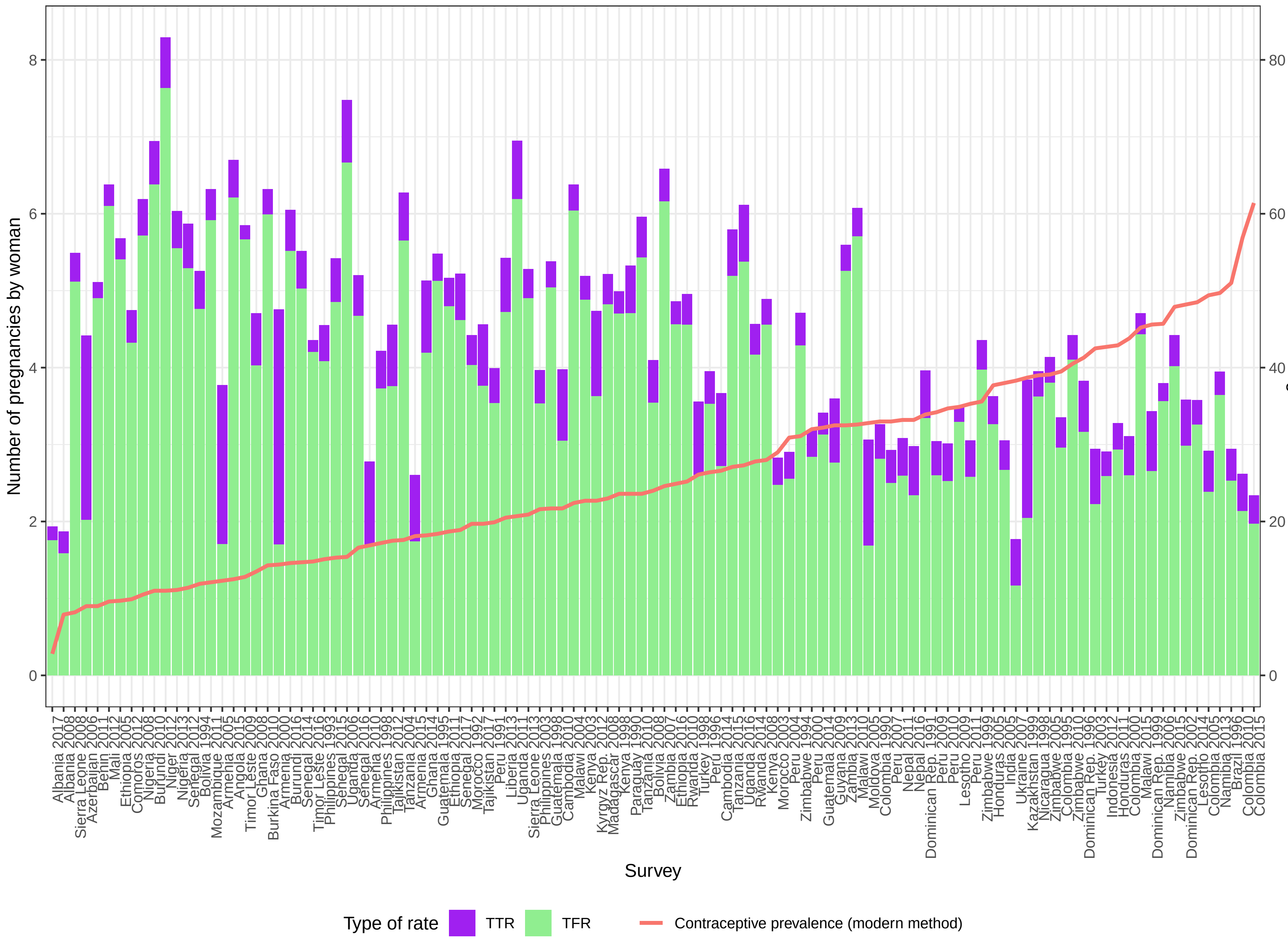

Figure 22: Total pregnancy rate (left-axis) and current contraceptive use of any modern method (right-axis) by survey.

Table 12: Contraceptive prevalence, total and general rates, and probability of pregnancy termination by survey.

			Probability PT (%)										
				Model estimates		Contraception (%)		Total rates			General rates		
Code	Survey	Cluster	T	IA	ST	Any	Modern	TFR	TTR	TPR	GFR	GTR	GPR
Africa													
AO	Angola 2015	1	6.7	1.6	5.1	13.3	12.5	6.2	0.5	6.7	216	15.4	231.4
BF	Burkina Faso 2010	1	5.0	1.1	3.9	15.3	14.3	6.0	0.3	6.3	206	10.8	216.8
BJ	Benin 2011	1	3.8	0.8	3.1	14.0	9.0	4.9	0.2	5.1	175	7.0	182.0
BU	Burundi 2010	1	7.3	1.8	5.5	13.4	11.0	6.4	0.6	7.0	203	16.0	219.0
BU	Burundi 2016	1	8.2	2.1	6.1	17.9	14.6	5.5	0.5	6.0	180	16.0	196.0
ET	Ethiopia 2005	1	4.3	0.9	3.4	10.3	9.7	5.4	0.3	5.7	179	8.1	187.1
ET	Ethiopia 2011	1	6.3	1.4	4.8	19.6	18.7	4.8	0.4	5.2	161	10.7	171.7
ET	Ethiopia 2016	1	5.3	1.2	4.1	25.3	24.9	4.6	0.3	4.9	156	8.7	164.7
GH	Ghana 2008	2	14.2	4.8	9.4	19.3	13.5	4.0	0.7	4.7	136	22.6	158.6
GH	Ghana 2014	2	18.2	7.2	10.9	22.8	18.2	4.2	0.9	5.1	143	31.7	174.7
KE	Kenya 1998	1	5.5	1.2	4.3	29.9	23.6	4.7	0.3	5.0	166	9.7	175.7
KE	Kenya 2003	1	5.6	1.2	4.3	28.4	22.7	4.9	0.3	5.2	171	10.1	181.1
KE	Kenya 2008	1	5.9	1.3	4.6	32.0	28.0	4.6	0.3	4.9	161	10.2	171.2
KM	Comoros 2012	1	7.6	1.9	5.7	13.7	9.9	4.3	0.4	4.7	142	11.7	153.7
LB	Liberia 2013	2	12.0	3.7	8.3	21.7	20.5	4.7	0.7	5.4	168	22.9	190.9
LS	Lesotho 2009	1	5.3	1.2	4.2	35.9	34.9	3.3	0.2	3.5	119	6.7	125.7
LS	Lesotho 2014	1	8.2	2.1	6.1	48.9	48.5	3.3	0.3	3.6	118	10.6	128.6
MA	Morocco 1992	1	8.5	2.2	6.3	22.9	19.7	4.0	0.4	4.4	127	11.8	138.8
MA	Morocco 2003	1	11.8	3.6	8.2	33.3	29.0	2.5	0.4	2.8	81	10.9	91.9
MD	Madagascar 2008	1	7.3	1.8	5.5	31.7	23.0	4.8	0.4	5.2	168	13.3	181.3
ML	Mali 2012	1	4.1	0.8	3.2	9.9	9.6	6.1	0.3	6.4	214	9.0	223.0
MW	Malawi 2004	1	4.9	1.1	3.9	25.7	22.4	6.0	0.3	6.3	215	11.2	226.2
MW	Malawi 2010	1	5.5	1.2	4.3	35.4	32.6	5.7	0.4	6.1	202	11.8	213.8
MW	Malawi 2015	1	5.7	1.3	4.4	46.0	45.2	4.4	0.3	4.7	158	9.5	167.5
MZ	Mozambique 2011	1	6.3	1.4	4.8	12.3	12.1	5.9	0.4	6.3	206	13.8	219.8
NG	Nigeria 2008	1	7.1	1.7	5.4	15.4	10.5	5.7	0.5	6.2	195	15.0	210.0
NG	Nigeria 2013	1	7.6	1.9	5.7	16.0	11.1	5.5	0.5	6.0	190	15.5	205.5

Table 12: Contraceptive prevalence, total and general rates, and probability of pregnancy termination by survey. *(continued)*

			Probability PT (%)										
				Model estimates		Contraception (%)		Total rates			General rates		
Code	Survey	Cluster	T	IA	ST	Any	Modern	TFR	TTR	TPR	GFR	GTR	GPR
NI	Niger 2012	1	7.0	1.7	5.4	12.5	11.0	7.6	0.7	8.3	269	20.4	289.4
NM	Namibia 2006	1	5.3	1.2	4.1	46.6	45.7	3.6	0.2	3.8	122	6.8	128.8
NM	Namibia 2013	1	6.9	1.6	5.3	50.2	49.7	3.6	0.3	3.9	125	9.3	134.3
RW	Rwanda 2010	1	7.1	1.7	5.4	28.6	25.2	4.6	0.4	5.0	151	11.6	162.6
RW	Rwanda 2014	1	7.9	2	5.9	30.9	27.8	4.2	0.4	4.6	142	12.2	154.2
SL	Sierra Leone 2008	1	6.3	1.5	4.9	10.2	8.2	5.1	0.4	5.5	180	12.1	192.1
SL	Sierra Leone 2013	1	6.8	1.6	5.2	22.1	20.9	4.9	0.4	5.3	169	12.3	181.3
SN	Senegal 2012	1	9.3	2.5	6.8	12.6	11.4	5.3	0.6	5.9	172	17.6	189.6
SN	Senegal 2014	1	8.3	2.1	6.2	16.0	14.7	5.0	0.5	5.5	167	15.2	182.2
SN	Senegal 2015	1	9.1	2.4	6.7	16.9	15.3	4.9	0.6	5.5	161	16.1	177.1
SN	Senegal 2016	1	9.1	2.4	6.7	18.0	16.6	4.7	0.5	5.2	156	15.6	171.6
SN	Senegal 2017	1	10.3	2.9	7.4	19.9	18.9	4.6	0.6	5.2	152	17.5	169.5
TZ	Tanzania 2004	1	8.8	2.3	6.5	22.5	17.6	5.7	0.6	6.3	199	19.2	218.2
TZ	Tanzania 2010	1	8.1	2	6.0	28.8	23.6	5.4	0.5	5.9	188	16.5	204.5
TZ	Tanzania 2015	1	9.8	2.7	7.1	32.4	27.1	5.2	0.6	5.8	178	19.3	197.3
UG	Uganda 2006	1	9.7	2.7	7.1	19.6	15.4	6.7	0.8	7.5	230	24.7	254.7
UG	Uganda 2011	1	10.0	2.8	7.2	23.6	20.7	6.2	0.8	7.0	217	24.1	241.1
UG	Uganda 2016	2	10.9	3.2	7.8	30.3	27.3	5.4	0.7	6.1	189	23.2	212.2
ZM	Zambia 2007	1	6.2	1.4	4.8	29.9	24.6	6.2	0.4	6.6	214	14.2	228.2
ZM	Zambia 2013	1	5.6	1.3	4.4	35.1	32.5	5.3	0.3	5.6	184	11.0	195.0
ZW	Zimbabwe 1994	1	8.2	2.1	6.1	35.1	31.1	4.3	0.4	4.7	148	13.3	161.3
ZW	Zimbabwe 1999	1	8.2	2.1	6.1	37.7	35.6	4.0	0.4	4.4	141	12.5	153.5
ZW	Zimbabwe 2005	1	7.3	1.8	5.5	40.1	39.1	3.8	0.3	4.1	137	10.7	147.7
ZW	Zimbabwe 2010	1	7.0	1.7	5.3	41.3	40.5	4.1	0.3	4.4	150	11.3	161.3
ZW	Zimbabwe 2015	1	8.5	2.2	6.3	48.6	47.9	4.0	0.4	4.4	144	13.3	157.3
Central and West Asia & Europe													
AL	Albania 2008	2	16.0	**7.2**	8.7	48.0	7.9	1.6	0.3	1.9	46	8.7	54.7
AL	Albania 2017	1	9.2	2.4	6.7	33.2	2.8	1.8	0.2	2.0	57	5.8	62.8
AM	Armenia 2000	4	62.8	58.5	4.4	39.0	14.4	1.7	3.1	4.8	56	94.7	150.7

Table 12: Contraceptive prevalence, total and general rates, and probability of pregnancy termination by survey. *(continued)*

			Probability PT (%)										
				Model estimates		Contraception (%)		Total rates			General rates		
Code	Survey	Cluster	T	IA	ST	Any	Modern	TFR	TTR	TPR	GFR	GTR	GPR
AM	Armenia 2005	4	51.9	**44.8**	7.2	33.1	12.3	1.7	2.1	3.8	58	62.7	120.7
AM	Armenia 2010	3	36.6	**29.6**	7.0	33.9	16.9	1.7	1.1	2.8	61	35.2	96.2
AM	Armenia 2015	3	32.4	**22.2**	10.2	36.7	18.1	1.7	0.9	2.6	64	30.6	94.6
AZ	Azerbaijan 2006	4	52.2	**45.7**	6.5	32.0	9.0	2.0	2.4	4.4	66	72.1	138.1
KK	Kazakhstan 1999	4	46.9	38.6	8.4	48.0	38.7	2.0	1.8	3.8	67	59.3	126.3
KY	Kyrgyz Rep. 2012	3	22.4	**12.3**	10.1	24.4	22.7	3.6	1.1	4.7	125	36.2	161.2
MB	Moldova 2005	4	44.1	**32.6**	11.5	49.8	32.8	1.7	1.4	3.1	55	43.4	98.4
TJ	Tajikistan 2012	3	16.0	**7.8**	8.2	18.9	17.5	3.8	0.8	4.6	134	25.4	159.4
TJ	Tajikistan 2017	2	15.9	**8.2**	7.7	21.3	19.7	3.8	0.8	4.6	141	26.6	167.6
TR	Turkey 1998	3	24.5	12.4	12.1	44.2	26.1	2.6	1.0	3.6	94	30.6	124.6
TR	Turkey 2003	3	23.0	**11.2**	11.8	71.0	42.5	2.2	0.7	2.9	79	23.6	102.6
UA	Ukraine 2007	3	34.0	**25.9**	8.1	50.9	38.3	1.2	0.6	1.8	39	20.1	59.1
Latin America													
BO	Bolivia 1994	1	9.0	2.4	6.6	30.1	11.9	4.8	0.5	5.3	163	16.2	179.2
BO	Bolivia 2008	1	12.9	4.1	8.8	41.3	24.0	3.5	0.6	4.0	121	18.0	139.0
BR	Brazil 1996	2	13.5	4.4	9.1	55.4	51.0	2.5	0.4	2.9	89	13.9	102.9
CO	Colombia 1990	2	12.5	3.9	8.6	39.9	33.0	2.8	0.4	3.2	105	15.0	120.0
CO	Colombia 1995	1	11.3	3.3	8.0	48.1	39.5	3.0	0.4	3.4	107	13.6	120.6
CO	Colombia 2000	2	15.7	5.7	10.1	52.8	43.8	2.6	0.5	3.1	92	17.2	109.2
CO	Colombia 2005	2	17.8	7	10.8	56.4	49.4	2.4	0.5	2.9	84	18.2	102.2
CO	Colombia 2010	2	17.8	7	10.8	61.2	56.9	2.1	0.5	2.6	74	16.0	90.0
CO	Colombia 2015	2	15.4	**3**	12.4	64.9	61.4	2.0	0.4	2.4	70	12.8	82.8
DR	Dominican Rep. 1991	2	14.4	4.9	9.5	36.8	33.9	3.3	0.6	3.9	125	21.0	146.0
DR	Dominican Rep. 1996	2	16.8	6.3	10.5	44.6	41.3	3.2	0.7	3.9	120	24.2	144.2
DR	Dominican Rep. 1999	2	21.8	10	11.8	48.8	45.6	2.7	0.8	3.5	100	27.9	127.9
DR	Dominican Rep. 2002	2	16.2	5.9	10.2	51.2	48.2	3.0	0.6	3.6	110	21.2	131.2
GU	Guatemala 1995	1	6.0	1.3	4.6	21.4	18.4	5.1	0.4	5.4	177	11.2	188.2
GU	Guatemala 1998	1	5.8	1.3	4.5	26.6	21.7	5.0	0.3	5.3	177	11.0	188.0
GU	Guatemala 2014	1	7.8	2	5.9	39.4	32.2	3.1	0.3	3.4	112	9.5	121.5

Table 12: Contraceptive prevalence, total and general rates, and probability of pregnancy termination by survey. *(continued)*

			Probability PT (%)										
				Model estimates		Contraception (%)		Total rates			General rates		
Code	Survey	Cluster	T	IA	ST	Any	Modern	TFR	TTR	TPR	GFR	GTR	GPR
GY	Guyana 2009	2	21.8	10	11.8	34.6	32.5	2.8	0.8	3.6	94	26.3	120.3
HN	Honduras 2005	1	9.1	2.4	6.7	43.2	37.7	3.3	0.4	3.7	117	11.7	128.7
HN	Honduras 2011	1	9.8	2.7	7.1	48.8	42.9	2.9	0.3	3.2	107	11.7	118.7
NC	Nicaragua 1998	1	8.0	2	6.0	40.8	39.0	3.6	0.3	3.9	132	11.5	143.5
PE	Peru 1991	1	10.2	2.9	7.4	35.7	19.9	3.5	0.4	4.0	121	13.8	134.8
PE	Peru 1996	1	10.0	2.8	7.3	40.9	26.4	3.5	0.4	3.9	122	13.6	135.6
PE	Peru 2000	1	10.3	2.9	7.4	44.0	32.0	2.8	0.3	3.1	98	11.2	109.2
PE	Peru 2004	1	11.3	3.3	8.0	45.8	30.9	2.6	0.3	2.9	87	11.1	98.1
PE	Peru 2007	2	14.0	4.7	9.3	48.0	33.0	2.5	0.4	2.9	85	13.8	98.8
PE	Peru 2009	2	14.0	4.7	9.3	49.2	34.2	2.6	0.4	3.0	88	14.4	102.4
PE	Peru 2010	2	15.8	5.7	10.1	50.1	34.7	2.5	0.5	3.0	86	16.1	102.1
PE	Peru 2011	2	15.1	5.3	9.8	50.9	35.3	2.6	0.5	3.1	87	15.5	102.5
PY	Paraguay 1990	1	10.9	3.2	7.8	32.7	23.6	4.7	0.6	5.3	160	19.6	179.6
South and Southeast Asia													
IA	India 2005	2	12.2	3.7	8.4	43.8	38.0	2.7	0.4	3.1	101	14.0	115.0
ID	Indonesia 2012	1	10.6	**0.2**	10.5	45.7	42.7	2.6	0.3	2.9	88	10.4	98.4
KH	Cambodia 2010	3	21.6	9.8	11.8	31.4	21.7	3.0	0.9	3.9	105	28.9	133.9
KH	Cambodia 2014	3	23.9	11.8	12.1	38.5	26.6	2.7	0.9	3.6	98	30.8	128.8
NP	Nepal 2011	2	14.9	**7.1**	7.8	38.2	33.2	2.6	0.5	3.1	96	16.8	112.8
NP	Nepal 2016	3	19.8	**8.9**	10.8	40.8	33.2	2.3	0.6	2.9	88	21.7	109.7
PH	Philippines 1993	1	9.7	2.6	7.0	24.2	15.1	4.1	0.5	4.6	138	14.8	152.8
PH	Philippines 1998	1	10.8	3.1	7.7	28.9	17.2	3.7	0.5	4.2	126	15.2	141.2
PH	Philippines 2003	1	10.4	**0.6**	9.8	31.6	21.6	3.5	0.4	3.9	119	13.8	132.8
TL	Timor Leste 2009	1	2.9	0.6	2.4	13.6	12.8	5.7	0.2	5.9	175	5.3	180.3
TL	Timor Leste 2016	1	3.4	0.7	2.7	16.1	14.8	4.2	0.2	4.4	136	4.8	140.8

Note:
Values in boldface correspond to induced abortion estimates from reported data.

4.6 Discussion

We have analyzed reported patterns of PT according to age, union status, and contraceptive use prior to pregnancy. This is the first such comparative study based on reproductive calendar history from DHS surveys and including all surveys irrespective of whether the type of pregnancy outcome is reported or not. Moreover, our protocol to select pregnancies makes it possible to relate the estimated conditional probabilities of termination to the age-specific fertility rates in the 3-years before the interview in order to derive consistent estimates of age-specific termination rates, total termination rates, total pregnancy rates, and related measures of reproductive health. Also, the comparison of surveys reporting and not reporting the type of pregnancy termination and from different contexts regarding the legality of abortion helps in the interpretation of the patterns found.

Consistent with expectations and with available evidence (Bradley, Croft, and Rutstein 2011; Cleland and Ali 2004; Polis et al. 2016; Marston and Cleland 2004), we find for most surveys, and especially for surveys reporting a high incidence of pregnancy termination, that women that were using contraception at the time of pregnancy and experienced a contraceptive failure are much more likely to report a PT. This suggests increasing likelihood of IA for these women as confirmed in the few surveys reporting the type of termination.

We also find that, while reported termination rates are higher for women using contraception, higher probabilities of termination for contraceptive users move together with higher probabilities for non-contraceptive users. There can be different factors behind this such as differences in the legal framework and the cultural acceptability of abortion. However, there is also the presence, among non-users, of women with unmet need for contraception. Although they are not using contraception, they are not willing to get pregnant. Moreover, in terms of IA, they behave more similar to contraceptive users since in both cases the pregnancy is unintended (Westoff 2005).

Regarding differences according to the legal framework, we find low reported probabilities of termination in all countries with restrictive laws, but there are also countries where abortion is legal reporting low incidence, such as Albania or Tajikistan. While this is consistent with higher levels of underreporting in contexts where IA is not legal, legal consequences could also deter the practice of IA. Differences in the DHS interview protocol might also be behind some of these differences. While we have found no differences according to whether the survey reported IA and ST as separate outcomes, there are grounds for improvement in reporting making sure that the questions are understood, increasing the confidentiality of reporting, or including specific questions on self-administered medication abortion (Rossier 2003; Moreau, Bajos, and Bouyer 2004; Jilozian and Agadjanian 2016; Sedgh and Keogh 2019).

Little is known behind the drivers of omssions in reported PT and more research is needed to determine to what extent differences in reported patterns are due to underlying differences in PT, in self-awareness of PT, or intentional and unintentional omissions. The use only of the most recent pregnancies in our research should minimize some of the problems connected to omissions that increase with time since the interview (MacQuarrie et al. 2018). The fact that overall reported levels in ST tend to be stable over time suggests that cultural factors or the functioning of public health systems might be behind these changes (Yogi, Prakash, and Neupane 2018). Levels of reported T are relatively stable and different surveys from the same country or for neighboring countries tend to fall in the same termination cluster. For the few countries changing cluster adscription over time, external sources suggest that changes in the incidence of IA are behind these changes (Jilozian and Agadjanian 2016; Merdani et al. 2016; Miller and Valente 2016), except in the case of Uganda (Prada et al. 2016).

Demographic differences in reported PT are important and consistent with previous research (Chae et al. 2017; Dankwah et al. 2018; Dickson, Adde, and Ahinkorah 2018; Ibisomi and Odimegwu 2008; Maharana 2017). For instance, as a woman ages, the probability of PT rises suggesting a higher risk of ST in low abortion countries, and the use of IA for limiting family size in high abortion settings. Also, not-in-union women have higher chances of ending their pregnancies before live-birth. However, these estimates consider exclusively the likelihood rather than the magnitude. In this regard, age-specific termination rates tend to be higher for women aged between 20 and 29 since pregnancy rates are much higher for them.

Cluster and PCA analysis suggest geographic proximity of patterns not only in reported levels but also in differentials according to age, union status, and contraceptive use at the time of pregnancy. However, there is some heterogeneity at the regional level. Latin American and African surveys belong to the two lowest PT clusters. Eurasia reports the maximum levels of PT, showing the largest differentials in countries in the former Soviet Union and where abortion is legal. Countries in insular Southeast Asia report some of the lowest levels. Cluster 2, in particular, shows that some countries reporting low levels of PT tend to report rates that are as high as in cluster 3 for women not-in-union using contraceptives. This suggests the use of IA to prevent out-of-union childbearing.

The use of a consistent framework for PT estimation and fertility estimation has allowed us to move from conditional probabilities of termination to age-specific termination rates, total termination rate, and the total pregnancy rate. While contraceptive use at pregnancy is associated with a higher likelihood of termination at the pregnancy level, the use of efficient contraceptive methods reduces the risk of getting pregnant contributing to a lower total pregnancy rate.

Given the observed pattern that high levels of reported T are associated with increasing IA levels, it is possible to interpret differences in T as differences in IA. In particular, clusters 3 and 4 include countries reporting high levels of termination and known to be high abortion countries. We propose a simple tentative approach to separate ST and IA based on total PT, based on surveys that report the type of termination. This model suggests that in most DHS surveys, especially those in clusters 1 and 2, reported IA is very low. It also suggests significant differences in reported ST from country to country. While some of these differences can be interpreted, such as low levels in high abortion countries due to competing risks of

IA and ST, there is currently a lack of understanding of what lies behind these differences. More research would be needed to address the roles of culture, education, and differential access to reproductive health behind them.

The fact that many of the countries reporting the lowest rates of PT are countries with the poorest levels of access to reproductive health, with high maternal mortality and infant mortality and low levels of antenatal care, such as many sub-Saharan African countries, suggests that cultural differences in the self-awareness of PT and clinical monitoring of pregnancies could be behind the differences more than real differences in the risk of PT. More research needs to be done in this respect, mainly due to the increased importance given to more sophisticated indicators of reproductive health, like stillbirth rates, unsafe abortions, or births and abortions prevented by using contraception in international monitoring efforts such as the Family Planning 2020 initiative (Family Planning 2020 2018). Measuring accurately reproductive health indicators is key to well-informed decisions and adequately monitoring the progress in the achievement of internationally agreed objectives, like universal access to reproductive health (United Nations 2015b).

Our research also has implications regarding fertility and family planning measurement. In particular, our results suggest the importance of treating separately contraceptive users and non-users when accounting for PT due to the significant connection between contraceptive use and terminations. Such connection is absent, for instance, in the proximate determinants framework of fertility analysis (Bongaarts 1978, 2015).

It is also important to learn more behind the drivers of reported PT. Whereas current international monitoring tends to use DHS surveys for estimation of fertility, contraception, unintended pregnancies, and unmet need, estimates of PT are not used due to concerns regarding their completeness (Sedgh et al. 2016; Singh et al. 2018; Bearak et al. 2019). However, if reported PT is not complete, estimates of unmet need and unintended pregnancies will also not be complete, and the role of contraception in the prevention of pregnancies will be underestimated. While we do not claim reported PT levels to be complete, the patterns reported in this research are at least internally consistent and could be taken as a departure point. Note also that rates reported here are much higher than alternative estimates based on prospective cohort monitoring (Ahmed et al. 2018).

5 Conclusiones generales

En esta tesis doctoral se han presentado tres investigaciones que aportan evidencia sobre la relación entre el uso de anticonceptivos y la fecundidad. Son investigaciones originales, inéditas y que utilizan datos que no han sido presentados anteriormente en los términos aquí expuestos. La principal lección aprendida es que una mujer que usa anticonceptivos tiene un comportamiento distinto frente al embarazo al de una que no utiliza.

En cuanto al enfoque de los determinantes próximos, se ha mostrado la necesidad de tratar a las mujeres de manera distinta según su estado civil ya que sus características y comportamientos son distintos. En términos generales, las solteras enfrentan riesgos mayores a las casadas. A pesar que la información todavía es escasa, existen cada vez más datos que permiten analizar las particularidades de las solteras. No solo es necesario enfatizar las políticas públicas para ellas sino también incluirlas en los indicadores internacionales.

Por otro lado, se ha encontrado que existen grupos de edad más vulnerables. Entre ellos se encuentran las adolescentes y mujeres de más de 35 años. En el caso de las primeras, iniciar su etapa fecunda o marital antes de los 19 años incluso puede llegar a constituir una vulneración de sus derechos y con marcadas consecuencias a futuro, esto es, menores logros académicos, menores ingresos y peor salud materna e infantil. Para las segundas, el riesgo de perder un embarazo es significativamente mayor, así como complicaciones durante el parto. Las políticas de protección reproductiva se han centrado principalmente en mujeres entre 24 y 35 años. La razón radica en la cantidad (magnitud) de embarazos que se dan a esas edades. No obstante, no se puede descuidar a quienes tienen más riesgo, aunque sea un grupo minoritario.

De la primera investigación, *Adolescent contraceptive use and its effects on fertility*, la principal conclusión radica en que las adolescentes solteras tienen más necesidades que las casadas, aunque ellas también sean un grupo de atención prioritaria. El incremento en la prevalencia de anticonceptivos ha fomentado la reducción de la fecundidad adolescente, caso contrario, las tasas de nacimiento serían más altas. Sin embargo, si las adolescentes pudiesen alcanzar los niveles de demanda total, el efecto sería mucho mayor en cuanto a la disminución de embarazos, pérdidas y nacimientos. Satisfacer las necesidades de las adolescentes provocará una mejoría en su salud y la reducción de embarazos no deseados. No obstante, no solo se debe enfocar esfuerzos en incrementar el uso de anticonceptivos sino también en la educación para su correcto uso. La educación sexual incrementa la efectividad de los anticonceptivos.

A partir de la investigación *Spontaneous termination and induced abortion according to contraceptive use at the time of pregnancy* se concluye que quedarse embarazada luego de un fallo en el uso de anticonceptivos tiene efectos sobre la probabilidad de aborto inducido y de pérdidas espontáneas. Al igual que estudios anteriores, los resultados aquí expuestos determinan que los embarazos no deseados terminan más probablemente en aborto. Además, es falso afirmar que existe una reducción en la probabilidad de embarazos perdidos por causas naturales cuando la mujer utilizaba anticonceptivos al momento de quedarse embarazada. Esto se debe al *competing risk* entre aborto inducido y espontáneo. Luego de controlarlo, se observa una probabilidad positiva también, es decir, incrementan las oportunidades de pérdidas naturales. Este hecho se debe principalmente a que mujeres en esta situación utilizan menos los cuidados prenatales. Existen factores demográficos que incrementan la probabilidad de terminación y no necesariamente afectan igual a ambos tipos. En cuanto al aborto inducido, lo que más afecta es el estado civil, terminaciones previas, paridad y educación. Para las terminaciones espontáneas, edad y estado civil principalmente.

En la segunda investigación se encontró que los embarazos más probablemente terminan en aborto mientras que en la tercera, *Reported patterns of pregnancy termination from Demographic and Health Surveys*, se observa un incremento en la probabilidad de terminación. Por lo tanto, ambas investigaciones se relacionan en una manera especial: las mujeres usuarias de anticonceptivos presentan los mismos patrones de comportamiento tras un embarazo no deseado. Se debe tomar en cuenta que estos resultados se dan en países donde el aborto está prohibido o altamente restringido. Por lo tanto, se podría entender que las mujeres están utilizando métodos de aborto riesgosos. Adicionalmente, existen similitudes entre países no solo por cercanía geográfica sino también por estructuras demográficas. Por último, se propone un método sencillo para estimar tasas de terminación a partir de las probabilidades estimadas y de las tasas de fecundidad calculadas Así mismo, una metodología para estimar la proporción de embarazos que terminan en aborto utilizando las terminaciones reportadas y el tipo de terminación de aquellas encuestas donde es posible diferenciarlo.

Las encuestas DHS son una fuente rica de información que permiten realizar análisis a nivel de cada mujer utilizando los datos del calendario reproductivo. Lastimosamente, no todas las encuestas incluyen el calendario, menos aún tienen muestra de mujeres solteras y no todas tienen calendario de uniones maritales. Dado que el objetivo es diferenciar a las mujeres por su estado civil, en algunos casos se pierde precisión al momento de imputar el estado civil a partir de las fechas de inicio y fin de la primera unión.

En cuanto a las limitaciones en el uso de datos, aparte de no contar con muestra de mujeres solteras para más encuestas de las utilizadas, no se ha distinguido el tipo de anticonceptivo utilizado. Podría ser que el tipo de anticonceptivo tenga un efecto en la decisión de abortar ya que pueden existir razones sociales o religiosas que impliquen que mujeres que utilicen métodos tradicionales tampoco consideren al aborto como opción. En el mismo sentido, no se ha analizado la efectividad de los métodos anticonceptivos usados, aunque existe el interés de estudiarlo posteriormente.

El trabajo de esta tesis doctoral radica en las implicaciones de política que se desprenden de las estimaciones. En las tres investigaciones se han analizado temáticas relacionadas directamente con los Objetivos de Desarrollo Sostenible y con la iniciativa 'Family Planning 2020'. A partir de lo obtenido en estas investigaciones es posible mejorar el monitoreo de las metas, así como ampliar el marco teórico disponible con base en evidencia empírica. Los países incluidos en las investigaciones de esta tesis son de ingresos medianos y bajos, ubicados principalmente en África y América Latina, que forman parte de los países analizados en 'Family Planning 2020'. Las estrategias internacionales permiten mejorar la calidad de vida de la población y, por ello, es imprescindible contribuir a mejorar los mecanismos de monitoreo y evaluación de tal manera que las buenas prácticas puedan ser implementadas con base en experiencias exitosas.

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