Global, regional, and subregional trends in unintended pregnancy and its outcomes from 1990 to 2014: estimates from a Bayesian hierarchical model

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Summary

Background Estimates of pregnancy incidence by intention status and outcome indicate how effectively women and couples are able to fulfil their childbearing aspirations, and can be used to monitor the impact of family-planning programmes. We estimate global, regional, and subregional pregnancy rates by intention status and outcome for 1990–2014.

Methods We developed a Bayesian hierarchical time series model whereby the unintended pregnancy rate is a function of the distribution of women across subgroups defined by marital status and contraceptive need and use, and of the risk of unintended pregnancy in each subgroup. Data included numbers of births and of women estimated by the UN Population Division, recently published abortion incidence estimates, and findings from surveys of women on the percentage of births or pregnancies that were unintended. Some 298 datapoints on the intention status of births or pregnancies were obtained for 105 countries.

Findings Worldwide, an estimated 44% (90% uncertainty interval [UI] 42–48) of pregnancies were unintended in 2010–14. The unintended pregnancy rate declined by 30% (90% UI 21–39) in developed regions, from 64 (59–81) per 1000 women aged 15–44 years in 1990–94 to 45 (42–56) in 2010–14. In developing regions, the unintended pregnancy rate fell 16% (90% UI 5–24), from 77 (74–88) per 1000 women aged 15–44 years to 65 (62–76). Whereas the decline in the unintended pregnancy rate in developed regions coincided with a declining abortion rate, the decline in developing regions coincided with a declining unintended birth rate. In 2010–14, 59% (90% UI 54–65) of unintended pregnancies ended in abortion in developed regions, as did 55% (52–60) of unintended pregnancies in developing regions.

Interpretation The unintended pregnancy rate remains substantially higher in developing regions than in developed regions. Sexual and reproductive health services are needed to help women avoid unintended pregnancies, and to ensure healthy outcomes for those who do experience such pregnancies.

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Introduction

Periodic estimation of the incidence of unintended pregnancy is needed so that policy makers, researchers, and other stakeholders can track progress towards helping women and couples achieve their reproductive goals. It also helps demonstrate the need for contraceptive services and the impact of programmes and policies on unintended pregnancies and their outcomes. These estimates can additionally be used to examine variations in how women resolve unintended pregnancies across settings and over time. Most unintended pregnancies occur in developing regions where, combined with limited access to safe abortion care, they are an important contributor to unsafe abortions worldwide.[1–3] Moreover, unintended pregnancies are widely acknowledged as both a cause and a consequence of socioeconomic inequality.[4,5]

Estimating the incidence of unintended pregnancy at the national or regional level is challenging. Data requirements include information on the proportion of births that arise from unintended pregnancies (hereafter referred to as unintended births), and data on the incidence of abortion. Estimates of the incidence of abortion worldwide for all regions and subregions have recently been published by a group that includes the coauthors of this study for the period 1990–2014.[6] Additionally, a substantial body of nationally representative surveys that measure the proportion of births that are unintended are available for this same time period.

Past estimates of global unintended pregnancy incidence relied primarily on computation of subregional averages using available country data and the assumption that these averages apply to countries without data. Statistical uncertainty in differences across regions or over time could not be computed.[1] Building on a method recently developed to estimate

Research in context

Evidence before this study
Previous estimates of global trends in unintended pregnancy were made for 1995, 2008, and 2012. These point estimates relied on country-level data on the incidence of unintended births and estimates or projections of abortion rates, and qualitative assessments of exchangeability to make inference from existing data to countries and territories lacking data. Separate databases were used to make estimates for each of the 3 years.

Added value of this study
We use birth rates estimated by the UN for 1990–2014, all available data on the proportion of births unintended, and recently published estimates of abortion incidence and factors associated with unintended pregnancy, including family-planning indicators for married women, to develop model-based estimates of pregnancy rates by intention status and outcome in all major regions and subregions of the world for 1990–2014. This is the first time that unintended pregnancy has been estimated using a statistical model, that differences in data quality have been accounted for, and that uncertainty intervals have been estimated. Data on unintended births and unintended pregnancies were compiled from nationally representative surveys done periodically in

developing and developed countries, and from one-time studies that were found through a PubMed literature search using multiple combinations of keywords. This data collection effort yielded 298 datapoints for 105 countries. We estimate that the global unintended pregnancy rate fell from 74 (90% UI 72–84) per 1000 women aged 15–44 years in 1990–94 to 62 (59–72) in 2010–14. The proportion of pregnancies that were unintended has not changed appreciably, and was 44% (90% UI 42–48) in 2010–14. Some 56% (90% UI 53–60) of all unintended pregnancies ended in abortion in this period.

Implications of all the available evidence
The findings underscore that women and couples are having smaller families and fewer unintended pregnancies in many parts of the world. The findings also emphasise the continuing need for investments to meet women's and couples' contraceptive needs. Unintended pregnancy rates remain much higher in developing regions compared with developed regions, and many of the resulting abortions are unsafe. Additional research on the causes and consequences of unintended pregnancy are needed to compel appropriate investments in programmes and design policies that meet the needs of women and couples everywhere.

global levels and trends in induced abortion for 1990–2014, and using estimates of abortion incidence for that period,[6] as well as the body of available data on the proportion of births that are unintended, we developed a Bayesian hierarchical time series model[7] to estimate subregional, regional, and global levels and trends in the incidence of unintended pregnancy over the period 1990–2014. With the recently estimated abortion rates and new estimates of the percentage of births that are unintended, applied to general fertility rates from the UN Population Division (UNPD), we produced estimates of the proportion of all pregnancies that are unintended and the proportion of unintended pregnancies that end in abortion.

Methods

Background
The statistical model is grounded in a theoretical framework in which the incidence of unintended pregnancy is a function of the numbers of women with an unmet need for contraception (ie, women who want to stop or delay childbearing but are not using any method of contraception) and women using a contraceptive method who experience a method or user failure, and the risk of unintended pregnancy in each of these subgroups. The risk of unintended pregnancy in these subgroups is in turn influenced by women's fecundity and the timing and frequency of their sexual activity.[8] Along with abortion, which affects the percentage of unintended pregnancies that end in a birth, these are key proximate determinants of fertility.[9]

We adapt the theoretical framework to take account of the available evidence, and estimate the incidence of unintended pregnancy as the sum of events among married women with an unmet need, married women experiencing failure with a contraceptive method, and all unmarried women. Following the standard Demographic and Health Survey (DHS) definition, married women included those living in a cohabiting union.[10]

Data
Pregnancies are comprised of births, abortions, and miscarriages. Livebirth estimates for each country and year were taken from the UNPD.[11] Numbers of abortions were taken from special tabulations of recently published estimates.[6]

We searched for data on the percentage of births that were unintended for every country and major territory in the world for 1990–2014. Data were obtained from nationally representative surveys and from published studies identified through literature searches. We systematically searched PubMed, JSTOR, and Google Scholar for a combination of the following terms: "incidence", "unplanned birth", "unintended pregnancy", "unwanted pregnancy", "unplanned pregnancy", "pregnancy intention", "unintended births", "unwanted births", and "pregnancy intention". We limited the search to papers studying the incidence of unintended pregnancy between Jan 1, 1990, and Dec 31, 2014.

In DHS surveys conducted periodically in developing countries, a birth is considered unintended if it occurred sooner than desired or if it was not wanted at all. Women

reported on births in the past 3 or 5 years. A supplementary analysis suggested that the reporting of unintended births generally decreased with increasing recall periods, although the extent of the decrease varied across surveys. Therefore, we only used a woman's report for the year preceding the interview. In total, data were tabulated from 219 of these surveys representing 72 countries (appendix pp 7, 8).

For another 50 DHS and Reproductive Health Surveys (RHS) representing 28 countries (including 16 countries with no other data sources), the data files were not publicly available and estimates were taken from published reports (appendix p 8). The reports presented the intention status of events in the past 3 or 5 years combined. For the USA, three estimates of the proportion of births that were unintended in the previous 5 years were calculated from the National Survey of Family Growth (NSFG).

29 datapoints for 17 countries were obtained from another 26 published studies: ten from nationally representative studies, six from subnational studies, and ten from studies focusing on a specific subpopulation. Six of these studies used the London Measure of Unplanned Pregnancy (LMUP),[12] which uses a 12-item scoring system to categorise pregnancies according to whether the woman said she planned the pregnancy, did not plan it, or was ambivalent about it. Based on a comparison of the LMUP to the approach used by the DHS,[13] we computed the minimum and maximum percentage of births that were unintended, excluding and including the percentage for which the woman was ambivalent about the pregnancy according to the LMUP, respectively. For four of these studies, data were available on the planning status of all pregnancies, not specifically births. These data were also useful because the model estimated the distribution of unintended pregnancies by outcome, using recently estimated abortion rates.

To further inform model-based estimates of unintended pregnancies and births, we used information on the proportion of unintended pregnancies or births that were experienced by unmarried women from DHS surveys and published studies from 195 surveys representing 69 countries. For DHS data on unintended births, we calculated the month of conception as the month of birth minus 9, and ascertained marital status in that month. Since the DHS recorded the date of first marriage but not the date of separation or remarriage, we calculated minimum and maximum values for the percentage of unintended births to married women. Data on the proportion of unintended births that were experienced by the subgroup of women who were contraceptive users were available from two published studies[14,15] (see appendix p 9 for details).

Abortions recently estimated to have been obtained by women not in need of contraception (comprised primarily of women who want a child within 2 years or are infecund)[16] were classified as intended pregnancies. All others were classified as unintended.

Estimates of the number of women of reproductive age, the percentage of these women who are married, and the percentage of married women with unmet need for contraception, no contraceptive need, and met need, by country and year, for women aged 15–49 years, were taken from the UNPD.[17–19] We used estimates of the proportion of married contraceptive users expected to experience contraceptive failure developed previously using method-specific contraceptive prevalence data and method-specific failure rates.[6]

See **Online** for appendix

Statistical analysis

A detailed description of the model is available in the appendix and summarised below.

We estimated unintended pregnancy rates and the corresponding estimates for the number of unintended pregnancies and unintended births. The model was fitted to all data pertaining to the percentage distribution of unintended births and unintended pregnancies by subgroup.

To estimate the unintended pregnancy rate, we used a Bayesian hierarchical time series model in which the dependent variable was the number of unintended pregnancies among all women of reproductive age in a given country and year. The predictors were the numbers of women of reproductive age in each of the three subgroups of women (married women with an unmet need, married women experiencing failure with a contraceptive method, and all unmarried women). The model did not include an intercept, and we constrained the coefficients to be positive; thus the coefficients represent unintended pregnancy rates in population subgroups. Overall unintended pregnancy rates in countries change over time if subgroup-specific rates change and as the sizes of the subgroups change. This follows the approach we used to estimate abortion incidence, except that the abortion model estimated a subgroup rate for married women with no need for contraception.[6] Differences in the proportion of women in each subgroup will not capture all variation across countries or over time in unintended pregnancy rates. Subgroup rates are also influenced by unobserved characteristics including women's fecundity and the timing and frequency of their sexual activity. Additionally, global estimates of contraceptive use among unmarried women are not available, and some women classified as having an unmet need might be post partum, with these proportions varying across countries and over time. Therefore, the model allows the subgroup rates to vary across countries and over time to capture the effects of these factors, and subgroup rates are not reported.

The model does not estimate variation in miscarriages (which are defined here to include all spontaneous fetal losses after 5 weeks of gestation, including stillbirths). Similar to previous studies, we obtain estimated unintended pregnancy rates by multiplying the estimated unintended birth rates by 1·2 and the estimated abortion

	Total number of countries	1990–94	1995–99	2000–04	2005–09	2010–14	1990–2014
World	184	47	64	60	71	64	105
Africa	54	20	24	25	25	32	42
Asia	47	8	16	15	16	14	25
Latin American region	35	12	14	13	13	5	15
North America	2	0	1	1	1	1	1
Europe	37	7	9	4	12	10	18
Oceania	9	0	0	2	4	2	4

Table 1: Number of countries with estimates of intention status of births, by region and time period
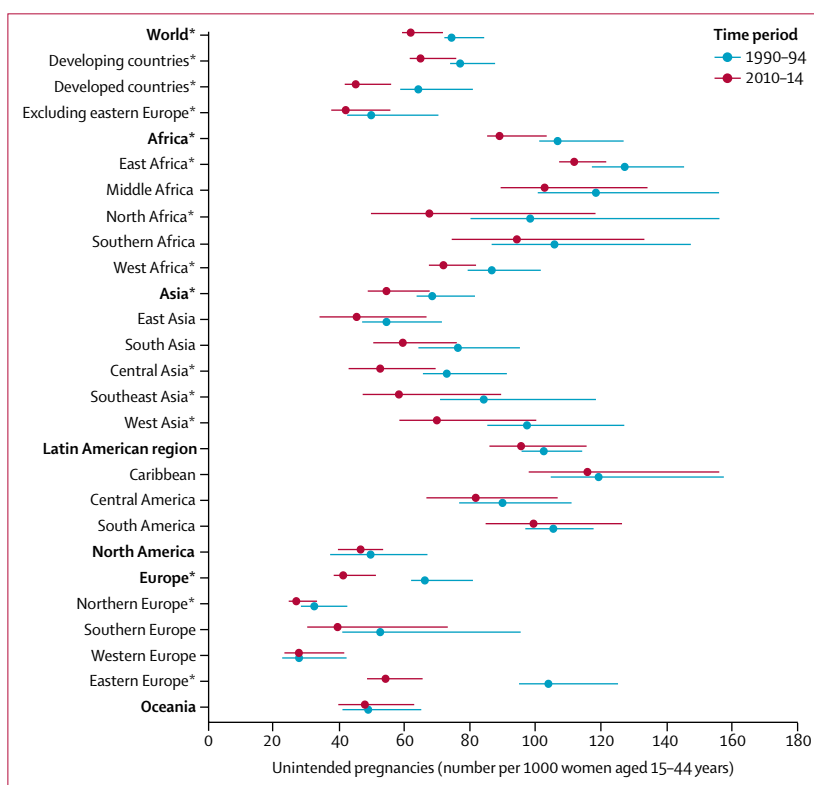

Figure 1: Unintended pregnancy rates per 1000 women aged 15–44 years, by geographical area and time period
Horizontal lines are 90% uncertainty intervals. *Posterior probability of change between 1990–94 and 2010–14 in the estimated direction is greater than 95%.

failure experienced an unintended pregnancy, the incidence of unintended pregnancy in this subgroup is allowed to vary across countries and regions and over time so as to capture variations in user failure rates.

The model assumes that subgroup unintended pregnancy rates, and trends in rates, will be more similar within subregions than between subregions. A few countries or UNPD subregions were merged with other subregions with similar measures on demographic and family-planning indicators for the analysis (appendix p 9). Final results are presented using the original UNPD classifications of subregions.

The sampling designs and sample sizes from the surveys were used to estimate the SE for data on the proportions of births or pregnancies unintended. Because this might not fully capture the uncertainty in the input data, the model includes additional error terms for the average non-sampling error across all surveys and for additional error in subnational and subpopulation surveys (appendix pp 9, 10). As a result, higher quality data influence the modelled estimates more than lower quality data. Additionally, variation in uncertainty in the input data is reflected in variation across settings and over time in the width of the UIs around the estimates.

We did validation exercises whereby 20% of the data on birth and pregnancy intention were left out at random, and the model-estimated rates for the excluded countries and years were compared with the estimates made for these countries and years when they were included. Additionally, we did a leave-one-country-out validation exercise in which, for each country with data, we compared the estimates for that country from a model with that country's data included to a model with that country's data excluded. We tested the sensitivity of our results to model assumptions and assessed whether the inclusion of additional covariates as proxies for unobserved behavioural factors could improve the model fit (appendix pp 12–18). These exercises showed that our estimates are unbiased, that our UIs are well calibrated, and that the estimates are approximately identical across candidate models (appendix pp 12–18). We report results based on the model without additional covariates (beyond the numbers of women of reproductive age in each of the three subgroups of women [married women with an unmet need, married women experiencing failure with a contraceptive method, and all unmarried women]).

Because of the paucity of evidence on which the estimates were based, we present unintended pregnancy estimates for 5-year periods rather than annual rates, and we present rates for subregions rather than for countries. We computed 90% UIs using the 5th and 95th percentiles of the posterior distributions. The interpretation of such intervals is that there is a 5% chance that the true outcome is below the interval, and there is a 5% chance that the true outcome is above the interval. For reported changes in values, posterior

rates by 1·1.[1] This approach is derived from life tables of pregnancy loss by gestational age.[9,20,21]

When we report unintended pregnancy rates, or any statistic that involves not just births but also abortions, the corresponding uncertainty intervals (UIs) capture the uncertainty in the abortion estimates.

We assumed that married women experiencing contraceptive failure would experience the highest unintended pregnancy rates of the three subgroups. Though by definition every woman experiencing a contraceptive

	1990–94		1995–99		2000–04		2005–09		2010–14		Change from 1990–94 to 2010–14		Percentage change from 1990–94 to 2010–14		Probability of change*
	Rate†	90% UI	Rate†	90% UI	Rate†	90% UI	Rate†	90% UI	Rate†	90% UI	Difference	90% UI	%	90% UI	
World	74	72 to 84	70	68 to 78	67	65 to 75	63	61 to 72	62	59 to 72	–12	–20 to –6	–17%	–25 to –8	99·8%
Developing countries	77	74 to 88	72	70 to 82	69	67 to 78	66	63 to 76	65	62 to 76	–12	–21 to –4	–16%	–24 to –5	98·9%
Developed countries	64	59 to 81	59	55 to 73	54	51 to 66	50	47 to 61	45	42 to 56	–19	–29 to –13	–30%	–39 to –21	100%
Excluding Eastern Europe	50	43 to 70	48	43 to 65	46	42 to 61	44	40 to 58	42	38 to 56	–8	–20 to –0	–16%	–31 to –1	95·8%
Africa	107	101 to 127	103	98 to 120	100	95 to 115	95	91 to 110	89	85 to 103	–18	–29 to –10	–17%	–24 to –9	100%
East Africa	127	117 to 145	125	117 to 140	126	120 to 138	122	117 to 133	112	107 to 122	–15	–31 to –4	–12%	–21 to –3	98·5%
Middle Africa	118	101 to 156	119	102 to 155	119	103 to 154	111	98 to 143	103	89 to 134	–16	–37 to 3	–13%	–26 to 3	91·7%
North Africa	98	80 to 156	84	67 to 136	71	55 to 118	68	52 to 116	68	50 to 118	–31	–57 to –11	–31%	–46 to –10	98·6%
Southern Africa	106	87 to 147	103	86 to 139	98	81 to 134	97	79 to 132	94	74 to 133	–11	–35 to 11	–11%	–28 to 10	82·7%
West Africa	87	79 to 102	88	81 to 100	86	80 to 98	78	73 to 89	72	67 to 82	–15	–27 to –5	–17%	–27 to –7	99·4%
Asia	68	64 to 82	63	58 to 74	59	55 to 70	55	51 to 67	54	49 to 68	–14	–25 to –3	–20%	–33 to –4	98·2%
East Asia	54	47 to 71	49	41 to 65	45	36 to 62	44	35 to 63	45	34 to 67	–9	–26 to 9	–17%	–42 to 17	82·5%
South and central Asia	76	65 to 95	69	60 to 83	66	59 to 76	61	54 to 73	59	50 to 75	–17	–36 to 1	–22%	–40 to 2	93·8%
South Asia	76	64 to 95	69	60 to 84	66	59 to 77	62	54 to 73	59	50 to 76	–17	–36 to 2	–22%	–40 to 3	93·3%
Central Asia	73	66 to 91	64	59 to 74	56	50 to 69	52	43 to 67	53	43 to 70	–20	–38 to –6	–28%	–45 to –8	98·7%
Southeast Asia	84	71 to 118	78	67 to 108	71	61 to 101	62	51 to 91	58	47 to 90	–26	–45 to –10	–31%	–44 to –12	99·6%
West Asia	97	85 to 127	95	83 to 124	87	76 to 114	76	66 to 104	70	58 to 100	–28	–44 to –10	–28%	–40 to –10	99·2%
Latin American region	103	96 to 114	99	92 to 111	98	91 to 111	96	88 to 113	96	86 to 116	–7	–20 to 12	–7%	–18 to 12	72·5%
Caribbean	119	105 to 157	119	106 to 156	120	106 to 157	118	102 to 155	116	98 to 156	–3	–27 to 18	–3%	–20 to 15	62·8%
Central America	90	77 to 111	85	72 to 106	85	72 to 107	84	72 to 107	82	67 to 107	–8	–23 to 10	–9%	–24 to 12	77·2%
South America	105	97 to 118	103	93 to 116	100	91 to 117	99	87 to 121	99	85 to 126	–6	–24 to 21	–6%	–22 to 20	63·9%
North America	50	37 to 67	49	40 to 57	51	46 to 57	50	46 to 56	47	40 to 53	–3	–21 to 11	–6%	–33 to 28	63·2%
Europe	66	62 to 81	59	56 to 72	52	49 to 64	46	43 to 57	41	38 to 51	–25	–34 to –19	–38%	–45 to –29	100%
Eastern Europe	104	95 to 125	88	81 to 108	76	69 to 93	65	59 to 77	54	49 to 66	–50	–66 to –39	–48%	–55 to –40	100%
Northern Europe	32	28 to 43	31	27 to 41	28	25 to 38	27	25 to 35	27	25 to 33	–5	–13 to –1	–17%	–32 to –2	96·9%
Southern Europe	53	41 to 95	50	39 to 87	44	34 to 78	41	32 to 75	40	30 to 73	–13	–36 to 2	–25%	–45 to 3	93·6%
Western Europe	28	23 to 42	29	24 to 42	28	23 to 41	28	23 to 42	28	23 to 42	0	–8 to 7	0%	–23 to 24	50·8%
Oceania	49	4 to 5	51	44 to 67	54	46 to 69	53	45 to 67	48	40 to 63	–1	–12 to 8	–2%	–21 to 18	59·1%

Proportionate change is computed from the unrounded estimates and then rounded. As such, there might be slight differences when computing the proportionate change over time from the rounded rates. UI=uncertainty interval. *Posterior probability of a change in the estimated direction. †Per 1000 women aged 15–44 years.

Table 2: Unintended pregnancy rates per 1000 women aged 15–44 years, by geographical area and time period

probabilities of an increase or decrease were calculated. These probabilities indicate the amount of certainty for the reported change: a higher posterior probability corresponds to greater certainty about the direction of change. Where the posterior probability of change in the estimated direction is less than 95%, the UI will include the scenario in which no change occurred. We present relevant findings for UN subregions and groups of countries classified by the legal status of abortion.[22]

Role of funding source

The funders had no role in the study design, data collection and analysis, the writing of the manuscript, or the decision to submit the paper for publication. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

In total, we collected 298 datapoints on the proportion of births or pregnancies unintended for 105 countries (table 1). Representation was best for Africa, where data were available for 42 of the 54 countries, and it was weakest for the Latin American region, where data were available for 15 of the 35 countries. Of the five time periods, we had data for the fewest countries in 1990–94 and the most for 2005–09. Countries were classed as developed and developing based on UNPD definitions.

We report estimated pregnancy and birth rates by intention, the estimated percentages of pregnancies and births unintended, the estimated percentages of unintended pregnancies that end in abortion, and the estimated number of unintended pregnancies. Additional results, including the estimated numbers of each of these events, are available in the appendix (pp 39–44).
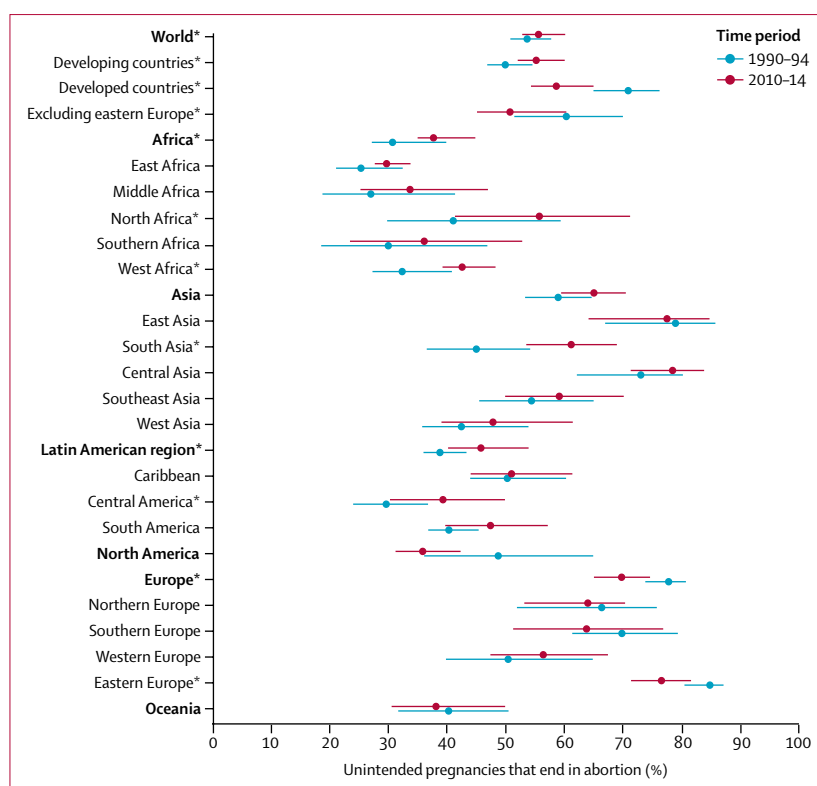
Figure 2: **Percentage of unintended pregnancies that end in abortion, by geographical area and time period**
Horizontal lines are 90% uncertainty intervals. *Posterior probability of change between 1990–94 and 2010–14 in the estimated direction is greater than 95%.

We estimate that there were 62 unintended pregnancies (90% UI 59–72) per 1000 women aged 15–44 years worldwide each year in 2010–14 (figure 1, table 2). This rate represents a decline of 17% (90% UI 8–25) since 1990–94, when the estimated rate was 74 (90% UI 72–84). Because of population growth, the absolute number of unintended pregnancies is estimated to have increased, but only by 6·6% (90% UI –3·0 to 17·8), and the posterior probability of change was 88·5%. There were 99·1 million (90% UI 94·9–114·9) unintended pregnancies per year in 2010–14 (appendix p 38).

The unintended pregnancy rate declined 16% (90% UI 5–24) in developing regions, from 77 (74–88) per 1000 women aged 15–44 years in 1990–94 to 65 (62–76) in 2010–14. It fell even more sharply, by 30% (90% UI 21–39), in developed regions, from 64 (59–81) in 1990–94 to 45 (42–56) in 2010–14. The decline in developed regions was steepest in eastern Europe. In the rest of the developed regions, the unintended pregnancy rate was already comparatively low in 1990–94 and it declined 16% (90% UI 1–31) from 50 (43–70) in 1990–94 to 42 (38–56) in 2010–14. In developing regions, substantial declines were evident in Africa and in Asia, whereas in no Latin American subregion did the decline exceed 9%, and the posterior probability of a decline in the Latin American subregions ranged from 62·8% to 77·2%.

Of the world's subregions in 2010–14, the unintended pregnancy rate was highest in the Caribbean at 116 (90% UI 98–156) and eastern Africa at 112 (107–122) per 1000 women aged 15–44 years. The rates were lowest in northern Europe (27 [90% UI 25–33]) and western Europe (28 [23–42]; table 2).

Globally, 44% (90% UI 42–48) of pregnancies and 23% (22–26) of births were unintended in 2010–14 (appendix pp 40, 41). These percentages were essentially unchanged since 1990–94, but the global statistics mask substantial regional variation in the time trends. The percentage of pregnancies that were unintended increased in all the subregions of the Latin American region, from 59% (90% UI 55–64) in 1990–94 to 69% (64–76) in 2010–14. Additionally, we observed declines in the percentage of unintended pregnancies through-out most of Europe, with the largest decline in eastern Europe, where unintended pregnancies declined by 22% (90% UI 15–29). In the other European subregions, the posterior probability of a decline ranged from 71·1% to 93·3%. For births, the proportion unintended decreased 11% (90% UI 4–17) in Africa. In Asia, the posterior probability of a decrease was only 71·8%. The estimated proportion of unintended births increased in the Latin American region, North America, Oceania, southern Africa, and eastern Europe, although the evidence for an increase was comparatively weak, such that except for the Latin American region, the posterior probability of an increase in the percentage of unintended births was at most 70·9% in any region and at most 80·1% in any subregion.

56% (90% UI 53–60) of all unintended pregnancies ended in abortion in 2010–14 (figure 2, table 3). Since 1990–94, this value increased 11% (90% UI 1–20) proportionately in developing regions, from 50% (47–55) in 1990–94 to 55% (52–60) in 2010–14, and declined 17% (7–24) proportionately in developed regions, from 71% (65–76) in 1990–94 to 59% (54–65) in 2010–14. There was variation in this probability across subregions in 2010–14: some 78% (90% UI 71–84) of unintended pregnancies ended in abortion in central Asia and 77% (71–82) in eastern Europe, compared with 30% (28–34) in eastern Africa.

In the group of countries where abortion is pro-hibited altogether by law or allowed only to save a woman's life, 48% (90% UI 45–54) of unintended pregnancies ended in abortion in 2010–14 (table 4). This proportion was substantially higher, at 69% (90% UI 62–74), in countries where abortion is allowed on request.

In developing regions between 1990–94 and 2010–14, the unintended birth rate declined 27% (90% UI 16–36) and the intended birth rate declined 24% (21–28). Although proportionate declines were similar, more of the decline in fertility in developing countries was due to a decline in intended fertility: the unintended birth rate fell by 8 (90% UI 4–12) births per 1000 women aged

	1990–94		1995–99		2000–04		2005–09		2010–14		Change from 1990–94 to 2010–14		Percentage change from 1990–94 to 2010–14		Probability of change*
	%	90% UI	%	90% UI	%	90% UI	%	90% UI	%	90% UI	Percentage point difference	90% UI	%	90% UI	
World	54%	51 to 58	52%	50 to 56	51%	49 to 55	53%	50 to 57	56%	53 to 60	2	–2 to 6	4%	–4 to 11	79·6%
Developing countries	50%	47 to 55	49%	47 to 54	49%	46 to 54	51%	48 to 56	55%	52 to 60	5	1 to 10	11%	1 to 20	97·0%
Developed countries	71%	65 to 76	67%	63 to 72	62%	58 to 67	60%	56 to 66	59%	54 to 65	–12	–17 to –5	–17%	–24 to –7	99·5%
Excluding Eastern Europe	60%	51 to 70	55%	49 to 64	52%	46 to 61	51%	45 to 60	51%	45 to 60	–10	–17 to –0	–16%	–26 to –0	95·1%
Africa	31%	27 to 40	32%	29 to 40	34%	31 to 41	34%	31 to 41	38%	35 to 45	7	2 to 11	23%	5 to 39	99·0%
East Africa	25%	21 to 32	26%	23 to 32	27%	24 to 32	26%	24 to 30	30%	28 to 34	4	–1 to 9	17%	–4 to 43	89·8%
Middle Africa	27%	19 to 41	28%	20 to 42	29%	21 to 43	30%	22 to 43	34%	25 to 47	7	–1 to 14	25%	–2 to 58	93·1%
North Africa	41%	30 to 59	46%	34 to 63	52%	39 to 68	54%	41 to 70	56%	41 to 71	15	4 to 23	36%	7 to 66	98·6%
Southern Africa	30%	19 to 47	31%	20 to 47	34%	23 to 49	33%	22 to 49	36%	23 to 53	6	–4 to 16	20%	–11 to 64	84·5%
West Africa	32%	27 to 41	33%	29 to 40	34%	31 to 41	36%	33 to 43	43%	39 to 48	10	3 to 16	32%	9 to 56	99·3%
Asia	59%	53 to 65	58%	53 to 63	57%	52 to 62	60%	55 to 66	65%	59 to 70	6	–1 to 12	10%	–1 to 22	92·9%
East Asia	79%	67 to 86	77%	65 to 83	76%	63 to 83	77%	64 to 84	77%	64 to 85	–1	–13 to 9	–2%	–17 to 13	60·3%
South and central Asia	46%	38 to 55	47%	40 to 55	48%	43 to 55	53%	48 to 59	62%	54 to 69	16	5 to 26	34%	10 to 66	99·1%
South Asia	45%	37 to 54	46%	39 to 54	48%	42 to 54	52%	47 to 59	61%	53 to 69	16	5 to 27	36%	10 to 70	99·2%
Central Asia	73%	62 to 80	73%	69 to 77	73%	67 to 79	74%	67 to 81	78%	71 to 84	5	–4 to 17	7%	–5 to 28	84·2%
Southeast Asia	54%	45 to 65	53%	46 to 64	52%	44 to 63	55%	46 to 67	59%	50 to 70	5	–4 to 13	9%	–7 to 26	82·1%
West Asia	42%	36 to 54	43%	37 to 54	46%	40 to 57	46%	39 to 58	48%	39 to 61	5	–3 to 14	13%	–7 to 36	86·3%
Latin American region	39%	36 to 43	40%	37 to 46	42%	38 to 47	45%	40 to 51	46%	40 to 54	7	1 to 14	18%	1 to 38	96·3%
Caribbean	50%	44 to 60	50%	44 to 60	49%	43 to 58	50%	44 to 60	51%	44 to 61	1	–6 to 8	1%	–12 to 16	58·7%
Central America	30%	24 to 37	32%	26 to 41	34%	27 to 42	37%	30 to 45	39%	30 to 50	10	1 to 18	33%	4 to 64	96·7%
South America	40%	37 to 45	42%	38 to 48	43%	39 to 50	46%	41 to 55	47%	40 to 57	7	–2 to 17	18%	–4 to 42	90·8%
North America	49%	36 to 65	44%	37 to 52	39%	35 to 43	37%	33 to 41	36%	31 to 42	–13	–29 to 2	–26%	–46 to 4	93·8%
Europe	78%	74 to 81	76%	72 to 79	73%	67 to 77	72%	67 to 76	70%	65 to 75	–8	–13 to –2	–10%	–16 to –3	99·3%
Eastern Europe	85%	80 to 87	85%	82 to 87	79%	72 to 84	79%	75 to 82	77%	71 to 82	–8	–13 to –2	–10%	–16 to –2	98·7%
Northern Europe	66%	52 to 76	64%	50 to 73	65%	51 to 74	67%	55 to 74	64%	53 to 70	–2	–12 to 9	–4%	–16 to 16	64·9%
Southern Europe	70%	61 to 79	66%	57 to 77	65%	55 to 77	63%	52 to 76	64%	51 to 77	–6	–17 to 4	–9%	–24 to 6	83·2%
Western Europe	50%	40 to 65	47%	37 to 61	54%	43 to 68	55%	44 to 68	56%	47 to 67	6	–5 to 16	12%	–9 to 37	80·5%
Oceania	40%	32 to 50	40%	33 to 50	39%	31 to 48	37%	31 to 47	38%	31 to 50	–2	–10 to 7	–5%	–22 to 20	60·8%

Proportionate change is computed from the unrounded estimates and then rounded. As such, there might be slight differences when computing the proportionate change over time from the rounded rates. UI=uncertainty interval. *Posterior probability of a change in the estimated direction.

Table 3: Percentage of unintended pregnancies that end in abortion, by geographical area and time period

15–44 years and the intended birth rate declined by 23 (19–26) births (appendix pp 42, 43).

Fertility trends in developed regions contrasted with those in developing regions in that there was little evidence of a decline in unintended fertility, and some evidence of an increase in intended fertility, in developed regions. Among the developed subregions, the posterior probability of a decline in the unintended birth rate was at most 72·8%. The intended birth rate increased 10% (90% UI 1–24) in western Europe, from 43 (38–46) per 1000 women aged 15–44 years in 1990–94 to 47 (44–49) in 2010–14. In southern Europe, we estimated a similar increase of 8% (–7 to 22), but the posterior probability of an increase was 83·3%. In 2010–14, the Latin American region as a whole presents the lowest intended birth rate in the world (36 [90% UI 29–41] per 1000 women aged 15–44 years; appendix p 43).

Abortion rates as estimated by Sedgh and colleagues[6] are shown in the appendix (p 44).

Discussion

Between 1990–94 and 2010–14, the global unintended pregnancy rate declined, and the magnitude of the decline and the extent to which this corresponded with a decrease in unintended births or abortions varied across geographical areas. In developing regions, the unintended birth rate fell while the abortion rate held steady, whereas in developed regions the abortion rate, but not the unintended birth rate, declined.

Developing regions saw a decline in the intended birth rate, which reflects the increasingly widespread desire for small families,[23] as well as a decline in the unintended birth rate, which indicates that a growing proportion of

	Unintended pregnancy rate in 2010–14		Proportion of unintended pregnancies ending in abortion in 2010–14	
	Rate*	90% UI	%	90% UI
Prohibited altogether or to save a woman's life	77	74–92	48%	45–54
Physical health	87	83–99	49%	47–54
Woman's mental health	78	71–96	41%	36–50
Socioeconomic grounds	52	42–71	58%	49–69
On request	48	42–62	69%	62–74

Countries were grouped by the legal status of abortion based on data from the Center for Reproductive Rights.[32] UI=uncertainty interval. *Per 1000 women aged 15–44 years.

Table 4: Unintended pregnancy rates and the percentage of unintended pregnancies that end in abortion in countries grouped by legal status of abortion

women and couples have been able to realise their fertility goals. These trends are probably due at least in part to family-planning programmes, which have led to an increase in the prevalence of contraception. The proportion of married women using a contraceptive method (modern or traditional) in developing countries increased 8 percentage points, from 54% to 62%, between 1990 and 2014 (with most of the increase taking place in the first decade of this 25-year period).[24] Additionally, among users of a contraceptive method, a growing proportion are using modern methods instead of traditional methods.[25]

However, because a growing proportion of women wish to avoid pregnancy, the percentage of married women in developing countries classified as having an unmet need for contraception fell by only 4 percentage points, from 16% in 1990 to 12% in 2014. Additionally, among users of modern methods, there has been a shift in some regions from permanent to reversible methods.[25] These factors can be expected to mitigate the impact of the increased prevalence of contraceptive use. The substantial decline in the unintended pregnancy rate in developing regions is thus particularly noteworthy. Potential causes of this decline, including changes in contraceptive method mix, contraceptive efficacy, women's fecundity, and the timing and frequency of sexual activity, deserve further study.

The decline in the unintended pregnancy rate in developing regions from 1990 to 2014 did not coincide with a decline in the abortion rate;[6] thus, the percentage of unintended pregnancies that end in abortion in this part of the world has increased. This finding might suggest that women who experience unintended pregnancies are increasingly motivated to avoid an unintended birth. It is also possible that improved access to safe abortion, such as through the knowledge and availability of misoprostol and other safe technologies, has made it possible for an increasing number of women

to safely terminate an unintended pregnancy, rather than continue with an unintended birth.[2]

By contrast, while the abortion rate declined substantially in developed regions, the unintended birth rate remained similar. This could signal that women and couples have increasingly managed to avoid the unintended pregnancies that they are most strongly motivated to prevent, for example through the effective use of contraception. Although new regulatory restrictions might have impeded some women's access to safe and legal abortion,[26] these changes have taken place in just a few developed countries; evidence from the USA shows that abortion rates declined in states which did and did not institute new regulations.[27]

We find that the unintended pregnancy rate is higher, and that the proportion of unintended pregnancies that end in abortion is lower, in countries that prohibit abortion, than in countries which allow abortion on request. By contrast, unintended pregnancy rates are lower, and the proportion of unintended pregnancies that end in abortion is higher, in countries that allow abortion on request (table 4).[18] As a result, abortion rates are similar in both groups of countries. Higher levels of unmet need for contraception contribute to the higher unintended pregnancy rates in countries in which abortion is prohibited, which in turn contribute to the similar abortion rates.[18] In concert with the recent estimate that three-quarters of abortions are unsafe in countries which prohibit abortion, this suggests that a substantial number of women in such countries would benefit from improved access to contraceptive services and access to safe abortion and post-abortion care.[2]

The lower propensity to abort an unintended pregnancy in countries which prohibit abortion might follow from a number of factors. These might be settings where a woman's or couple's motivation to avoid an unintended birth is, on average, relatively weak. Women might also experience cultural barriers, social and personal stigma when considering terminating an unintended pregnancy, or concrete barriers to realising their reproductive preferences. Additionally, women might be deterred from terminating pregnancies by barriers to accessing a safe and legal procedure. Research on variation in these drivers of unintended fertility across settings is needed.

The Latin American region is the only region in which the percentage of births unintended increased substantially between 1990–94 and 2010–14. This is because, although the unintended birth rate in the Latin American region declined 19% (90% UI 6–30), the intended birth rate declined 40% (31–50). More research is needed to better understand global variation in childbearing preferences, decisions, and processes.

The estimates and the model on which they are based face a number of limitations. Data were not available for all countries, and some of the data came from non-representative samples (appendix p 8); our model accounted for differences in data quality, and differences

across geographical areas in the quantity and quality of the data are reflected in wide UIs where the evidence base is weak. We incorporated all available data from the DHS and RHS and other published studies covering a 25-year period. In future analyses, inclusion of data from the Multiple Indicator Cluster Surveys can be explored. Also, in order to make global estimates over a period of time, we employed a widely used, dichotomous definition of unintended pregnancy. But the intention status of pregnancies can fall on a spectrum, as reflected in the LMUP, and several studies explore the development of more nuanced measures of birth intention.[12,13,28,29]

Some details of the surveys varied. Estimates might be conservative for countries where the data were obtained from published studies in which birth intention was averaged over all births that occurred 3–5 years before the date a woman was interviewed. Additionally, the DHS changed the way it asked about intention status of births, potentially inducing confusion between mistimed with unwanted births. As unintended pregnancies are the sum of these two quantities, this should not affect our results. However, to examine whether women are systematically less likely to report a birth as unintended with the new questioning approach (ie, because they did not realise that they should include mistimed births when answering the first question), we examined the trend in the reported percentage of births unintended across all countries where surveys had been done before and after this change in the line of questioning. We did not observe a consistent decline across countries in the proportion of unintended births.

We use the standard DHS definitions of unmet need and unintended births in constructing predictor and outcome variables, respectively, but these definitions do not perfectly align. Women are classified as having an unmet need if they wish to avoid pregnancy for at least 2 years, but mistimed births are classified as unintended even if they were mistimed by less than 2 years.

We classified all abortions obtained by women with no need for contraception as intended pregnancies, and all abortions obtained by unmarried women as unintended pregnancies. Some misclassification might have occurred in both groups.

We assume that the proportion of pregnancies that end in miscarriage and stillbirth is relatively constant across populations. It has been suggested that miscarriage rates can be higher in disease-endemic areas, such as where HIV prevalence is high and malaria is endemic.[20] Sufficient empirical evidence on which to base an alternative approach is lacking, but if miscarriage rates are higher in some settings than estimated by our approach, the intended and unintended pregnancy rates in those settings would also be slightly higher than estimated.

This approach to estimating the incidence of unintended pregnancy represents a substantial improvement over the approach used previously. The Bayesian model allowed

us to make formal inference, present UIs around the estimates, and examine the robustness of the results with validation exercises. It also allowed us to use additional data (such as data on the percentage of unintended births that were experienced by married women) and to incorporate information on the likely precision of the data inputs. Moreover, unlike previous estimates, we used women's reports of the intention status of births that took place in the year before the survey, rather than the 3 or 5 years before the survey wherever possible. This approach reduced the potential for recall bias to influence our findings. Future research should be directed towards assessing these biases. Using Bayesian modelling, we were able to make better use of all available data to study global variation and trends. However, advanced statistical modelling does not substitute for regular collection of high-quality data. Wide UIs in some regions and time periods should motivate additional investment in data collection, particularly for abortion incidence, where data reliability is an increasing concern.[2,6]

Our estimates of unintended pregnancy for 2010–14 are higher than the previous estimates for 2012. As these were estimated using qualitative inference, substantive conclusions cannot be drawn from a comparison of these studies. Our estimated time series is intended to replace all previous cross-sectional estimates.

As women and couples increasingly wish to have small families and to control the timing and spacing of their births, investments in health-care programmes and policies are needed to address the growing demand for family-planning services. However, even if all individuals and couples who wished to avoid pregnancy used a method of contraception, some unintended pregnancies would still occur, because contraceptive methods are imperfect and people do not always use them correctly and consistently. Thus, it will remain imperative to help couples manage the outcomes of unintended pregnancies in ways that optimise their health and wellbeing, including access to safe and legal abortion services. These investments are also necessary to achieve the UN Sustainable Development Goals, namely universal access for women and couples to sexual and reproductive health and reproductive rights.[30]

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