Three Simple Approaches for Estimating Births Averted Due to Contraception at the National Level

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Abstract

Background: Estimates of births averted were generated frequently in the 1960s and 1970s to assess family planning program effectiveness. However, such estimates have not been recently available. This paper compares estimates of births averted from several approaches applied to recent national data. **Methodology:** Three simple methods for estimating births averted are presented. The first method is based on the relationship between the general fertility rate (GFR) and contraceptive prevalence rate for all women (CPR(AW)). The second is based on the relationship between total fertility rate (TFR) and CPR(AW), while the third method uses Bongaarts' proximate determinants model. **Results:** Estimates of births averted and the percent change in births in the absence of contraception, based on the three methods, are fairly consistent. **Conclusion:** The three methods provide reasonable estimates of births averted due to contraceptive use by national populations.

Background

In the 1960s and 1970s methods for estimating and estimates of births averted were found frequently in the literature on family planning program effectiveness (e.g. Mauldin, 1968; Prada-Solas, 1975), but infrequently in recent years. Used primarily to measure the effectiveness of contraceptive practice, estimates of pregnancies or births averted have enabled researchers and family planning program managers to assess the impact of various contraceptive methods and modes of service delivery. Practical applications of estimated births averted to calculate cost savings can be found in state and national budgets in the U.S. and elsewhere (e.g., http://www.agi-usa.org/pubs/memo012604.pdf). The steady rise in contraceptive method use globally implies that many unwanted pregnancies are being averted. At the same time there are few or no studies with national estimates of births averted from contraception.

This paper compares estimates of births averted from several approaches applied to recent national data. Previously published methods to calculate births averted are quite complicated and are often tailored to specific contraceptive methods (e.g. Potter, 1969; Venkatacharya, 1971). Three simple methods to estimate births averted due to contraceptive use are presented here and estimates are made utilizing the latest data available from countries around the world. For the purpose of comparisons, another indicator--percent increase in births in the absence of contraception--is also used. Comparisons are made among the three methods.

A limitation of previous estimates of births averted is that virtually all have been based on data for married women. For example, a recent analysis of the relationship between fertility and contraceptive use was conducted using contraceptive prevalence of currently married/cohabiting women (Ross, 1993). However, contraception is increasingly being used by individual women and men outside of marriage. In fact, for some countries in Sub-Saharan Africa, a higher proportion of women outside than inside marriage are using some form of contraception. Thus modeling the relationship between contraception and the fertility level of currently married or cohabiting women will underestimate the impact of contraceptive use. In this paper, we estimate the contraceptive prevalence rate for all reproductive-aged women, in the process of estimating births averted.

Methodology

Three simple methods of estimating births averted due to contraception are presented. The first method is based on the observed linear relationship between the General Fertility Rate (GFR) and contraceptive prevalence rate for all women (CPR(AW)). The second method is similarly constructed using the observed linear relationship between the Total Fertility Rate (TFR) and CPR(AW). The third method is based on Bongaarts' proximate determinants model (Bongaarts, 1982). Note that for this method we utilize contraceptive prevalence rates for women who are in a marriage or consensual union (CPR(CMW)), instead of CPR(AW), because this method has a separate indicator for the effect of marriage.

Data sources

Data from 127 countries with population size above one million in 2002 were utilized for this analysis. This represents 83% of all 153 countries with available contraceptive prevalence rates. Twenty one countries with population less than one million were excluded*.

CPR(CMW), as well as the total fertility rates (TFR) for the most recent year were obtained from the UN Population Division. The method-specific CPR, was obtained from the World Contraception Use 2001 Data Sheet also of the United Nations. The TFR was adjusted to be in the same age range as CPR(AW) for each country-- details are given in Appendix Table A1. Also, if necessary, both the GFR and TFR were interpolated (or extrapolated) to obtain the estimates for the same year as CPR(AW). The total number of births for each country is calculated by multiplying the total population by the crude birth rate for the same year as the CPR(AW). The total number of births for all 127 countries is also utilized for an overall comparison. Age-specific fertility rates (ASFR) came from either the Demographic Yearbook, the United Nations Population Division database or Demographic and Health Survey data. If necessary, they were also interpolated to the same reference year as CPR(AW).

For the Bongaarts' model, values of use-effectiveness of contraceptive methods were estimated from failure rates given by Hatcher et al. (1994) for more developed countries (MDCs), and borrowed directly from Bongaarts (1982) for less developed countries (LDCs). (See Appendix Table A2).

Total contraceptive prevalence rates and prevalence by method for all reproductive-aged women (CPR(AW) were obtained from DHS for countries if available. Data of CPR by marital status were also available from the United Nations. Through these two sources 70 countries had CPR(AW) available.

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* Also Yugoslavia was excluded due to unavailability of other needed data. Another 4 countries (Finland, Belgium, Norway and Belarus) were excluded because of irregular age groups for the contraceptive prevalence rates.

Estimation of CPR(AW)

CPR(AW) for other countries was estimated as follows. The 127 countries were divided into five geographic groups: (1) Sub-Saharan Africa, (2) North Africa, (3) Asia, (4) Latin America, Caribbean, Central America and South America, as well as (5) Europe, North America and Oceania. CPR(CMW) is available for all 127 countries, so the ratio of CPR(AW)/CPR(CMW) was calculated for countries with CPR(AW) also available within each of the five groups. Then the means of the group-specific ratios were used to estimate the unknown CPR(AW) for county *j* within that region. Specifically:

$$CPR(AW)_j = CPR(CMW)_j * Mean_i[\frac{CPR(AW)^{known}}{CPR(CMW)^{known}}] \qquad (1)$$

where, *i* indexes the region containing country *j*. Several assumptions underlie this method. First, countries within each region are assumed to have the same CPR(AW)/CPR(CMW) ratios. Second, the CPR(AW)/CPR(CMW) ratio does not change over time. With regard to the first assumption, separate analyses showed that the CPR(AW)/CPR(CMW) ratios are nearly constant within regions.

***Calculation procedures* of the three methods**

1. Using GFR and CPR

First, the GFR was calculated from the crude birth rate, female population and total population:

$$GFR = CBR / {}_{15}^{49}C \qquad (2)$$

where ${}_{15}^{49}C$ is the proportion of reproductive aged women in the population.

Then ordinary least squares (OLS) regression was conducted using CPR(AW) to predict GFR for all 127 countries. Robust regression was used to underweight outliers or high influence points[**].

(The rreg command in STATA 7 was used; STATACorp, 2001). Based on the robust regression coefficients, $GFR_i^{potential}$ was obtained by:

$$GFR_i^{potential} = GFR_i^{actual} - \hat{\beta} * CPR(AW)_i \qquad (3)$$

where

$GFR_i^{potential}$ is the potential GFR that reproductive aged women would have experienced had they not adopted any family planning in country *i*.

GFR_i^{actual} is the actual GFR data calculated by formula (2) for country *i*.

$\hat{\beta}$ is the estimated slope obtained from the robust regression of GFR on CPR(AW).

Assuming the estimated linear relationship between GFR_i^{actual} and $CPR(AW)_i$ holds for each country, then the country-specific intercept, i.e. the potential GFR for country *i*, was obtained by formula (3). (Note that $\hat{\beta}$ is negative so $GFR_i^{potential} > GFR_i^{actual}$.) Births averted for method 1 was then obtained as:

$$BAV(1)_i = [GFR_i^{potential} - GFR_i^{actual}]/1000 * P_i(a)_{15-49}^{f} \qquad (4)$$

where $P_i(a)_{15-49}^{f}$ is the reproductive-aged female population of country *i*.

Because the total population as well as the number of births varies substantially between countries, for comparison purposes, the percent increase (PI) in births if contraceptive use were nil is also presented. The percent increase in births based on method 1 (*PI(1)*) is:

$$PI(1) = \frac{BAV(1)}{births^{actual}} * 100 \qquad (5)$$

** Tolerance and the biweight tuning constant were set at their default values in STATA (0.01 and 7, respectively).

2. Using TFR and CPR

Similar OLS and robust regressions were conducted for TFR on CPR(AW). Then $TFR^{potential}$ is estimated by:

$$TFR_i^{potential} = TFR_i^{actual} - \hat{\beta} * CPR(AW)_i \qquad (6)$$

where,

$TFR_i^{potential}$ is the potential TFR that reproductive aged women would have experienced had there been no family planning in country *i*.

TFR_i^{actual} is the actual TFR for country *i*.

$\hat{\beta}$ is the estimated slope obtained from the robust regression of TFR on CPR(AW).

Estimates of births averted were then obtained by two different methods. Births averted for countries with age-specific fertility rates available (94 countries in total) was estimated by method a; for those countries without ASFR available (33 countries in total), births averted was calculated by method b. These two methods are:

a. For countries with ASFR available:

$$BAV(2a) = \sum_{a=15}^{50} \{P(a) * [ASFR^{potential} - ASFR^{actual}]\} / 1000 \qquad (7)$$

where,

P(a) is the number of women in age group a.

$ASFR^{potential}$ are the potential age-specific fertility rates women would have experienced had there been no family planning. These are obtained by assuming the relative effect of contraception is the same for all age groups, i.e.

$$ASFR^{potential} = \frac{TFR^{potential}}{TFR^{actual}} * ASFR^{actual} \qquad (8)$$

b. Countries without ASFR available. In this case only a more rough estimation is possible using numbers of women in five-year age groups:

$$BAV(2b) = \frac{\sum_{a=17.5}^{47.5} [\frac{50-a}{50-15} * P(a)]}{35} * [TFR^{potential} - TFR^{actual}] \qquad (9)$$

where, a is the mean age of each five-year age group (i.e. 17.5, 22.5 … and 47.5). In this formula, the gap between potential TFR and actual TFR is multiplied by a weighted average of the number of women in each age group with their remaining reproductive years as weights and then divided by 35 to convert lifetime births averted into births averted in a year. The percent increase in births (*PI(2)*) is obtained by a similar formula to formula (5).

3. Using Bongaarts intermediate fertility model

According to Bongaarts (1982), TFR is composed of four multiplicative elements which vary between 0 and 1, and all multiplied by a hypothetical maximum fertility.

$$TFR^{actual} = C_m * C_a * C_i * C_c * TF \qquad (10)$$

where, C_m is the index of marriage, C_a is the index of induced abortion, C_i is the index of postpartum infecundability, C_c is the index of contraception, and *TF* is maximum fertility. C_c equals 1.0 in the absence of contraception and is set to 0.0 if all fecund women use 100% effective contraception. The potential TFR without contraception would be:

$TFR^{potential} = C_m * C_a * C_i * 1 * TF$. To calculate C_c, Bongaarts suggests using:

$$C_c = 1 - 1.08 * e * u \qquad (11)$$

where,

u is contraceptive prevalence of currently married or cohabiting women (i.e., CPR(CMW)).

e is a weighted average of effectiveness across contraceptive methods with the weights being the proportions using each method.

Method-specific use-effectiveness values are calculated separately for more developed countries (MDCs) and less developed countries (LDCs). The values for MDCs are derived from failure rates as well as our estimate of 0.85 as the probability of becoming pregnant in a year if no contraception were used, both based on Hatcher et al. (1994). These were obtained as follows:

$$e(m) = [A - f(m)] / A * 100 \qquad (12)$$

where,

$e(m)$ is the use-effectiveness for method m.

A is the probability a woman would become pregnant within a year if no contraception were used. (A is taken to be 0.85)

$f(m)$ is the failure rate in a year for method m

The estimates for LDCs are given by Bongaarts (1982). Table A2 in the appendix shows the estimates for both MDCs and LDCs. Then the overall effectiveness is given by:

$$e = \sum e(m) * u(m) / u \qquad (13)$$

where,

e is the average use-effectiveness.

e(m) is as given above.

u(m) is the proportion of women using method *m*, i.e., the method-specific contraceptive prevalence.

u is the total proportion of women using contraception, i.e. CPR(CMW).

Then the percent increase in births (PI(3)) if there were no contraceptive use is estimated by:

$$PI(3) = \frac{TFR^{potential} - TFR^{actual}}{TFR^{actual}} = \frac{Cm*Ca*Ci*1*TF - Cm*Ca*Ci*Cc*TF}{Cm*Ca*Ci*Cc*TF} = \frac{1-Cc}{Cc} \quad (14)$$

and the births averted is obtained by:

$$BAV(3) = PI(3)*births^{actual} \quad (15)$$

The derivations and input data needed for the three methods are contrasted in Table 1. For summary purposes, the medians of the estimates for each of the methods are calculated and compared. In addition, the magnitude of the births averted due to contraception at the global level is estimated by summing estimates across the 127 nations.

- Table 1 about here

Results

Figure 1 shows the robust regression fits to the data for GFR and TFR. The linear regression equations fit the data quite well. Note however, that the residuals from the fitted values do vary systematically in the two regressions with a tendency to be positive for low values of contraceptive prevalence, slightly negative for middle values of prevalence and positive again for high values of prevalence. Residual tests (not shown) confirmed the presence of this pattern.

This suggests that a non-linear equation might be superior; this will be explored in future research.

- Figure 1 about here

Results for each country are given in Table 2. The percent increase in births demonstrates the magnitude of the effect of contraceptive use and can be compared across countries and regions. Figure 2 shows boxplots of these percentages for each of the methods. The three methods produce a similar range of estimates of the percent change in births in the absence of contraception. The medians for the three methods (80%, 75% and 91%), are quite close to each other. (The means were 135%, 110% and 136%). Estimates of the percent increase in births are clearly right-skewed. Outliers are mostly countries with high contraceptive prevalence and low fertility. The number of births averted calculated by Bongaarts' intermediate fertility model is consistently greater than the estimates based on GFR and TFR in 53 countries out of 127. Comparing the estimates for each method by country to the mean of the three estimates, the GFR method gives estimates on average (median) 4% above the average, while the TFR method gives estimates on average 4% below the average, and Bongaarts method gives estimates on average 1% above the mean (not shown). Among the 55 countries where the estimated increase in births is less than 80% in the absence of contraception by all three methods, 33 are in the Sub-Saharan region.

- Table 2 and Figure 2 about here

Based on the average of the results from GFR and TFR methods which are more conservative (lower estimates), for 127 major countries around the world there would have been approximately 123% more births or 155,528,000 additional births in a recent year if there had been no contraceptive use (The median year for the calculation of births averted across all 127 countries is 1996). The results from analyses based on CPR(CMW) (not shown) are fairly close to the results derived from CPR(AW). The mean difference of the estimated percent increase in births with the two robust GFR regressions is 17%.

Another way to look at the results is to see how close the estimates are for the three methods via correlation analyses. The correlation coefficients for the three estimates of percent increase in births are given in Table 3. Births averted calculated by the three methods have reasonable agreement, judged by these correlation coefficients.

- Table 3 about here

Discussion

Three simple methods have been presented to estimate births averted due to contraception at the national level. The estimated numbers of births averted and percent increase in births using these three methods based on the GFR, TFR and Bongaarts proximate determinants' model are fairly consistent. The medians of the percent increases in births estimated by the three methods are close to each other.

The difference between the GFR and TFR models and the Bongaarts' model is worth noting. The births averted estimates based on GFR and TFR take into account contraceptive use outside of marriage. In Bongaarts' model, we use CPR(CMW), the contraceptive prevalence of married/cohabiting women, to estimate births averted. Since contraceptive use within marriage is virtually always higher than that outside marriage around the world, the number of births averted estimated using Bongaarts' model are higher than estimates based on GFR and TFR, which used CPR(AW) in the regression equation.

The effect of using CPR(AW) rather than CPR(CMW) in the first two estimation methods is not as great as we expected. Nonetheless, basing the estimates of births averted on contraceptive use by all, rather than only married, reproductive-aged women is conceptually preferred . Besides this wider definition of contraceptive use applied in this paper, the simplicity of the three methods is an additional strength of this study. Compared to papers in the 1960s and 1970s the methods presented here are based on simple algebra with basic demographic formulas and utilize easily accessible data. Choices among the methods could be made according to the availability of data, as well as the purpose of specific studies. The GFR method is conceptually simple, the data utilized are relatively easy to access, and the births averted calculation is straightforward and the results are quite consistent with those of the other two methods so we recommend this method in general.

There are two assumptions underlying the estimation of CPR(AW) from CPR(CMW) where CPR(AW) was not available. The first assumption, that women have identical region-specific CPR(AW)/CPR(CMW) ratios, has been validated by our data. But the second assumption, that the CPR(AW)/CPR(CMW) ratio does not change over time, is likely to be a rough approximation. In this vein, it would be interesting to examine the time trend for the ratio between the prevalence of contraceptive use among the married and unmarried.

In addition, there are about 15 countries with CPR(CMW) for different years as compared to CPR(AW). This affects the comparison of the estimates using Bongaarts model with the estimates from the other two methods. However, in approximately half of these fifteen, the reference year for CPR(CMW) was earlier and in about half it was later than the reference year for CPR(AW) so we expect only minor effects from these differences.

As couples' fertility preferences shift downward, their achievement through contraceptive practice can be facilitated by organized family planning efforts. The estimates from this study show that contraceptive practice may have helped avert more unwanted births in a year than the number that actually occurred. Many of the averted births, if not prevented, would likely have resulted in unsafe abortions and maternal deaths. Simplified methods to estimate births averted put helpful evaluation tools and information at the disposal of those managing reproductive health programs and deciding on the allocation of resources. This research is the first phase of a study that will estimate abortions and maternal deaths averted through contraception.

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Table 1. Details of three methods for estimation of births averted and percent increase in births if there were no contraception

Item	Method		
	1. GFR regression	**2. TFR regression**	**3. Bongaarts model**
Data utilized	CPR(CMW), CPR(AW), $P_i(a)^f_{15-49}$, CBR, total population.	CPR(CMW), CPR(AW), TFR, ASFR (where available), $P_i(a)^f_{15-49}$, CBR, total population.	CPR(CMW) by method, failure rates by method, CBR, total population.
Estimation technique	Ordinary least square regression (OLS) and robust regression	OLS and robust regression	$TFR = C_m * C_a * C_i * C_c$
Preliminary calculation	$GFR = CBR / {}^{49}_{15}C$ $GFR_i^{potential} = GFR_i^{actual} - \hat{\beta} * CPR(AW)_i$	$TFR_i^{potential} = TFR_i^{actual} - \hat{\beta} * CPR(AW)_i$ $ASFR^{potential} = \frac{TFR^{potential}}{TFR^{actual}} * ASFR^{actual}$	$e = \sum e(m) * u(m) / u$ $Cc = 1 - 1.08 * e * u$
Equation for BAV	$BAV(1)_i = [GFR_i^{potential} - GFR_i^{actual}] / 1000 * P_i(a)^f_{15-49}$	$BAV(2a) = \sum_{a=15}^{50} \{P(a) * [ASFR^{potential} - ASFR^{actual}]\} / 1000$ $BAV(2b) = \frac{\sum_{a=17.5}^{47.5} [\frac{50-a}{50-15} * P(a)]}{35} * [TFR^{potential} - TFR^{actual}]$	$BAV(3) = PI(3) * births^{actual}$
Equation of % increase in births	$PI(1) = \frac{BAV(1)}{births^{actual}} * 100$	$PI(2) = \frac{BAV(2)}{births^{actual}} * 100$	$PI(3) = \frac{1 - Cc}{Cc}$

Figure 1. Observed relationship between GFR vs. CPR(AW) and TFR vs. CPR(AW) for 127 countries and robust regression fits

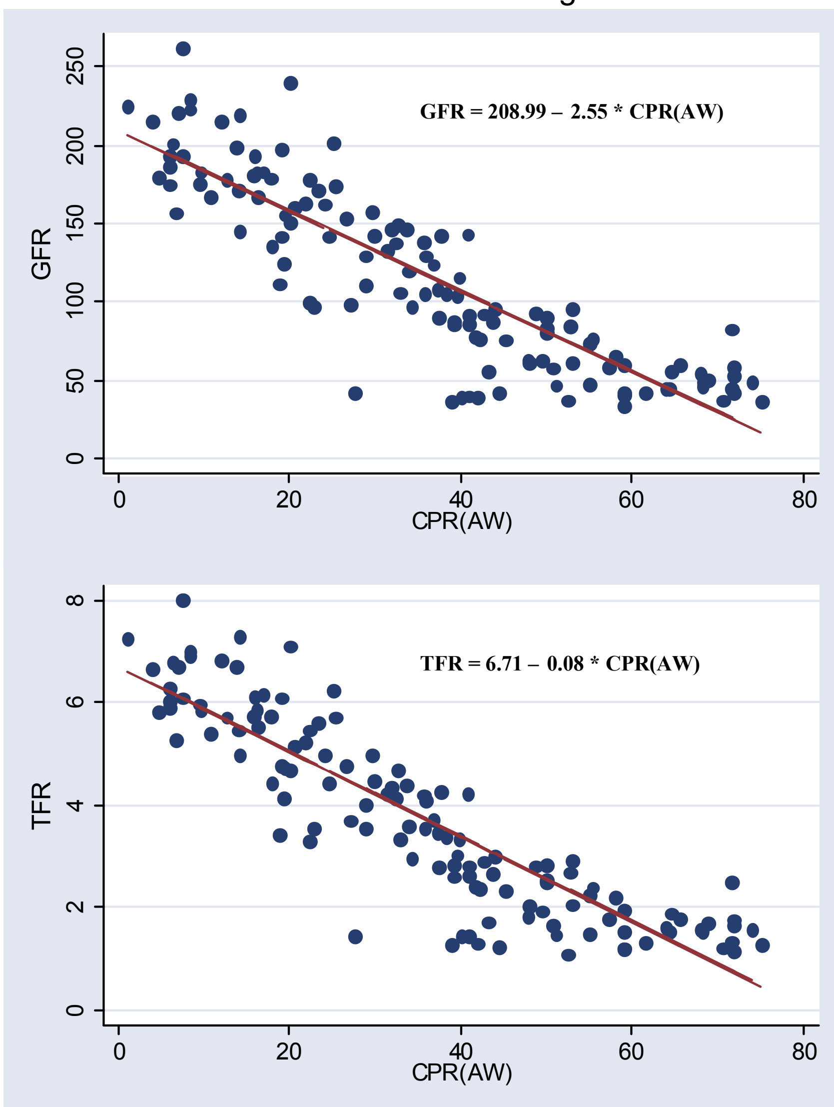

Table 2. Input data (births, CPR(AW), GFR and TFR) and estimates of births averted and percent increase in births in the absence of contraceptive use, estimated by three methods, by region and country*

Region and Country	Input data						Method					
							GFR		TFR		Bongaarts	
	Year**	Births (1,000)	CPR (AW)	CPR (CMW)	GFR	TFR (adj.)	# of BAV	% inc.	# of BAV	% inc.	# of BAV	% inc.
AFRICA							**9316**		**9263**		**9196**	
Algeria	1995	728	35.8	56.9	105.7	3.5	630	87	544	75	799	110
Benin	2001	268	17.8	16.4	178.6	5.8	68	25	62	23	33	13
Botswana	1988	47	29.7	33.0	157.8	5.0	23	48	23	48	23	48
Burkina Faso	1998/99	556	12.0	11.9	215.4	6.8	79	14	83	15	54	10
Burundi	1987	247	6.4	8.7	200.5	6.8	20	8	20	8	15	6
Cameroon	1998	538	24.0	19.3	161.9	5.0	204	38	217	40	91	17
C.A.R.	1994/95	136	14.1	14.8	171.7	5.5	28	21	29	21	15	11
Chad	1996/97	342	3.9	4.1	215.0	6.7	16	5	17	5	11	3
Côte d'Ivoire	1998/99	563	20.7	15.0	160.1	5.1	186	33	195	35	79	14
Dem. Rep. of the Congo	1991	1887	7.0	7.7	220.3	6.7	153	8	86	5	106	6
Egypt	2000	1813	38.4	56.1	105.3	3.4	1689	93	1758	97	2221	123
Eritrea	1995	136	5.9	5.0	185.7	6.0	11	8	11	8	6	5
Ethiopia	2000	2849	5.9	8.1	193.2	6.3	222	8	229	8	228	8
Gabon	2000	41	35.6	32.7	138.2	4.2	27	66	31	75	13	31
Gambia	1990	40	9.7	11.8	182.8	5.8	5	14	3	7	4	11
Ghana	1998	632	18.0	22.0	135.9	4.5	214	34	214	34	138	22
Guinea	1999	354	7.6	6.2	193.4	6.1	36	10	38	11	20	6
Kenya	1998	1009	29.9	39.0	142.4	4.5	541	54	572	57	572	57
Lesotho	1991/92	56	19.1	23.2	141.6	4.8	19	34	11	19	15	27
Liberia	1986	108	8.4	6.4	222.1	6.9	10	10	10	10	7	6
Libya	1995	113	27.2	39.7	98.5	3.7	80	71	63	56	61	54
Madagascar	1997	645	16.0	19.4	193.0	6.1	137	21	140	22	122	19
Malawi	2000	523	25.0	30.6	201.7	6.2	166	32	179	34	214	41
Mali	2001	613	8.4	6.7	229.0	7.0	57	9	53	9	34	6
Mauritania	2001	115	4.8	3.3	179.4	5.8	8	7	3	3	2	3
Mauritius	1991	22	55.0	74.7	74.0	2.2	41	190	21	98	36	166
Morocco	1992	687	22.9	50.3	97.4	3.6	413	60	343	50	593	87
Mozambique	1997	718	6.0	5.6	174.6	5.9	63	9	61	9	41	6
Namibia	1992	62	23.3	28.9	170.4	5.6	21	35	20	33	24	38
Niger	1998	557	7.6	8.2	261.1	8.0	41	7	44	8	38	7
Nigeria	1999	4546	15.7	15.3	181.0	5.7	1007	22	1064	23	652	14
Rwanda	1992	269	13.8	13.2	198.0	6.7	48	18	61	23	40	11
Senegal	1997	337	10.8	12.9	166.3	5.4	56	17	55	16	40	12
South Africa	1998	1037	50.1	56.3	90.1	2.8	1472	142	1556	150	1392	134
Sudan	1992/93	1000	6.8	8.3	157.0	5.3	111	11	61	6	84	8
Swaziland	1988	34	17.0	19.9	182.5	6.2	8	24	5	14	8	23
Togo	1998	172	25.3	23.5	173.9	5.7	64	37	64	37	33	19
Tunisia	1994	194	41.0	60.0	86.6	2.8	234	121	151	78	262	135
Uganda	2000/01	1230	20.1	14.8	239.8	7.1	263	21	239	19	138	14
Tanzania	1999	1402	22.3	24.2	177.9	5.5	449	32	491	35	384	27

Zambia	1996	430	19.2	25.0	196.9	6.1	107	25	112	26	107	25
Zimbabwe	1999	421	37.7	53.5	142.0	4.3	285	68	322	76	440	105
ASIA							**101885**		**107011**		**187943**	
Afghanistan	1972/73	679	1.1	1.6	224.4	7.3	8	1	5	1	10	2
Armenia	2000	32	39.0	60.5	36.2	1.3	88	275	92	286	26	82
Bangladesh	1999/00	4188	36.8	53.8	123.9	3.7	3179	76	3718	89	4017	96
Cambodia	2000	461	14.2	23.8	145.1	5.0	115	25	112	24	129	28
China	1997	20127	57.3	83.8	59.0	1.8	49904	248	54347	270	132224	657
Hong Kong	1992	68	59.0	86.2	41.3	1.2	249	365	121	177	220	324
Dem. People's Rep. of Korea	1990/92	423	42.3	61.8	76.0	2.4	601	142	310	73	644	152
Georgia	1999/00	58	27.7	40.5	42.3	1.5	97	167	96	165	27	46
India	1998/99	25823	33.0	48.2	105.8	3.3	20568	80	22206	86	24290	94
Indonesia	1997	4576	39.3	57.4	85.0	2.6	5403	118	5742	125	5667	124
Iran	1997	1246	49.9	72.9	80.3	2.5	1978	159	1992	160	2322	186
Iraq	1989	671	9.4	13.7	175.5	6.0	92	14	52	8	95	14
Japan	1994	1212	40.1	58.6	38.8	1.5	3197	264	1454	120	1451	120
Jordan	1997	141	36.0	52.6	129.4	4.1	100	71	103	73	126	89
Kazakhstan	1999	263	48.0	66.1	61.4	2.0	526	200	522	198	410	156
Kuwait	1996	39	34.3	50.2	96.9	3.0	35	90	38	99	33	84
Kyrgyzstan	1997	109	42.8	59.5	92.0	2.9	130	119	133	122	135	124
Laos	1993	182	12.7	18.6	178.0	5.7	33	18	18	10	39	21
Lebanon	1996	68	41.7	61.0	77.1	2.4	94	138	96	140	62	91
Malaysia	1994	549	37.3	54.5	108.0	3.5	484	88	254	46	423	77
Mongolia	1998	59	41.0	59.9	91.0	2.6	68	115	77	131	72	122
Myanmar	1997	1203	22.4	32.7	100.0	3.3	689	57	676	56	551	46
Nepal	1996	766	19.5	28.5	155.3	4.7	246	32	259	34	309	40
Oman	1995	74	16.2	23.7	182.4	5.9	17	23	15	20	19	25
Pakistan	1996/97	4933	16.4	23.9	167.4	5.5	1234	25	1213	25	1299	26
Philippines	1998	2024	28.9	46.0	110.8	3.6	1349	67	1398	69	1359	67
Rep. of Korea	1997	626	55.1	80.5	47.7	1.5	1848	295	1947	311	1936	309
Saudi Arabia	1996	654	21.8	31.8	163.3	5.2	223	34	212	32	279	43
Singapore	1982	42	50.8	74.2	57.5	1.7	95	226	52	122	72	171
Sri Lanka	1993	332	45.2	66.1	75.3	2.3	509	153	541	163	485	146
Syrian Arab Rep.	1993	446	24.7	36.1	141.7	4.5	199	45	115	26	225	50
Thailand	1996/97	1076	49.4	72.2	62.7	1.9	2163	201	2285	212	2783	259
Turkey	1998	1494	43.7	63.9	86.8	2.7	1921	129	2087	140	1694	113
Turkmenistan	2000	107	39.2	61.8	87.5	2.8	123	114	131	122	144	134
U. A. E.	1995	51	18.8	27.5	111.6	3.4	22	43	22	43	18	34
Uzbekistan	1996	602	39.6	55.6	104.5	3.0	583	97	618	103	732	122
Viet Nam	1997	1613	71.7	75.3	82.3	2.5	3591	223	3830	237	3474	215
Yemen	1997	748	14.2	20.8	218.8	7.3	124	17	120	16	144	19
EUROPE							**20305**		**13514**		**19565**	
Austria	1995/96	86	44.4	50.8	42.7	1.2	228	265	255	298	94	109
Bulgaria	1995	74	75.1	85.9	36.3	1.3	394	529	325	436	297	399
Czech Rep.	1993	113	59.0	68.9	42.6	1.5	399	354	185	165	214	190
Denmark	1988	60	68.2	78.0	46.0	1.6	226	379	106	178	229	383
Estonia	1994	15	61.5	70.3	41.6	1.3	56	378	26	173	33	223
France	1994	736	69.0	74.6	50.4	1.7	2575	350	1187	161	2574	350
Germany	1992	806	72.0	74.7	41.6	1.2	3565	442	1653	205	2871	356
Hungary	1993	116	64.0	77.4	45.2	1.6	420	361	195	168	454	391

Italy	1996	531	52.6	60.2	37.0	1.1	1927	363	2159	406	720	136
Latvia	1995	23	42.0	48.0	38.8	1.3	65	276	54	231	21	91
Lithuania	1994/95	41	51.2	58.5	46.7	1.5	116	280	104	252	49	119
Netherlands	1993	195	74.0	78.5	48.5	1.6	760	390	350	179	909	466
Poland	1991	525	43.2	49.4	55.4	1.7	1048	199	496	94	411	78
Portugal	1979/80	161	58.0	66.3	65.8	2.2	363	225	182	113	251	156
Rep. of Moldova	1997	52	64.4	73.7	44.8	1.5	190	367	177	344	136	263
Romania	1993	256	41.0	63.8	40.2	1.4	668	260	558	218	330	141
Slovakia	1991	75	64.7	74.0	56.3	1.9	220	294	107	142	156	208
Spain	1995	384	70.7	80.9	37.0	1.2	1879	489	1836	478	2715	706
Sweden	1981	95	68.2	78.0	49.4	1.6	334	353	160	169	312	329
Switzerland	1994/95	79	71.7	82.0	44.9	1.3	320	408	347	442	441	562
Ukraine	1999	434	59.0	67.5	33.9	1.2	1932	445	1842	424	741	171
United Kingdom	1993	750	72.0	82.0	52.6	1.8	2621	350	1210	161	5607	748
LATIN AMERICA AND THE CARIBBEAN							**12587**		**12705**		**22334**	
Bolivia	1998	255	31.4	48.3	132.4	4.2	154	61	161	63	171	67
Brazil	1996	3438	55.4	76.7	77.1	2.4	6315	184	6477	188	11001	320
Colombia	2000	973	52.8	76.9	84.7	2.7	1549	159	1656	170	2617	269
Costa Rica	1992/93	80	53.0	75.0	95.2	2.9	114	142	60	75	177	221
Cuba	1987	180	47.9	70.0	62.5	1.8	352	196	187	104	422	235
Dominican Rep.	1999	198	48.8	63.7	92.8	2.8	266	134	277	140	359	182
Ecuador	1987	296	29.0	65.8	129.2	4.0	170	57	188	63	502	166
El Salvador	1985	152	32.3	59.7	137.4	4.1	91	60	108	71	242	148
Guatemala	1998/99	394	26.6	38.2	154.0	4.8	174	44	190	48	226	57
Haiti	2000	247	19.4	28.1	124.9	4.1	98	40	100	41	84	34
Honduras	1996	198	32.0	50.0	146.4	4.3	111	56	118	59	179	90
Jamaica	1997	55	50.0	65.9	83.2	2.5	84	154	91	166	86	157
Mexico	1987	2301	33.9	66.5	119.8	3.6	1664	72	1742	76	4323	185
Nicaragua	1997/98	166	40.8	60.3	143.0	4.2	121	73	137	82	256	154
Panama	1984	60	39.8	58.2	115.5	3.3	53	88	30	49	84	141
Paraguay	1990	148	32.7	57.4	149.8	4.7	83	56	94	64	200	124
Peru	2000	634	44.0	64.2	95.1	3.0	750	118	772	122	823	126
Puerto Rico	1995/96	60	53.1	77.7	61.1	2.1	134	222	127	211	192	317
Trinidad and Tobago	1987	28	37.4	52.7	90.5	2.8	30	106	35	127	24	85
Venezuela	1977	468	33.7	49.3	145.9	4.4	276	59	156	33	365	78
NOTHERN AMERICA							**11368**		**11513**		**15791**	
Canada	1984	373	68.0	74.7	54.4	1.6	1193	320	1264	338	1271	364
U. S. A.	1990	4063	59.0	76.4	60.2	2.0	10175	250	10249	252	14520	355
OCEANIA							**976**		**612**		**1220**	
Australia	1986	242	72.0	76.1	58.7	1.7	757	313	379	157	965	399
New Zealand	1995	57	65.5	74.9	60.0	1.8	159	279	172	301	200	351
Papua New Guinea	1996	176	20.0	25.9	150.0	4.7	60	34	62	35	55	31
Total births (Births averted) (1,000)		126095					(156437)		(154619)		(256050)	

NOTE:

* 127 countries with over 1 million population in 2002 and available data.

** There are 15 countries which have different reference year in the Bongaarts method than the GFR and TFR methods. See Appendix Table A3 for details.

Figure 2. Boxplots of estimates of percent increase in births in the absence of contraception for 127 countries, by method of estimation

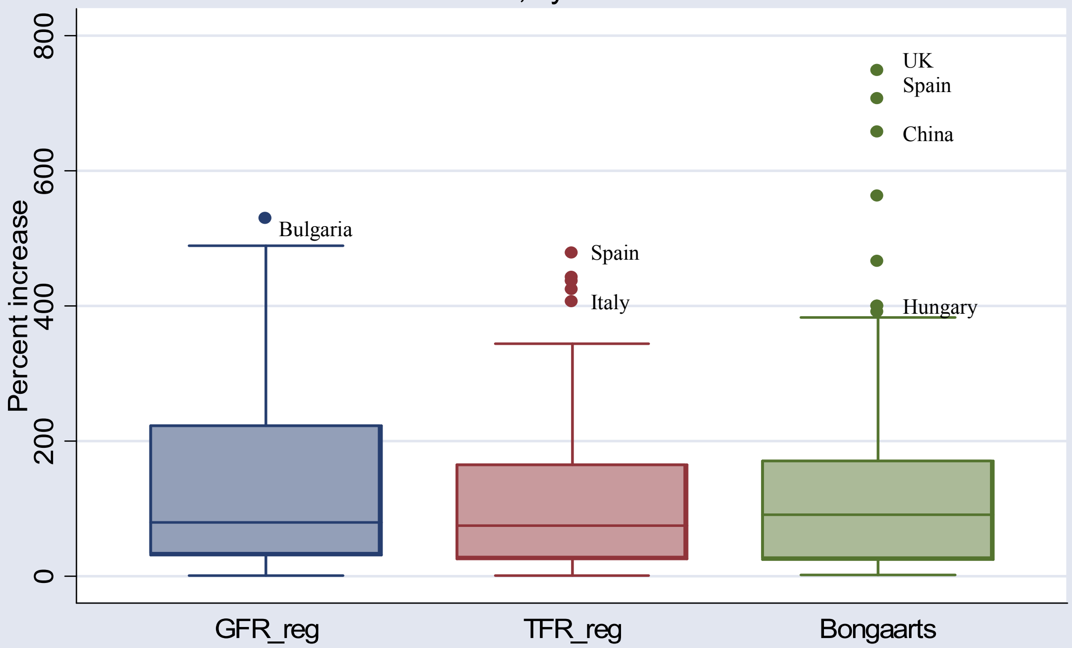

Table 3. Correlation coefficients between three estimates of percent increase in births in the absence of contraception (PI) for 127 countries

Correlation coefficients	Estimate using GFR	Estimate using TFR	Estimate using Bongaarts' model
PI in GFR	1.00	0.89	0.72
PI in TFR		1.00	0.68
PI in Bongaarts' model			1.00

Appendix Table A1. TFR adjusted into the same age range as CPR, details

Age range of CPR	# of Countries	Countries (if frequency ≤ 4)	Adjustment method
15-49	91		None needed
15-44	17		(1)
20-49	7		
18-49	4	Latvia, Lithuania, Spain, Canada	(2)
20-44	2	Sweden, France	(3)
20-39	1	Germany	
10-49	1	Bangladesh	None; considered as 15-49
16-49	1	United Kingdom	
<50	1	Kuwait	
18-41	1	Hungary	(3); considered as 18-49
18-42	1	Netherlands	

There are 11 different age ranges for CPR.

(1) For countries with CPR for age groups (15, 44) or (20-49), TFR were adjusted based on Demographic and Health Survey data. $TFR^{15\text{-}44}$ and $TFR^{20\text{-}49}$ from DHS were used to get the mean of $\frac{TFR^{15-44}}{TFR^{15-49}}$ and $\frac{TFR^{20-49}}{TFR^{15-49}}$, which were used to adjust available $TFR^{15\text{-}49}$ to $TFR^{15\text{-}44}$ or $TFR^{20\text{-}49}$ where needed.

(2) For countries with CPR for age groups (18-49), data of $TFR^{15\text{-}49}$ and $TFR^{20\text{-}49}$ were obtained from the Demographic Yearbook and the United Nations (200x) World Population Monitoring 2000. Then $TFR^{17.5\text{-}49}$ was calculated as the average of $TFR^{15\text{-}49}$ and $TFR^{20\text{-}49}$. (We equated $TFR^{18\text{-}49}$ with $TFR^{17.5\text{-}49}$.)

(3) For countries with CPR for age groups (20-44) and (20-39), age-specific fertility rate or age-specific live births and female population of the specific year from the Demographic Yearbook were used to calculate the corresponding TFR.

Appendix Table A2. Estimates of contraceptive effectiveness by methods and national development level*

METHOD	LDCs (From Bongaarts)	MDCs (Derived)
Sterilization (female)	100	99.53
Sterilization (male)	100	99.82
Pill	90	99.65
Injectables	95	99.65
IUD	95	98.86
Condom	70	85.88
Vaginal barrier methods	70	78.82
Other modern methods	70	99.89
Rhythm	60	76.47
Withdrawal	60	77.65
Other traditional methods	50	50.00

* National development level is defined according to UN Population Division. The more developed regions comprise all regions of Europe and Northern America, Australia/New Zealand and Japan. The less developed regions comprise all regions of Africa, Asia (excluding Japan) and Latin America and the Caribbean, as well as the regions of Melanesia, Micronesia and Polynesia.

Appendix Table A3. Countries which have different reference year and births in the Bongaarts method than the GFR and TFR methods

Country	Year	Births (1,000)
Rwanda	2000	359
Uganda	1995	1020
Morocco	1995	679
Benin	1996	254
Mali	1995/96	554
Mauritania	1990/91	92
Romania	1999	234
Dominican Rep.	1996	197
El Salvador	1998	164
Mexico	1995	2340
Ecuador	1999	303
Paraguay	1998	161
Peru	1996	652
Canada	1995	349
United States of America	1995	4092