Induced Abortion in the Developing World: Indirect Estimates

By Heidi Bart Johnston and Kenneth H. Hill

An analysis of Demographic and Health Survey data provides indirect estimates of the prevalence of abortion in 21 developing countries by rearranging Bongaarts's proximate determinants model to allow calculation of the index of abortion from the other principal proximate determinants of fertility (marriage, contraceptive use and postpartum insusceptibility to pregnancy), average total fecundity and total fertility. On average, abortion appears to have an influence on fertility similar to that of contraceptive use. This influence appears to be particularly strong in the four Latin American countries in the analysis, where abortion reduces fertility by 38–55%. In contrast, abortion's fertility-reducing effect is only 6–19% in the Near East and 0–32% in Africa. In five countries for which two sets of DHS data are available, this reductive effect appears to have increased over time. (International Family Planning Perspectives, **22:**108–114 & 137, 1996)

Induced abortion has long been recognized as one of the principal determinants of fertility levels and is thought to be practiced throughout the world, regardless of its legal status.[1] Nevertheless, the demographic impact of abortion in developing countries remains uncertain. Without estimates of abortion, demographers cannot accurately model fertility trends nor can they thoroughly understand the relationships between the determinants of fertility and the fertility level. Family planning program managers need estimates of abortion levels to identify and meet the need for modern contraceptives, and policymakers need to be aware of the levels of abortion and the conditions under which it is provided, particularly in areas where maternal morbidity and mortality are linked to unsafe abortion.

Data quality is an important consideration in studying the effects of abortion on fertility. Direct measures can be used only where termination of pregnancy is accurately reported. Abortion, however, is generally stigmatized and is thus subject to considerable underreporting.[2] Abortion data typically come from one of two sources: clinic or hospital records or individual surveys. Abortion data from clinic or hospital sources are thought to be accurate in some countries where abortion is legal and accessible,[3] but are likely to be inaccurate where abortion is illegal, severely restricted or difficult to obtain.[4] Individual surveys underestimate the prevalence of induced abortion even in countries where abortion is legal.[5]

The shortcomings of direct measurement of abortion justify exploring the use of indirect estimation methods to measure abortion. Singh and Wulf estimated levels of induced abortion in six Latin American countries by adjusting data on abortion-related hospitalizations—which represented an estimate of the total number of abortion-related hospitalizations in the country—for underreporting of induced abortion.[6] They multiplied the adjusted hospitalization data by a factor, ranging from three to seven, that represented the availability of safe abortion in a country. The value of the multiplier was larger for countries where relatively safe abortion is more accessible. The resulting value is an estimate of the total number of abortions performed in the country. To implement Singh and Wulf's approach, however, researchers must develop and continually update a wide range of assumptions and adjustment factors.[7] Maintaining the necessary inputs for calculating abortion rates using this scheme is daunting even at the regional level and is much more so at the global level.

Foreit and Nortman[8] developed an indirect technique to calculate abortion incidence for married women in three South American countries. To obtain an estimate of births averted by abortion per married woman, they used an adaptation of Bongaarts's proximate determinants of fertility model.[9] They first estimated the total natural fertility rate by multiplying total potential fertility by an index representing the fertility-reducing effects of postpartum insusceptibility. They subtracted total marital fertility and births averted by contraceptive use from this estimate to arrive at births averted by induced abortion per married woman. They then translated this result into a total marital abortion rate, using a method proposed by Bongaarts and Potter.[10]

The problem with this approach is that it imposes an inappropriate sequencing of effects for the proximate determinants of the Bongaarts model. Specifically, Foreit and Nortman multiplied the index of postpartum insusceptibility by the average total fecundity rate (TF) to account for births averted by postpartum insusceptibility. Multiplying the index of a single proximate determinant by TF to account for births averted is likely to overestimate the fertility-reducing impact of that determinant, so the technique presented by Foreit and Nortman is likely to overestimate the fertility-reducing effects of postpartum insusceptibility and underestimate the total marital abortion rate.

In this article, we present an alternative indirect method of calculating the influence of abortion on fertility that can be calculated with data available from standard fertility surveys. Using this method, we provide abortion estimates for 21 developing countries. Like Foreit and Nortman, we use a residual technique based on Bongaarts's proximate determinants model.[11] After describing the method and presenting the estimates, we discuss the results of tests for confounding between the abortion estimates and the "minor" proximate determinants of fertility not included in the model.

Methodology

Proximate Determinants of Fertility

The indirect method with which our estimates are calculated is based on the concept that all socioeconomic, cultural and biological variables that influence fertility work through a limited number of proximate factors. The concept was developed by Davis and Blake[12] and later refined by others, including Bongaarts.[13] The seven factors currently accepted as the proximate determinants of fertility are the proportion of females married or in sexual

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unions; contraceptive use and effectiveness; the prevalence of induced abortion; the duration of postpartum insusceptibility; fecundability; spontaneous intrauterine mortality; and the prevalence of permanent sterility.

Bongaarts demonstrated, in an analysis of 41 developing, developed and historical populations, that four proximate determinants (marriage, contraceptive use, abortion and postpartum insusceptibility) explained 96% of the variation in fertility.[14] The small amount of unexplained fertility is, in part, a result of variations in the remaining three proximate determinants—fecundability, sterility and intrauterine mortality. These minor proximate determinants are thought not to vary substantially by country or across time.

In Bongaarts's proximate determinants model, the total fertility rate (TFR) is approximated by the average total fecundity rate (TF) adjusted for indices representing the fertility-reducing effect of each of the four principal proximate determinants: $TFR = TF \times C_m \times C_c \times C_a \times C_i$, where TFR is the average total number of lifetime births per woman if current age-specific fertility rates prevail throughout her childbearing years; TF is the mean potential number of lifetime births per woman during her reproductive years, estimated at an average of 15.3; C_m is the index for the proportionate reduction in fertility caused by nonexposure to sexual intercourse; C_c is the index for the proportionate reduction in fertility caused by use of contraceptives; C_a is the index for the proportionate reduction in fertility caused by induced abortion; and C_i is the index for the proportionate reduction in fertility caused by postpartum insusceptibility.

The TFR and the index for each of the principal proximate determinants, with the exception of abortion, can be calculated directly from the data collected in standard fertility surveys. Each index has a value ranging between 0 and 1. The lower the value for an index, the greater the reductive effect of that factor on fertility. For example, an index of 1 indicates that the specified factor has no fertility-reducing effect, and an index of 0 implies that all fertility is prevented by that particular factor.

Estimating Abortion as a Residual

The index of abortion can be estimated as a residual by rearranging Bongaarts's equation as $C_a = TFR/(TF \times C_m \times C_c \times C_i)$. Like the indices representing the other proximate determinants, the index representing the fertility-reducing effects of abortion should have a value between 0 and 1, although with real data there is no guarantee that a residual estimate of the index will not exceed 1.

There are three major potential sources of error in the rearranged equation: the possible measurement error in the indices of the fertility-reducing effects of the major determinants; omission of the effects of the three proximate determinants not included in the model (fecundability, spontaneous intrauterine mortality and permanent sterility); and the use of a single value for TF, the average total fecundity rate of a population in the absence of any fertility-reducing effects of proximate determinants. As with any residual method of estimation, any overestimation or underestimation of the contributing values will affect the size of the residual and thus the accuracy of the estimate.

Bongaarts estimated that TF averages about 15.3 lifetime births per woman for developed and developing countries and ranges from 13 to 17, depending on the fertility-reducing effects of the proximate determinants not included in Bongaarts's model.[15]

In calculating TF, Bongaarts made some simplifying assumptions that could influence our estimates of abortion. First, he assumed that the minor proximate determinants—natural fecundability, intrauterine mortality and primary sterility—have a fairly small fertility-reducing effect, and that this effect varies little between populations or over time, thus contributing minimally to differentials and trends.[16] Second, for all of the developing countries but South Korea, and all of the historical populations, he assumed that the effect of abortion on fertility was negligible.[17] Bongaarts's estimate of TF thus may include some fertility-reducing effect of abortion. Residual estimates of the fertility-reducing effects of abortion from our rearranged equation are therefore relative to the average unmeasured influence of abortion in the populations contributing to the estimated TF of 15.3, rather than absolute estimates.

Equation Variables

To estimate values for the equation variables, we use data from 26 Demographic and Health Surveys (DHS) conducted in 21 countries in Africa, Asia and Latin America. Most of the data were collected in the 1990s; however, for five countries in which two surveys have been conducted, we use data sets from both the 1980s and the 1990s to examine temporal trends in abortion. Sixteen of the surveys included in this analysis drew their sample from all women of reproductive age (15–49), regardless of marital status. In 10 surveys—those from countries in which few, if any, sexual relationships are thought to occur outside of marriage—DHS limited the sample to ever-married women aged 15–49.

The TFR is calculated by summing age-specific fertility rates for the three years preceding the survey. Data on fertility come from a full pregnancy history asked of women of reproductive age. In countries where the DHS sampled all women aged 15–49, regardless of marital status, the TFR is based on the data for all women in that age-group. In countries where the DHS sampled only ever-married women aged 15–49, calculations of the TFR include only births to ever-married women. Although not free of error, TFR estimates from the DHS are thought to be "reasonably complete and accurate."[18] Where the TFR is underestimated, the fertility-reducing effect of abortion will be overestimated, and vice-versa.

The indices for marriage, contraceptive use and postpartum insusceptibility are calculated according to formulas presented by Bongaarts,[19] except as described below. For each index, we discuss the data used to calculate the indices, the estimated values of the indices, and the potential influence of data error. For the five countries for which we have data from two DHS surveys—Egypt, Kenya, Indonesia, Morocco and Senegal—we report the changing influence of each principal proximate determinant over time.

For two of these five countries, there is an important difference between the data collected in the first and second surveys. The data collected for the later Kenya and Senegal surveys include information on exposure to intercourse; the data collected in the earlier surveys do not. For consistency of measurement when analyzing temporal changes in the indices, we use data for ever-married women (including women ever in stable sexual unions) to calculate the index of marriage, and data for contraceptive use among currently married women to calculate the index of contraception. As a result, for Kenya and Senegal, the values for the indices of marriage, contraception and abortion in the temporal trends analysis differ from those in Table 1 (page 110) and in the main analysis.

• *Total fertility rate.* The TFRs for the countries included in the study range from 2.7 lifetime births per woman in Turkey to 7.7 in Yemen. The TFR decreased over time in all five countries surveyed more than once. The absolute decrease in the TFR was most dramatic in Kenya—from 6.7 in

Table 1. Total fertility rates (TFRs) and estimated indices of the principal proximate determinants and indicators of the minor proximate determinants, by country, Demographic and Health Surveys, 1986–1993

Country (and year of survey)	Observed TFR	Index of marriage	Index of contraception	Index of postpartum insusceptibility	Index of abortion	Indicator of fecundability	Indicator of intrauterine mortality	Indicator of sterility
N.E. Brazil (1991)	3.66	0.694	0.669	0.935	0.551	0.789	0.974	0.910
Burkina Faso (1993)	6.91	0.942	0.947	0.533	0.949	0.410	0.949	0.969
Cameroon (1991)	5.83	0.951	0.850	0.604	0.780	0.554	0.967	0.897
Colombia (1990)	2.86	0.696	0.658	0.901	0.452	0.688	0.989	0.939
Egypt (1988)	4.69	0.683	0.672	0.749	0.891	u	u	0.956
Egypt (1992–1993)	3.93	0.653	0.577	0.830	0.821	u	0.967	0.957
Indonesia (1987)	3.43	0.716	0.574	0.722	0.755	u	u	0.953
Indonesia (1991)	3.03	0.717	0.539	0.775	0.661	0.849	0.968	0.951
Jordan (1990)	5.57	0.604	0.724	0.885	0.941	u	0.979	0.960
Kenya (1988–1989)	6.71	0.771	0.824	0.683	1.011	u	u	0.972
Kenya (1993)	5.40	0.886	0.780	0.683	0.748	0.583	0.974	0.989
Namibia (1992)	5.37	0.875	0.786	0.746	0.684	0.582	0.969	0.966
Niger (1992)	7.38	0.967	0.976	0.593	0.861	0.691	0.959	0.981
Madagascar (1992)	6.13	0.914	0.919	0.631	0.755	0.686	0.961	0.899
Malawi (1992)	6.73	0.918	0.928	0.658	0.785	u	0.959	0.989
Morocco (1987)	4.84	0.619	0.718	0.735	0.967	u	0.959	0.951
Morocco (1992)	4.04	0.612	0.662	0.760	0.856	u	0.969	0.958
Paraguay (1990)	4.70	0.830	0.753	0.866	0.568	u	0.981	0.951
Peru (1991–1992)	3.54	0.673	0.748	0.743	0.618	0.731	0.975	0.961
Rwanda (1992)	6.23	0.764	0.892	0.567	1.055	0.743	0.961	0.994
Senegal (1986)	6.62	0.857	0.942	0.576	0.930	u	u	0.948
Senegal (1992–1993)	6.03	0.853	0.952	0.610	0.795	0.401	0.965	0.976
Sudan (1989–1990)	4.96	0.628	0.935	0.617	0.894	u	0.956	0.956
Turkey (1993)	2.65	0.614	0.609	0.901	0.515	u	0.971	0.971
Yemen (1991–1992)	7.67	0.816	0.936	0.813	0.807	u	0.963	0.993
Zambia (1992)	6.47	0.935	0.943	0.662	0.723	0.625	0.960	0.986

Note: u=unavailable

1988–1989 to 5.4 in 1993. The average TFR in the 26 data sets used in this study is 5.2.

•*Index of marriage.* The index of marriage, C_m, is intended to measure exposure to sexual intercourse. In most cultures, age at first sexual intercourse is a more accurate measure of exposure to risk of pregnancy than age at first marriage or at first stable sexual union.[20] For this reason, where the DHS provides such data, we use proportions of women who have ever had intercourse, rather than proportions of women who have ever been married, as the basis for calculating C_m.

Because not all women who have ever had intercourse are exposed to intercourse regularly, this measure could overestimate exposure. For the 10 countries in this analysis for which data on nonmarital intercourse are not available, we use the proportion of women who have ever been married as the basis for calculating C_m. We will continue to refer to C_m as the index of marriage, but it should be interpreted as an index of exposure to sexual intercourse.

Estimates of the index of marriage (Table 1) range from 0.60 in Jordan (showing a moderate effect) to 0.97 in Niger (showing a minimal effect). The average value of the index of marriage in the 26 data sets used in this study is 0.78. The effect on fertility of delaying marriage appears to have increased over time for four of the five countries for which we have data from two surveys. It increased most in Senegal—where the value of C_m fell from 0.86 in 1986 to 0.79* in 1992–1993—and negligibly in the remaining four countries.

•*Index of contraception.* The index of contraception, C_c, represents the extent to which populations limit fertility through use of modern and traditional contraceptives. To measure the fertility-reducing effects of contraceptive use, the prevalence and the use-effectiveness of each method must be known. While data on the prevalence of contraceptive methods within countries are available, data for contraceptive use-effectiveness are less country-specific. Although contraceptive use-effectiveness has been shown to fluctuate across countries,[21] this analysis uses a standard set of contraceptive use-effectiveness rates[22] (see Table 2).

In general, the contraceptive use-effectiveness rates applied represent the lower limits of available estimates. By using the lower limits, we assume we are more accurately reflecting reality, although we may be underestimating contraceptive effectiveness for some countries in the analysis. Any underestimation or overestimation of contraceptive effectiveness or any underreporting or overreporting of current contraceptive use will contribute to inaccurate estimates of C_a. According to an analysis of DHS data, the information on current contraceptive prevalence is generally acceptable.[23]

We calculate two indices of contraception—one for traditional methods and one for modern methods. The product of the two indices represents the total influence of contraceptive use on fertility. Traditional methods appear to have a minimal effect that varies little from country to country. The effect of modern methods, on the other hand, varies substantially. The combined index of contraception varies from 0.98 in Niger (minimal importance) to 0.54 in Indonesia (great importance). The average value of the index in the 26 data sets is 0.79. For each of the countries with multiple observations except Senegal, the fertility-reducing effects of contraceptive use increased between the two surveys. The increase in the fertility-reducing effects of contraceptive use was greatest in Egypt, where the value of the index fell from 0.67 in 1987 to 0.58 in 1991.

•*Index of postpartum insusceptibility.* The index of postpartum insusceptibility, C_i, measures the fertility-reducing effects of sexual abstinence or amenorrhea following a birth. The index is calculated using data on postpartum abstinence and postpartum amenorrhea among women who had given birth up to 35 months before the DHS survey. In the 22 data sets that include the median duration of abstinence or amenorrhea, the median duration is used; elsewhere, the mean is used. As current status data are considered reliable,[24] we assume that misreporting contributes minimally to the variation in C_i.

Estimates of the index of postpartum insusceptibility range from 0.94 in Northeast Brazil (showing little effect) to a high

Table 2. Contraceptive use-effectiveness rates, by method

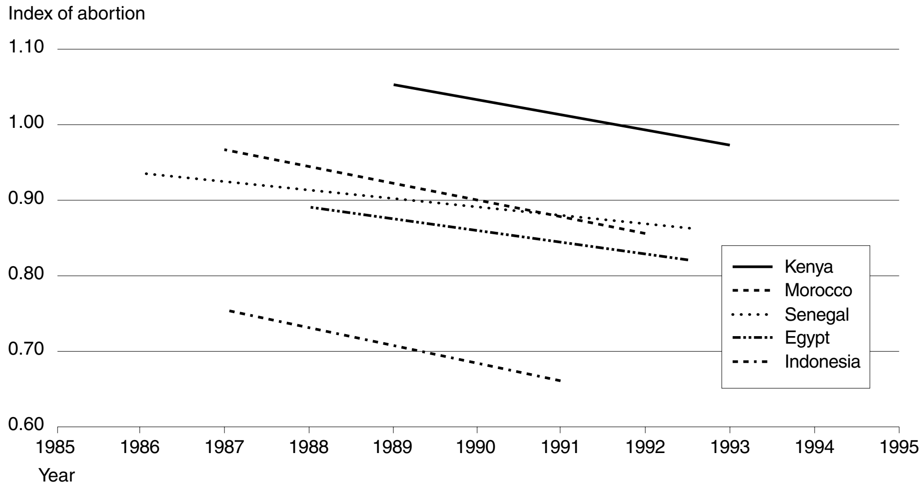
Method	Rate
Oral contraceptives	0.82
Injectable	0.96
Implant	0.99
Tubal sterilization	0.99
Vasectomy	1.00
IUD	0.90
Condom	0.62
Vaginal methods	0.80
Periodic abstinence	0.50
Withdrawal	0.38
Other	0.10

Sources: **Modern methods**—J.G. Hutchings, G. Perkin and L. Saunders, 1987 (see reference 22); **Periodic abstinence and withdrawal**—S. Thapa, D. Hamill and P. Lampe, 1993 (see reference 22); **Other**—A. K. K. Sayila, 1992 (see reference 22).

*To allow comparison with the estimate of C_m for 1986, we recalculated the estimate for 1992–1993 using data for ever-married women.

of 0.53 in Burkina Faso (showing a strong effect). The average value of the index of postpartum insusceptibility in the 26 data sets is 0.72, making postpartum insusceptibility, on average, the most influential principal proximate determinant in this analysis. The fertility-reducing effects of postpartum insusceptibility decreased over time in four of the five countries with two observations.

Figure 1. Trends in the index of abortion as a predictor of fertility in five countries



Note: For consistency in measurement across time, the index of abortion for all 10 observations was calculated using data for ever-married women (for the index of marriage) or currently married women (for the index of contraception), and not for women who had ever had intercourse. For this reason, the values for the index of abortion for Kenya and Senegal differ from those presented in Table 1.

Abortion's Effect on Fertility

The estimates generated using the indirect method presented here suggest that abortion has a large effect on fertility in some settings and a small effect in others. Abortion appears to have a strong effect in South America, with index values ranging from 0.45 in Colombia to 0.62 in Peru, yet seems to have only a marginal impact in high-fertility areas of Africa, as suggested by values of 0.95 in Burkina Faso and 1.06 in Rwanda.

The effect of abortion on fertility appears to be geographically clustered, suggesting that common socioeconomic situations and cultural heritages influence abortion levels. Abortion appears to have the greatest impact on fertility in Latin America, a strong influence in Southeast Asia (as measured using data from Indonesia), a varying impact in Sub-Saharan Africa, and the weakest influence in the Near East (barring Turkey). That Turkey is an exception is no surprise—of the 21 countries* included in the study, Turkey has the least restrictive laws regarding access to abortion.[25]

Table 1 exaggerates the change over time in the influence of abortion on fertility for Kenya and Senegal. For both countries, the index of abortion for the earlier period refers to ever-married women (including women ever in a stable sexual union), and the index for the second period refers to women who had ever had intercourse. The index of marriage from the earlier survey probably overestimates the fertility-reducing effects of delaying entrance into sexual activity and underestimates the fertility-reducing effects of abortion. If this is the case, the use of data for ever-married women rather than those for women who had ever had intercourse could be one reason the value of C_a for Kenya in 1988–1989 exceeds 1.

The average value for the index of abortion is 0.78, indicating that the fertility-reducing effect of abortion is similar to the influence of contraceptive use and marriage, but less important than that of postpartum insusceptibility for the countries included in this analysis. The fertility-reducing effects of abortion appear to be increasing with time—a trend shown in Figure 1 for each of the five countries with two observations. The increase was greatest in Indonesia, where the value of the index fell from 0.76 to 0.66 between 1987 and 1991. Figure 1 corrects for the exaggerated change over time shown in Table 1 for Kenya and Senegal by using consistent definitions across time.

We can compare direct and indirect estimates of the index of abortion using data from the 1993 Turkey DHS. The directly estimated total abortion rate, 0.52, represents the average number of abortions a Turkish woman will have in her lifetime if she has abortions at the age-specific rates prevailing in the five years before the survey. The estimate is calculated as the number of abortions recorded in the five-year calendar of respondents' fertility histories, divided by the total number of woman-years represented in the calendar. To obtain abortion data, the DHS interviewers in Turkey asked respondents about their pregnancy histories over the preceding five-year period and probed to determine how incomplete pregnancies ended.[26] Using the direct method of estimating the index of abortion presented by Bongaarts and Potter,[27] the total abortion rate of 0.52 translates to an abortion index of 0.89, very different from the indirectly estimated index of 0.52.

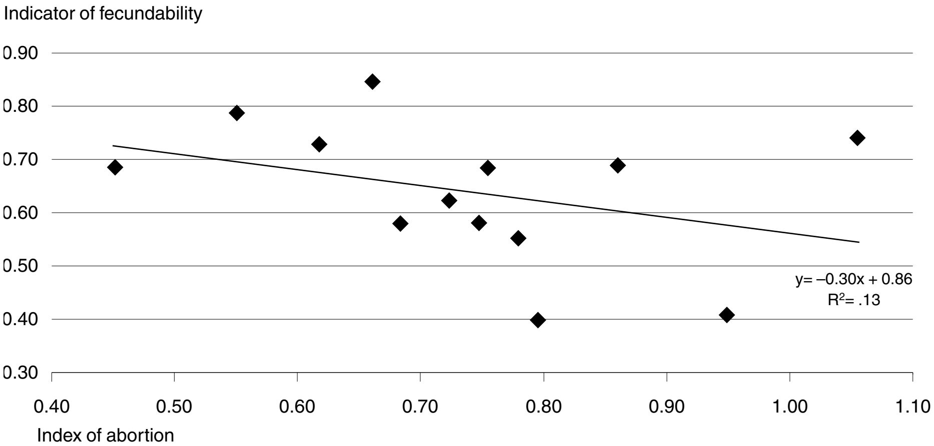
The vast difference in the direct and indirect estimates of the effect of abortion on fertility could be a result of abortions being underreported in Turkey; the general consensus is that women, in Turkey and elsewhere, tend to underreport abortion, whether it is legal or illegal. In 1975, when abortions were illegal in Turkey, Tezcan found that when asked directly, 14% of a nationally representative sample of Turkish women reported having had an abortion; when the randomized response technique was used, 33% of the same sample reported having had at least one abortion.[28] Since 1975, abortions are thought to have increased, as a result of the legalization of abortion in 1983 and of a decrease in desired family size.[29]

Alternatively, the difference in estimates could be a result of the proposed residual technique overestimating the influence of abortion on fertility. The equations or the data used to measure the indices of the principal proximate determinants of fertility may underestimate the fertility-reducing effect of the determinants and thus overestimate the fertility-reducing effect of abortion. In addition, missing determinants may contribute to the residual and lead to an overestimate of the fertility-reducing effect of abortion.

The difference between direct and indirect estimates probably results from the combined effect of underreporting and measurement error. At any rate, the two estimates of C_a that exceed 1 suggest that some unidentified error is influencing the estimates. The factors most likely to influence residual fertility are the three proximate determinants not included in Bongaarts's fertility model—fecundability, natural sterility and intrauterine mortality. Misestimating the average total fecun-

*In this article, average values for the 21 countries included in the analysis are based on 26 data sets because Egypt, Indonesia, Kenya, Morocco and Senegal are each represented twice.

Figure 2. Regression of the indicator of fecundability on the index of abortion



dity rate (TF) could also influence the estimate of the effect of abortion, although the effect would not differ across countries.

There is also a minor timing inconsistency in the measures used. The TFR is measured for the three-year period prior to the survey, whereas the measures of the other factors in our equation refer to the time of the survey. If fertility is falling, the TFR will be somewhat overestimated in relation to the measures of the proximate determinants, and the fertility-reducing effect of abortion will be somewhat underestimated. The effect is not likely to be large, particularly in view of the tendency in DHS data for recent births to be pushed backward in time.[30]

To ensure that the error is not the result of a systematic influence on fertility of one or more minor proximate determinants, or a miscalculation of TF, we examine the potential for bias linked to these sources.

Minor Proximate Determinants

Bongaarts acknowledges that the three proximate determinants not included in his fertility model directly influence fertility.[31] Only in unusual circumstances is the influence of these variables on fertility differentials or trends considered more than minimal.[32] However, given the sensitivity of a residual to measurement error, the minor proximate determinants could bias our estimates of the abortion index.

To determine the relationships between the minor proximate determinants and the estimate of abortion, we develop indicators for the minor proximate determinants that can be derived from DHS data. The indicators are expected to covary with the indices they represent. Like the indices, the indicators have values between 0 and 1, where 0 represents the maximum fertility-reducing effect and 1 represents no effect. As the minor proximate determinants are thought to have a minimal influence on fertility, we expect the values obtained to be fairly close to 1.*

To test for association between the minor proximate determinants and residual fertility, we regress the indicators against the residual estimate of the index of abortion. A significant positive relationship between an indicator and the estimate of the abortion index would suggest that the minor proximate determinant has a fertility-reducing effect that should be accounted for in the model.

• *Fecundability.* Fecundability is the probability of conception, assuming exposure, per menstrual cycle. Fecundability is considered to have a lesser effect on fertility than any of the four principal proximate determinants but a greater effect than either sterility or intrauterine mortality. A population's TFR is thought to be somewhat sensitive to variations in fecundability.[33]

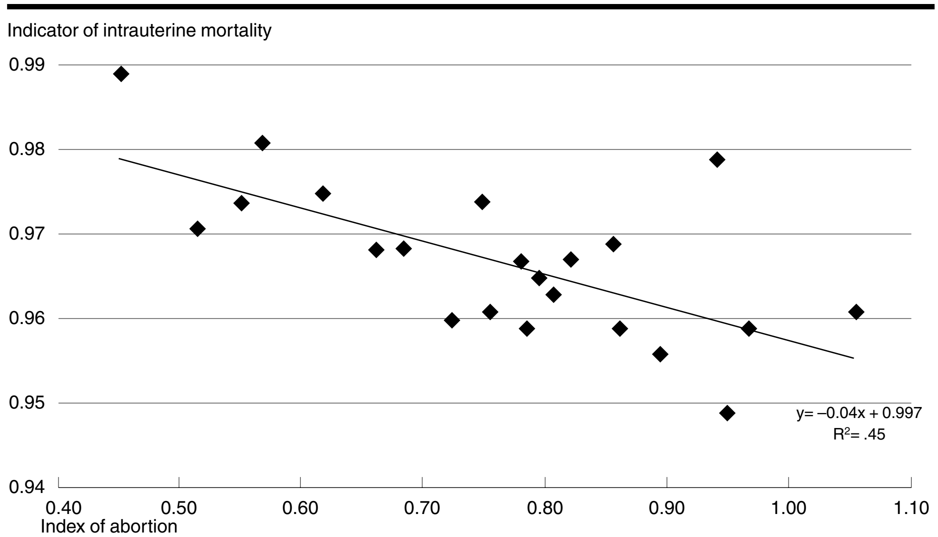
Frequency of intercourse—a proxy for fecundability—is available in some DHS data sets. To test the influence of fecundability on fertility, we developed an indicator representing the proportion of women who had ever had intercourse who were sexually active in the four weeks preceding the survey. Because the indicator measures frequency of intercourse among those who have ever been sexually active rather than among women currently in a union, the values of our indicator of fecundability may overestimate the influence of fecundability on fertility.

Only 13 of the 26 data sets included in our study report data on frequency of intercourse. In these data sets, the value of the indicator of fecundability ranges from 0.40 in the more recent of the two Senegal surveys to 0.85 in the more recent of the two Indonesia surveys.

Figure 2 shows the scatterplot of residual fertility against the fecundability indicators for the 13 data sets; the solid line plots the regression. Fecundability appears to explain little of the variation in the residual estimate of abortion (R^2=.13; p>.10). The association is negative, the opposite of the expected effect, but not significantly different from zero. Fecundability as proxied in this analysis has no statistically significant relationship with the residual fertility reduction and does not explain the variability in the abortion estimates.

• *Intrauterine mortality.* Of all the proximate determinants, spontaneous intrauterine mortality, or spontaneous abortion, is thought to have the least influence on the

Figure 3. Regression of the indicator of intrauterine mortality on the index of the abortion



*However, our main interest is not in the absolute values of the indicators, but rather in their relation to the residual estimates of abortion.

total fertility rate of a population.[34] To test the influence of intrauterine mortality on fertility, we developed an indicator based on the neonatal mortality rate, which is available in most DHS data sets. We chose this indicator on the assumption that the proportion of conceptions that do not result in a live birth will covary with the neonatal mortality rate. This assumption is based on the grounds that many of the conditions associated with the component of intrauterine mortality most likely to vary across populations or over time, spontaneous abortions occurring in late pregnancy, are associated with the neonatal mortality rate.* To obtain the indicator for intrauterine mortality, the neonatal mortality rate for the period 0–4 years prior to the survey is subtracted from 1.

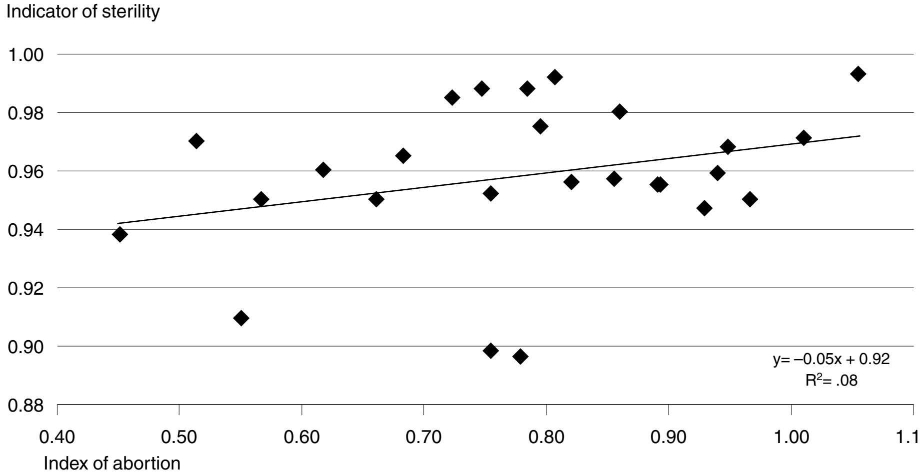
Twenty-two of the 26 data sets include information from which the indicator of intrauterine mortality can be calculated. For these 22, the values of the indicator range from 0.95 in Burkina Faso to 0.99 in Colombia. As illustrated in Figure 3, regression of the indicator of intrauterine mortality against the estimate of the index of abortion shows a statistically significant negative relationship between the two variables (R^2=.45, $p<.01$). Whereas a significant positive association would suggest that the variation in intrauterine mortality might bias the residual estimates of abortion, the significant negative association indicates that some other unexplained relationship exists between the two variables.

• *Sterility.* The sterility indicator is intended to measure the inability of a couple to reproduce, for reasons other than contraceptive sterilization, after the woman's menarche and before menopause. Although fertility rates in populations are thought to be moderately sensitive to different levels of sterility, fluctuations in rates of primary sterility across countries are considered uncommon.[35]

To examine the influence of sterility on fertility, we developed an indicator for sterility calculated by subtracting from 1 the proportion of women aged 45–49 who have ever been married or in a union and have no children. If, as we assume, all couples in the 26 data sets in this analysis who are able to have children will have at least one child, the indicator will include only women who are sterile for reasons other than contraceptive sterilization. The indicator does not measure the level of secondary sterility, that is, the proportion of couples who become sterile for reasons other than contraceptive sterilization after having one or more children.

All 26 data sets used in our study include the information necessary to calculate the indicator. The values of the indicator of sterility range from 0.90 in Cameroon and Madagascar to 0.99 in Rwanda and Yemen. The high values suggest that primary sterility has only a small impact on fertility in any of the 21 countries considered here. Regression of the sterility indicator against the residual estimate of abortion (Figure 4) shows that primary sterility does not explain the variation in the abortion estimate (R^2=.08, $p>.10$). Residual fertility is positively associated with this measure of sterility, as would be expected if sterility were a confounding factor, but the relationship is not statistically significant and thus does not observably bias our abortion estimates.

Figure 4. Regression of the indicator of sterility on the index of abortion



Total Fecundity Rate

To determine a value for average total fecundity, Bongaarts regressed values for the total marital fertility rate in the absence of postpartum infecundability against values for contraceptive prevalence, using data from 23 developing countries, eight developed countries and 10 historical populations. The resulting value for average total fecundity, 15.3, was the total marital fertility rate when contraceptive prevalence was 0.0.[36] In calculating the values for total marital fertility rates in the absence of postpartum infecundability, Bongaarts employed the simplifying assumption that for all but one of the historical populations and developing countries in the study, the effect of abortion on fertility was negligible.[37] If abortion had an effect that was not accounted for in the calculation of 15.3, then 15.3 underestimates TF, and residual estimates of abortion may underestimate abortion rates.

As our examination of the data for Colombia, Indonesia, Jordan, Kenya, Peru and Turkey—the six countries included both in Bongaarts's 1982 analysis and in this study—will show, Bongaarts's estimate of TF may be confounded by the effects of abortion; thus, the abortion estimates presented here may be too low. We explore this possibility by rearranging Bongaarts's model to isolate TF, using data presented in Bongaarts's 1982 analysis (including observed rather than estimated TFRs). For the developing countries in the analysis, Bongaarts used data from the mid-1970s. A residual value for TF of less than 15.3 would suggest that the fertility-reducing effects of a proximate determinant, such as abortion, were not included in the model.

If we assume that populations using contraceptives to limit fertility also turn to abortion, according to the data presented in Bongaarts 1982 analysis, women in two of the six countries, Colombia and Turkey, and to a lesser extent, those in Indonesia, Jordan and Peru would use abortion to reduce fertility. In Turkey and Colombia (the two countries in our study where abortion appears to have the strongest effect), the total fecundity rate, as estimated from Bongaarts's data, is lower than 15.3 (Turkey, 14.5; Colombia, 14.6), suggesting that abortion or the minor proximate determinants reduced fertility more in these countries than they did, on average, in all countries in the study, and that, in general, 15.3 could be an underestimate of TF.

In Indonesia, Jordan and Peru, the level of contraceptive prevalence suggests that

*Factors associated with early pregnancy loss are less likely to affect neonatal mortality, but are also less likely to vary between populations or over time, thus having little effect on our estimates.

the desire to control fertility existed, but was weaker than in Turkey or Colombia. We therefore expect abortion to have a slight effect on fertility in those countries. Because a low level of abortion is included in Bongaarts's estimated average of the total fecundity rate, we expect the country-specific estimates to be close to 15.3. In Indonesia, his estimated rate is 15.2, and in Jordan and Peru it is 15.9. The high estimates for Jordan and Peru imply that fertility-reducing factors not included in Bongaarts's model (abortion or the minor proximate determinants) have less of an effect than for all the studied countries as a group.

In Kenya in 1976, contraceptive use had a negligible effect on fertility. We suspect that abortion also had next to no influence on fertility. (Indeed, according to our estimates, abortion had no effect in Kenya in 1988–1989, but had a substantial effect in 1993.) As we calculate total fecundity from the data presented in Bongaarts's analysis, Kenya's total fecundity rate equals 15.9, implying that abortion or other minor proximate determinants had less of an effect in Kenya than in other countries for which data were collected in the 1970s.

The presence of some fertility-reducing effect of abortion in the estimate of average total fecundity would yield, in our residual estimation technique, an index of abortion that exceeds 1 in countries where the true incidence of abortion is negligible. Thus, an underestimate of total fecundity might partially explain the two values that exceed 1 in our analysis (Kenya 1988–1989, 1.01; Rwanda, 1.06). In both countries, the minimal use of contraceptives to limit fertility would be consistent with negligible use of abortion.

These examples suggest that the estimate of 15.3 for total fecundity includes some small effect of induced abortion, and that the use of 15.3 in our rearranged equation results in slight underestimates of the effect of abortion on fertility.* If the extent of this underestimation is not balanced by an overestimation caused by factors such as overlapping indices (for example, use of contraceptives while breastfeeding) or concurrent use of multiple contraceptive methods, our estimates will slightly underestimate the effect of abortion on fertility.

Conclusion

While the technique proposed here of rearranging Bongaarts's proximate determinants model to estimate indirectly an index of abortion is promising, it is not without limitations. As we discussed earlier in this article, some amount of measurement error associated with the principal proximate determinants contributes to the residual estimate of abortion. Furthermore, determinants not included in the model might contribute to the residual estimate. However, we found no statistically significant relationship in the expected direction between any of the minor proximate determinants and the residual estimate of abortion, suggesting that the fertility-reducing effects of the minor proximate determinants do not contribute substantially to the residual. Nevertheless, the proxies we developed may not capture existing relationships between the minor proximate determinants and the residual abortion estimate.

Despite these limitations, the estimates generated using this technique demonstrate believable international trends and differentials. Although abortion is illegal in all but one of the countries included in the analysis, the study results imply that in many countries women are resorting to illegal, possibly unsafe, means of inducing abortion. They indicate that abortion is widely used to control fertility; that the use of abortion is geographically clustered; that in settings where fertility is declining, abortion has an increasing influence over time; and that, on average, the fertility-reducing influence of abortion is similar in magnitude to that of contraceptive use, the other principal method of controlling fertility.

*It is reassuring, however, that in the residual estimation equation, the value of 15.3 can be replaced with values of 14 or 16 without having much effect on the resulting estimate of the index of abortion.

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Resumen

El análisis de los datos de las Encuestas Demográficas y de Salud ofrece cálculos indirectos sobre la prevalencia de aborto en 21 países en desarrollo. Esto se logra reordenando los determinantes inmediatos del modelo de Bongaarts para permitir el cálculo del índice de abortos usando los otros tres principales determinantes inmediatos de la fecundidad (matrimonio, uso de anticonceptivos y falta de susceptibilidad al embarazo), más el promedio de la fertilidad total y la fecundidad global. En promedio, el aborto parece influir en la fecundidad en forma similar al uso de anticonceptivos. Esta influencia parece ser particularmente sólida en los cuatro países latinoamericanos estudiados, donde el aborto reduce la fecundidad en un 38–55%. Por el contrario, el efecto del aborto en la reducción de la fecundidad es solamente del 6–19% en el Medio Oriente y del 0–32% en el Africa. En cinco países de los que se dispone de dos juegos de datos de la EDS, este efecto de reducción debido al aborto parece haber aumentado a través del tiempo.

Résumé

Une analyse des données d'Enquêtes démographiques et de santé (EDS) procure une estimation indirecte de la prévalence de l'avortement dans 21 pays en voie de développement, par le réarrangement du modèle de déterminants immédiats de Bongaarts pour permettre le calcul de l'indice d'avortement en fonction des autres principaux déterminants immédiats de la fécondité (le mariage, la pratique contraceptive et l'insusceptibilité du post-partum à la grossesse), de l'indice synthéthique de la fertilité moyenne et de l'indice synthétique de la fécondité. En moyenne, l'avortement semble exercer sur la fécondité une influence comparable à celle de la pratique contraceptive. Cette influence semble particulièrement forte dans les quatre pays d'Amérique latine soumis à l'analyse, où l'avortement réduit la fécondité de 38 à 55%. Par contre, l'effet amoindrissant de l'avortement sur la fécondité se limite à une plage de 6 à 19% au Proche-Orient et de 0 à 32% en Afrique. Dans les cinq pays pour lesquels deux ensembles de données EDS sont disponibles, cet effet réducteur semble avoir augmenté avec le temps.