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A NEW APPROACH TO ESTIMATING ABORTION RATES

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MEASURE DHS assists countries worldwide in the collection and use of data to monitor and evaluate population, health, and nutrition programs. Additional information about the MEASURE DHS project can be obtained by contacting Macro International Inc., Demographic and Health Research Division, 11785 Beltsville Drive, Suite 300, Calverton, MD 20705 (telephone: 301-572-0200; fax: 301-572-0999; e-mail: reports@macrointernational.com; internet: www.measuredhs.com).

The main objectives of the MEASURE DHS project are:

- to provide decisionmakers in survey countries with information useful for informed policy choices;
- to expand the international population and health database;
- to advance survey methodology; and
- to develop in participating countries the skills and resources necessary to conduct high-quality demographic and health surveys.

DHS Analytical Studies No. 13

A New Approach to Estimating Abortion Rates

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Preface

One of the most significant contributions of the MEASURE DHS program is the creation of an internationally comparable body of data on the demographic and health characteristics of populations in developing countries.

The *DHS Comparative Reports* series examines these data across countries in a comparative framework. The *DHS Analytical Studies* series focuses on analysis of specific topics. The principal objectives of both series are to provide information for policy formulation at the international level and to examine individual country results in an international context.

While *Comparative Reports* are primarily descriptive, *Analytical Studies* comprise in-depth, focused studies on a variety of substantive topics. The studies are based on a variable number of data sets, depending on the topic being examined. A range of methodologies is used in these studies including multivariate statistical techniques.

The topics covered in *Analytical Studies* are selected by MEASURE DHS staff in conjunction with the U.S. Agency for International Development.

It is anticipated that the *DHS Analytical Studies* will enhance the understanding of analysts and policymakers regarding significant issues in the fields of international population and health.

Ann Way
Project Director

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Abstract

This paper presents a method to estimate induced abortion rates in different countries based mainly on regression equations featuring contraceptive prevalence and total fertility. For the more developed countries with presumably reliable abortion reporting, the first equation shows an extremely close fit. The principal predictor is the proportion of married women using modern methods of contraception. For less developed countries, other equations depend mainly on both modern method use and total fertility and are more questionable since reliable external estimates of abortion are less available. Estimates of abortion rates are nevertheless presented for a large number of less developed countries, based on recent data on contraceptive prevalence and fertility from a variety of sources.

1

Introduction

This paper is an attempt to develop a useful procedure to estimate abortion rates for different countries of the world where such information is lacking. Why is this a desirable goal? First, induced abortion is a subject of interest for reproductive health since unsafe abortion is associated with maternal mortality and other health concerns. Second, abortion is strongly associated with the absence of modern contraceptive use. As modern contraceptive prevalence increases, abortion rates decline.

The almost complete lack of information on the prevalence of abortion in developing countries is an important rationale for this effort. Where reliable data on abortion exist, in the more advanced countries of the Eastern European and Eurasia regions for example, it has been possible to analyze the impact of family planning programs on reducing abortion. Where such estimates do not exist, it is only possible to hypothesize. For example, in West Africa there are instances, e.g. Cameroon, where fertility was declining in advance of increases in modern contraceptive prevalence. In other instances, such as recently in Ghana, increased modern contraceptive prevalence has not been met with a commensurate decline in fertility. In both cases, abortion may be the missing explanatory factor. But without reliable data, this remains a hypothesis. To the extent that reducing abortion has become a key rationale for family planning programs, the ability to analyze this impact is a desirable goal.

Population research has indicated that abortion rates are an extremely difficult demographic measure to estimate accurately, either because of the inadequacy of registration systems or because of the reluctance of women to report such events fully in surveys, or some combination of the two (Jones and Kost, 2007; Jagannathan, 2001; Lara et al., 2004; Philipov et al., 2004). The approach described below is a straightforward and simple method for estimating abortion rates that seems promising. The objective is solely the estimation of rates for populations, not the analysis of the numerous covariates of abortion for individuals.[1]

The procedure is based on a previously documented strong correlation between the contraceptive prevalence rate and the abortion rate estimated for countries where some confidence can be placed in the completeness of abortion reporting (Westoff, 2005; Marston and Cleland, 2003). This earlier work showed a very high negative correlation (-.92) between the use of modern methods of contraception (MOD) and the total abortion rate (TAR) and a strong positive association (.55) between the use of traditional methods (TRAD) and the TAR. These results, however, were based on only 18 countries mainly in Eastern Europe and Central Asia. The present work expands this approach to include more observations and a wider geographic coverage. The additional countries were chosen on the basis of expert judgments about the quality of the abortion data.

The updated data set, with 59 observations (15 of which are for the same country at different times[2]) shows the same patterns of association with the TAR as the earlier study (see Figures 1 and 2) with correlations of -.95 with the use of modern methods, and .79 with the use of traditional methods. The change in

[1] In countries where contraceptive prevalence and fertility are estimated for regions and socio-economic strata, estimates of abortion for sub-national populations can also be derived.

[2] The inclusion of two observations for the same country does not inflate the correlation.

Figure 1. Total abortion rates and the prevalence of modern contraceptive methods in 59 countries

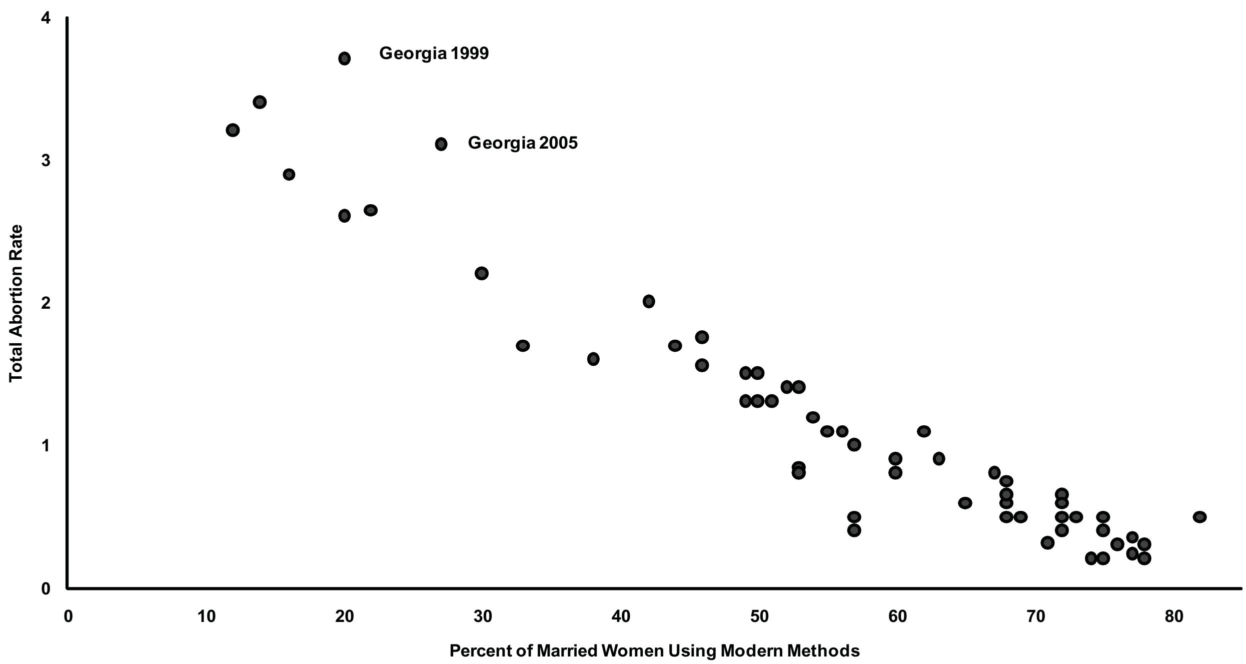
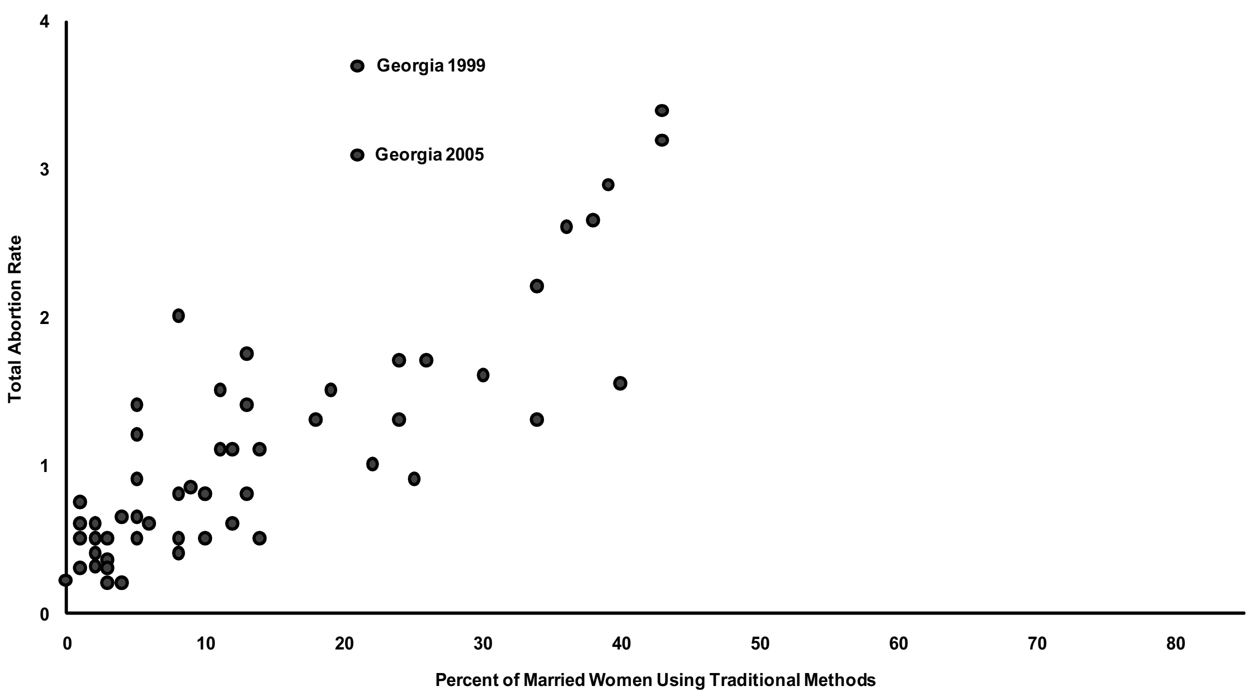


Figure 2. Total abortion rates and the prevalence of traditional contraceptive methods in 59 countries



the direction of the association reflects the high failure rate with the use of traditional methods (mainly withdrawal). These 59 observations are predominantly in the more developed world, with some Asian and South American representation where there is some confidence in the abortion estimates, but no countries from sub-Saharan Africa or from the least developed countries elsewhere.

The regression equation with both MOD and TRAD along with the Total Fertility Rate (TFR) shows the same very high correlation with the TAR (Equation 1) as with MOD alone. In fact, MOD alone accounts for almost all of this explained variance of the TAR (Equation 2)[3] and by itself would be a simple way of estimating the abortion rate, but *only* in developed countries where both TRAD and the TFR are low. One problem (addressed below) is that these equations yield predicted abortion rates that are implausibly high for the less developed countries.

(1) TAR = 4.41 - .052(MOD) - .010(TRAD) - .110(TFR)

N =59 R = .95

(2) TAR = 3.69 - .046(MOD)

N=59 R = .95

[3] The correlation between MOD and TRAD in these countries is -.85.

2

Data

The data on abortion used as the criteria for the estimating equations are from a variety of sources. A principal source is the abortion surveillance program of the Guttmacher Institute and the work of Stanley Henshaw (Henshaw et al., 1999) updated in 2007 (Sedgh et al., 2007) who continued the work begun by Christopher Tietze of The Population Council (Tietze and Henshaw, 1986 and earlier versions). The second source is the survey programs of DHS and CDC in countries where abortion is believed to be reliably reported, mainly in eastern Europe and Central Asia, where abortion had long been the principal method of birth control and apparently has been free of the social stigma present elsewhere. The third source, which includes data for several Latin American countries and a few African countries, is based on research also from the Guttmacher Institute, where estimates were developed from hospitalization records.

The 59 observations plus the Guttmacher estimates for some other countries where abortion reporting is uncertain bring the total to 67 observations (listed in Appendix A). These are the basis for the regression Equations 3 and 4 that yield a lower correlation of .88 than the .95 in the preceding equations.

(3) TAR = 3.43 - .036(MOD) + .010(TRAD) - .244(TFR)

N=67 R=.88

Since TRAD has such a small coefficient here that is not statistically significant, Equation 3 can be simplified without any loss of predictive power in Equation 4.

(4) TAR = 3.99 - .042(MOD) - .308(TFR)

The Guttmacher estimates of abortion rates for 12 countries, based on adjusted hospitalization data, are shown in Col. 1 of Table 1 in comparison with estimates from three regression equations. The first regression-derived estimate in Col. 2 is based on the predicted values from Equation 1 with 59 observations. Comparison of these predicted values with those from the Guttmacher studies indicates similar values for the six Latin American countries, with the exception of Guatemala, but different values for the other six countries. The six Latin American countries, excluding Guatemala, have been included in the equation for the 59 countries, but the close fit also appears when the prediction equation excludes them.

Since the Guttmacher estimates are all for developing countries, an estimation equation based solely on such countries is more appropriate. Some of the Guttmacher estimates are for very low-income countries in Asia and Africa, while others in Latin America are for countries much further along in the development process. A classification of all 67 countries/surveys based on per capita income shows 33 in the most developed group, 26 in the middle development group, and 8 in the least developed countries. These eight are: Bangladesh, China (in 1985), Egypt, Guatemala, Nigeria, Pakistan, Philippines, and Uganda.

Income is a relevant covariate of abortion as indicated in Equation 5:

(5) $TAR = 4.41 - .030(MOD) + .011(TRAD) - .282(TFR) - .140(logINCOME)$

$N = 67 \quad R = .89$

Since the eight countries in the least developed category are an insufficient number on which to build an estimating equation, they have been combined in Equation 6 with the middle group for a total of 34 developing countries. This category excludes the 34 most developed countries where abortion is legal and the data on abortion the most reliable and results in a correlation of .83, considerably lower than the .95 in Equations 1 and 2 based on both the most developed and the more advanced developing countries.

(6) $TAR = 3.63 - .033(MOD) + .009(TRAD) - .333(TFR)$

$N = 34 \quad R = .83$

Again, as in Equation 3, the inclusion of TRAD contributes little to the prediction and can be deleted with no loss of power in Equation 7.

(7) $TAR = 4.09 - .037(MOD) - .386(TFR)$

The predicted values from Equation 6 are shown in Col. 3 of Table 1. The correspondence with the Guttmacher estimates is a little closer for the least developed countries although there is now a greater difference for a few of the more developed countries, such as Brazil and the Dominican Republic, as well as for Uganda. Unlike the estimates for sub-Saharan African countries, this version yields lower and more credible values of abortion rates than Equation 1. Although more credible than the prediction from the equation for the more developed countries, there is no way of knowing how close these estimates are to the true prevalence of abortion for the least developed countries.

Toward the end of this paper (see “Estimates of Current Abortion Rates”), where TAR estimates for these countries based on the most recent data are presented (Table 2), we use the estimating equation for the less developed countries in general (Equation 6) along with Equation 10 which adds education.

Although there are large differences in some of the TARs estimated from the Guttmacher studies based on hospitalizations compared with the regression estimates, one could argue that the hospitalization approach might yield underestimates in some countries or, more precisely, that the multipliers developed on the basis of medical judgments might be too low in the least developed countries. In all fairness, the Guttmacher estimates come with wide ranges of highs and lows that frequently encompass the regression estimates.

Table 1. Total abortion rates estimated from regression analyses compared with Guttmacher Institute estimates from hospitalization data

Country	Year	Guttmacher Estimate	Regression Estimates		
			Eq. 1	Eq. 6	Eq. 9
Brazil	1991	1.2	1.1	0.7	0.7
Colombia	1990	1.1	1.1	1.0	1.1
Dominican Republic	1990	1.4	1.3	0.9	1.4
Mexico	1990	0.8	1.1	0.7	1.0
Peru	1996	1.5	1.3	1.2	1.3
Guatemala	2003	0.7	2.0	0.9	1.2
Bangladesh	1995	0.8	1.8	1.3	0.9
Pakistan	2002	0.9	2.7	1.7	0.9
Philippines	2000	0.8	2.3	1.6	1.6
Egypt	1996	0.7	1.2	1.0	0.7
Nigeria	1996	0.8	3.4	2.0	1.0
Uganda	2002	1.7	2.7	0.8	1.4

An easy test of the plausibility or reasonableness of Equation 6 or 7 was suggested by John Bongaarts in personal correspondence reacting to an earlier draft of this paper. Think of a population with only natural fertility, say a TFR of 8.0 and zero contraceptive prevalence. The estimate of the TAR for such a population would be 1.0 which may be on the high side but not completely unlikely. (If the TFR were 10, the estimated TAR would be 0.3). The estimated TAR for Niger in 2006 which has minimal contraceptive practice (MOD is 5 percent and TRAD is 6 percent) is 1.2; with education added, it is 1.0. This estimate may be high but who knows? Uganda in 2006 had a TFR of 6.5 and an estimated TAR of 1.3. Considering that the Guttmacher estimate for Uganda in 2002 was 1.7, the 1.3 does not seem high.

2.1 Other Data Quality Issues

Unlike the quality of data on abortions, there is little reason for questioning the validity of the estimates of contraceptive prevalence and the fertility rates. The measurement of these parameters now has a rich history and the estimates included here are drawn from numerous national surveys in the DHS and CDC programs (United Nations, 2000 and 2004) and some other national surveys. In many developed countries the fertility information is from national registration systems. Since abortion rates and fertility rates are based on all women (of reproductive age) while contraceptive prevalence is most often reported for married women of reproductive age, an effort was made to determine whether the prediction of abortion rates is affected if the contraceptive prevalence rate (CPR) is calculated for all women. For the small number of developing countries (23) with available data, however, there is no difference in the correlation of the two alternative measures with the TAR. So, given the limited availability of data for all women, it does not seem fruitful to pursue this direction.

One interesting case relates to the quality of the reporting of contraceptive prevalence in China where MOD is reported at 90, the highest in the world (the closest is the UK for 2005/06 at 82). A MOD of 90 with a TFR of 1.4 would imply at TAR of 0.2 which is lower than the reported rate of 0.5. It seems more likely that, in light of the strong pressures by the Chinese family planning program, MOD is more over-reported than is the TAR.

2.2 Contraceptive Failure and Discontinuation

The estimating equations rely on contraceptive prevalence but do not take contraceptive failure into account. Data on failure rates by method are increasingly available from surveys, at least those surveys that include monthly calendars of contraceptive practice. Unfortunately, this excludes most sub-Saharan African countries. For developing countries where such information is available by individual methods (see Appendix B), we have calculated total failure rates as well as separate estimates of failure rates for modern and traditional methods. We focus here on 29 developing countries where such estimates are available but also include seven countries where average failure rates from reported data are applied.

For the 29 countries the average failure rate (based on failures in the last 12 months) for modern methods is 3.1, and 17.9 for traditional methods (rhythm and withdrawal). The most commonly used modern methods are the IUD and female sterilization. The overall failure rate is 7.9. If we focus on this total failure rate, we find that its inclusion in an equation estimating the TAR from the CPR and TFR increases the correlation from .54 to .87.

The next step was to modify the main equation (Equation 6) by including information on failure rates for MOD and TRAD separately. This took the form of subtracting the country-specific failure rates from the prevalence estimates and re-estimating the regression equation. The interpretation then becomes the level of effective MOD and TRAD contraceptive practice. This made little difference, however, in the prediction of the TAR compared with Equation 6.

The conclusion is that the addition of information on the effectiveness rates for MOD and TRAD does not improve the correlation with the TAR. The inclusion of rates of discontinuation of use for reasons other than failure and desire to become pregnant makes only a slight difference. The reasons for discontinuation include side effects, husbands' objections, religious objections, inconvenience and others. These add to more than twice the discontinuation because of method failure. Its inclusion raises the correlation of the TAR with MOD and TFR from .90 to .93 but there are only 17 observations with such information available along with the TAR.

2.3 Other Interesting Cases

In several countries the predicted TARs seem more accurate than the reported rates, even where data on abortions are more trustworthy. For example, the published TAR for Armenia in 2005 is 1.8 while the predicted value is 2.7. Considering that the reported TAR in 2000 was 2.6 and that neither the TFR nor MOD changed over the period, the reported sharp decline in the TAR seems suspicious. The authors of the Armenia DHS report also are skeptical of this apparent decline and believe that there has been significant under-reporting of abortions in the 2005 survey. They attribute the under-reporting to the recent introduction of an over-the-counter synthetic prostaglandin that may be reported as a menstrual regulation procedure rather than as an abortifacient that may have been its intended but unreported use (National Statistical Service [Armenia] et al., 2006).

Azerbaijan is similar. The reported TAR declined from 3.2 in 2001 to 2.3 in 2006. However, the TFR did not change and MOD increased by only four percentage points. The TAR estimated from the regression equation is 2.8, which seems more credible. The authors of the 2006 report are also puzzled by the extent of this apparent decline. They explore various possible explanations but reach the conclusion that under-reporting of abortion in the later survey is the most likely explanation. An increase in anti-abortion campaigns may lead women "to feel an increased reluctance to openly answer questions about abortion." Another possibility suggested in the report is the increased use of menstrual regulation procedures (as in Armenia).

The case of Moldova is less clear. The reported decline of the TAR from 1.3 in 1997 to 1.1 in 2005 though small is inconsistent with a *decline* in MOD from 50 to 44 percent. The exclusion of one of the provinces (Transnistria) in the later survey does not change the picture substantially. The estimated TAR for the country for 2005 is 1.7, which may be too high, but an increase rather than a decrease in abortion seems more plausible.

The estimated TAR for Albania in 2002 is in the range of 2.6 to 3.0 which is quite high. In the CDC 2002 survey, abortion data were collected but were so under-reported (estimated to be by 50 to 77 percent) that the authors of the survey report declined to publish a rate (Morris et al., 2005). Albania is an interesting country demographically, one in which the TFR, once the highest in Europe, declined rapidly to 2.6 in 2000-02 and by 2006 was reported to be 1.8, but where the principal method of contraception is withdrawal, at 67 percent, with MOD at only 8 percent. Given the high prevalence and failure rate of withdrawal and the low TFR, the high estimated TAR is not implausible.

2.4 The Proximate Determinants Approach to Estimating Abortion Rates

Another approach to estimating abortion rates that was explored before developing the regression approach described here is derived from the well-known "proximate determinants" formula. Developed by Bongaarts and Potter (1983) to quantify the components of total fertility, the equation can theoretically yield estimates of abortion as the residual when the other main determinants of fertility (mainly marriage, contraceptive prevalence and postpartum infecundity) are accounted for. An extensive review of this approach which includes estimates of the abortion component for 26 developing countries/ surveys along with a complete discussion of its weaknesses was published in 1996 (Johnston and Hill). A comparison of the TARs estimated from this procedure for a set of 10 of these countries indicates an average TAR of 3.1 compared with 1.2 from the regression approach. The lower figure seems much more plausible especially in countries where fertility is very high, abortion is illegal and medical facilities are inadequate. The pitfalls of this procedure are numerous and serious (Rossier, 2003) and there seems to be little justification for using this approach for which the original proximate determinants formulation was not intended.

A more recent use of the proximate determinants model to deduce abortion rates is for Iran (Erfani and McQuillan, 2008), from which the authors estimate a TAR of 0.26. The closest regression approach yields an estimate of 0.9. Their estimate places the abortion rate for Iran at the very bottom of 13 countries in that geographic region. They calculate abortion rates of zero for 10 of 29 provinces of Iran, while the lowest estimate from the regression approach is 0.5. The correlation between the two estimated values for the 29 provinces is .80, however, which suggests a similar track, but the magnitudes are very different.

2.5 Son Preference and Abortion

India, where preference for sons is known to be widespread, provides an indirect opportunity to evaluate the validity of the abortion prediction equation. The widespread use of ultrasound technology to determine fetal gender which may lead to sex-selective abortion is well known. The measure of son preference in the 2006-07 DHS and in the 1998-99 DHS used here is the percentage of women who want more sons than daughters. The estimating equation selected for abortion rates is based on the 26 less developed countries but excludes the eight least developed countries in our study (see "Data" on page 4):

(8) $TAR = 4.09 - .046\,(MOD) - .177\,(TFR)$

$N = 26 \quad R = .94$

A data set with estimates of the TAR along with the measure of son preference has been created for the 29 provinces in India in 2006-07 (25 in 1998-99). For both surveys, there is a considerable difference in the estimated TARs for the extreme cases. In 2006-07, the province of Tamil Nadu shows the smallest son preference (6 percent of women wanting more sons than daughters) with an estimated TAR of 1.0. The province of Bihar has the highest son preference (39 percent) and an estimated TAR of 2.0. In 1998-99, Tamil Nadu also had the lowest son preference (10 percent) with an estimated TAR of 1.4 while Uttar Pradesh had a son preference of 53 percent and an estimated TAR of 2.4. The correlation between these two variables is .36 for 2006-07 and .46 for 1998-99. Son preference is negatively associated with literacy (-.60).

Another available measure with some relevance to abortion, using 2006-07 India DHS data, is the percentage of women who report having had a non-live birth in the past five years, which includes miscarriages, abortions and stillbirths. These data are admittedly subject to under-reporting which may be particularly serious for induced abortions. The correlation of the measure with the estimated abortion rate is .37, not very high but consistent with expectation.

Since we know that abortion and contraceptive failure are strongly related (Westoff and Serbanescu, 2008), one would expect a positive correlation in the provincial data. The measure here is the percentage of women who discontinued the use of any modern contraceptive method within a 12-month period. The correlation with the estimated abortion rate for the 29 provinces is .56. Unfortunately, this measure includes discontinuation not only for method failure but also for side effects, to become pregnant, and other reasons.

These findings indirectly increase confidence in the validity of our formula to estimate abortion rates.

2.6 Other Possible Dimensions of Abortion

As shown earlier, in the more developed countries the very high correlation of abortion rates with the three predictors MOD, TRAD and TFR is almost exclusively due to MOD. The other two predictors, TRAD and TFR, only become relevant when the least developed countries are included. The role of the TFR in this equation requires some discussion.

For many of the least developed countries, there is still little contraceptive practice and especially little use for purposes of limiting births rather than for spacing. Most of the resulting high fertility is more or less intended. The three predictors do not adequately capture the extent to which there is a demand for limitation among the large proportion of nonusers that theoretically could lead to abortion. We do know from other research (Westoff, 2006) that there is an unmet need for family planning in sub-Saharan Africa, although this is predominantly for the spacing of births rather than for limiting. In Asia, Latin America, and the Near East and North Africa, the overall level of unmet need is lower than in sub-Saharan Africa but is greater for limiting births than for spacing.

In an effort to measure some of this potential demand among nonusers, four additional variables have been considered: the level of total unmet need, unmet need for limiting, the percent of married women who want no more children, and the ideal number of children among women 20-34 years of age. There are numerous problems in including these measures such as lack of information for many of the developed countries and lack of comparability of definitions in different surveys. In any event, an analysis of their association with the TAR or with the predicted TARs does not enhance the predictability of abortion probably because these additional measures mostly exclude the representation of the more developed countries in the analyses. In the subset of the less developed countries, the unmet need for limiting shows some association with abortion but the overall level of unmet need shows little association with either the observed or the predicted abortion rate. The number of children considered ideal shows a negative association with abortion as does the TFR, since they are highly correlated, and does not show a significant relationship when included in the same equation with the TFR.

Another variable that might relate to the abortion rate particularly in developing countries is postpartum insusceptibility (postpartum amenorrhea and abstinence). Long durations of postpartum insusceptibility would be expected to act as a form of fertility regulation. We have estimates for 25 developing countries, and the median duration of insusceptibility shows a correlation of -.48 with the TAR. When the TFR is included in the regression, however, the effect of insusceptibility becomes insignificant.

A more demanding estimation equation for developing countries incorporates the unmet need[4] for limiting measure (LIMIT) as well as the proportion of women ever married (MARR) and indices of education, both the proportion of women with no education (NOED) and the proportion with secondary or higher education (SEC).

(9) TAR = 2.29 - .035(MOD) - .397(TFR) - .037(NOED) - .013(SEC) + .028(LIMIT) + .039(MARR)

N = 28 R = .94

Estimates of the TAR based on this equation are shown in the last column of Table 1. The fit with the Guttmacher estimates is closer than those from Equation 6 with several exceptions. Indeed, the overall correlation of .94 is considerably higher than the correlation of .83 in Equation 6 but the usefulness of Equation 9 is severely limited by the data demands it imposes.

One problem is for Georgia in 2005 (see Figure 1), where the reported TAR in the CDC survey was 3.1, possibly the highest abortion rate in the world. Our closest estimate is 2.7. There is no obvious explanation. The two outliers in Figures 1 and 2 are both for Georgia for 1999 and 2005. The abortion rates should be lower if determined only by contraceptive prevalence, which although not very high (in 2005, MOD was 27 and TRAD 21) would not typically be compatible with such a high TAR. This suggests that unmeasured covariates of abortion beyond contraception are involved. Indeed, the estimates based on Equation 9 exactly predict the TARs for both Georgia surveys. Contraceptive failure rates may play a role. The 2005 Georgia survey indicates one-year failure rates of 5 percent for modern methods and 21 percent for traditional methods. If contraceptive failure is taken into account, the estimated TAR for Georgia in 2005 is 2.9. There are also high one-year rates of contraceptive discontinuation in Georgia, averaging 32 percent for MOD and 40 percent for TRAD.

In sum, none of these additional measures contributes to the basic prediction equations either because they are not available for many of the countries or because they are largely redundant with the major predictors. Not all of the determinants of abortion can be easily measured. These are discussed at length in an earlier article (Bongaarts and Westoff, 2000). It is important to keep in mind that our principal estimating procedure only includes contraception and fertility. The inclusion of the TFR presumably captures some of the unmeasured demand for children among nonusers.

There is also a different question of how much the addition of information on abortion increases the correlation of the CPR and the TFR, a question addressed in Appendix D.

[4] A further exploration of the association of unmet need with abortion, based on provincial data is described in Appendix C.

3

Estimates

Given all the uncertainties, it is no doubt risky to estimate abortion rates for a large number of less developed countries. For whatever its worth, such estimates are shown in Table 2 based on Equation 6 as well as on Equation 10 (discussed below). These are for the most recent data available. At this stage of the research, they are the most likely estimates of the abortion rate. The estimates may still be somewhat high but are within the realm of plausibility.

Table 2. Total abortion rates for less developed countries estimated from Equations 6 and 10

Country	Year	(6)	(10)	Country	Year	(6)	(10)
Albania	2002	3.0	2.6	**Malawi**	2004	0.8	0.8
Azerbaijan	2006	2.8	2.9	**Mexico**	2004	1.0	0.9
Bangladesh	2004	1.3	0.8	**Nepal**	2006	1.2	0.9
Brazil	2005	0.7	0.5	**Niger**	2006	1.2	1.0
Cambodia	2005	1.7	1.4	**Nigeria**	2003	1.5	1.3
Cameroon	2004	1.7	1.5	**Pakistan**	2006-07	1.6	1.4
China	2003	0.4	0.4	**Peru**	2004-05	1.3	1.4
Colombia	2005	0.7	0.6	**Philippines**	2003	1.5	1.7
Cuba	2004	0.9	1.0	**Saudi Arabia**	1995-2000	1.2	1.2
Egypt	2005	0.8	0.7	**Senegal**	2005	1.6	1.4
Ghana	2003	1.6	1.4	**South Africa**	2003	0.9	1.0
Haiti	2005-06	1.5	1.3	**Syria**	1995-2000	1.4	1.4
India	2005	1.0	1.0	**Tanzania**	2004	1.3	0.9
Indonesia	2003	0.9	0.8	**Uganda**	2006	1.3	1.0
Iran	2000	1.2	0.9	**Yemen**	2005	1.2	1.2
Jordan	2002	1.2	1.2	**Zambia**	2001-02	1.1	0.8
Kenya	2003	1.1	1.1	**Zimbabwe**	2006	0.5	0.5

(10) TAR = 2.94 - .033(MOD) - .252(TFR) + .091(YRSEDUC)

N = 31 R = .86

In Equation 10 the education variable added is the average number of years of schooling for females aged 15 and over in developing countries. These data are derived from both the DHS household tabulations and another compilation for a large number of countries (The World Bank, 2008). The correlation between the TAR and YRSEDUC for developing countries is .59. Very similar results are observed using female literacy rates, which are more widely available.[5] The literacy measure is less attractive than years of schooling, however, because so many countries have universal literacy.

[5] The measure used is based partly on the Population Reference Bureua (PRB) 1998 Women of our World data sheet showing the percent of women aged 15+ who are literate. The regression equation for the developing countries is: TAR = 2.62 - .037 (MOD) - .237 (TFR) + .013 (LIT) based on 33 observations with a correlation of .86.

The estimates of abortion rates based on Equation 10 are quite similar to those based only on Equation 6 and shows a slightly higher correlation. The estimates of the TAR with education included are probably closer to reality. Considering the kinds of measurement error and time disjunctions involved, the high correlations are remarkable although the small number of observations needs to be kept in mind. Given the greater convenience of making estimates based on Equation 6 or 7, it seems preferable to rely on them instead of on Equation 10, with the likelihood that the TAR is being somewhat overestimated in many countries. (A set of model estimates based mainly on Equation 7 appears in Appendix D).

3.1 Urban-Rural and Educational Differentials

The typical DHS survey includes estimates of contraceptive prevalence and fertility for various subdivisions of the national population and thereby permits the estimation of abortion rates. Such estimates have been made for urban and rural areas and for several categories of educational attainment. Two important reservations are in order: First, the estimates rely only on the basic equation for the national rates in developing countries (Equation 7). Second, the sampling error for subdivisions of the population are greater than for national totals. Thus, the results of this exercise should be viewed primarily as an effort to elicit the general picture of the association of abortion with residence and education.

In Figure 3 the estimated TARs are depicted for urban and rural residents for three groups of 34 developing countries. In 28 of the 34 countries the estimated TAR is higher for women in cities than in rural areas, 4 are the same, and only 2 of the 34 countries show a higher rate in rural areas.

The pattern by education (Figure 4) is less clear but the estimated TARs are mostly higher for women with secondary or higher education. In 25 of 32 countries the rate is highest among the most educated women. There is little difference for women who have no education compared with women with primary education.

At the extremes, TARs in 37 developing countries for rural women with no education average 1.1 compared with an average of 1.5 for urban women who have had at least some secondary education.

In sum, abortion rates are estimated to be highest in urban areas and among women with the most education. These tend to be associated with the subcultures in which fewer children are preferred.

Figure 3. Estimated average total abortion rates by urban-rural residence

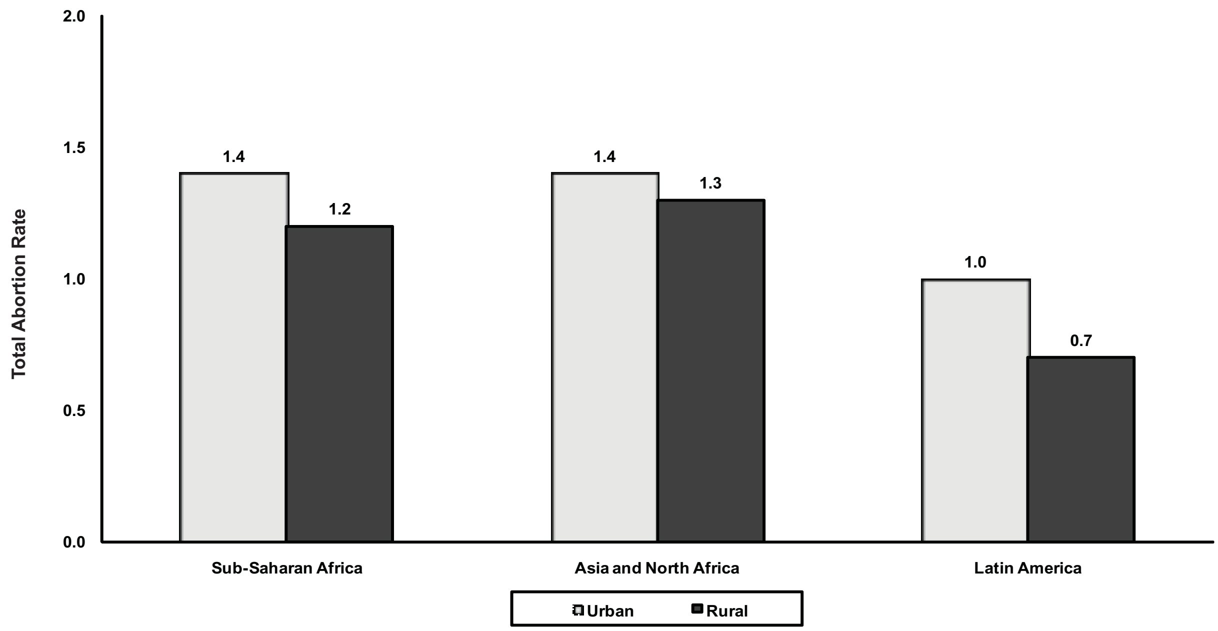
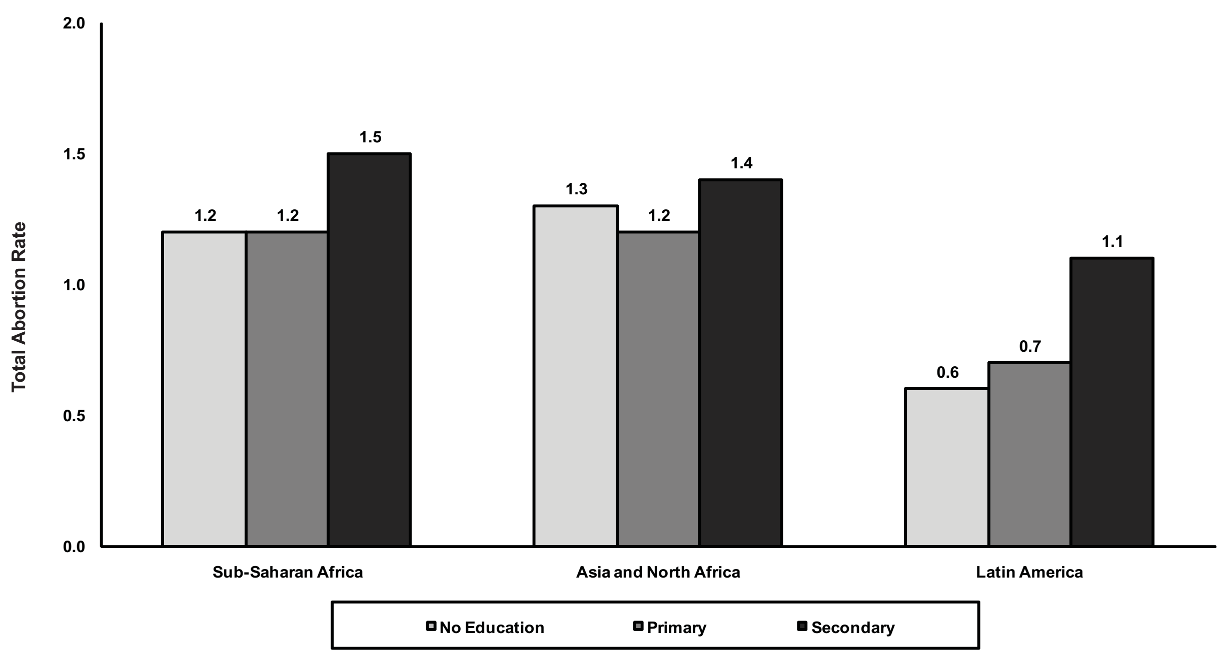


Figure 4. Estimated average total abortion rates by highest educational attainment



3.2 Comparisons with World Regional Estimates

New estimates of abortion rates for the period around 2003 have recently been published in a study by the Guttmacher Institute research staff and the World Health Organization (WHO) (Sedgh et al., 2007). These estimates permit additional comparisons for different regions of the world. These new estimates are based on a variety of methods and sources that include official registration data, sample survey estimates, hospitalization studies, and published reports. A comparison of these estimates with those from the relevant regression equations is shown in Table 3. For the world as a whole, there is no difference - a TAR of 0.9 from both the Guttmacher-WHO calculations and from the regressions. There also is little difference between the aggregated developed and the developing countries.

A major difference is evident, however, for Southern Europe where Italy and Spain are the most populous countries (39% and 28% of the Southern Europe total respectively). The regression estimate for the TAR is much higher than the Guttmacher-WHO reported rate. Italy is particularly problematic where the application of Equation 1 yields a TAR for 2003 much higher than the 0.3 from the registration system. Considering that Italy has one of the lowest TFRs in the world (1.3) and comparatively has a very low MOD (41), a higher abortion rate than the official estimate would seem likely. A MOD value of 75 rather than 41 would be necessary for the equation to yield a TAR of 0.3. Moreover, Italy has a very high TRAD with the use of withdrawal which has long been the most common method among Italian married couples and which has a high failure rate. Adding per capita income and years of education to the prediction equation for developing countries yields the closest approximation for Italy, with an estimated TAR of 0.8 - more than twice as high as the reported rate.

Some have argued that withdrawal can be used effectively (Santow, 1993) or that Italians in particular use withdrawal more effectively (Castiglioni et al., 2001) but it remains a matter of interest and speculation about "how is it possible to reconcile the relatively backward forms of contraception used by married women in Italy with such contained rates of fertility and contraception" (Dalla Zuanna, 2005).

Two other countries in Southern Europe - Albania and Greece - are thought to have high abortion rates. As noted earlier, Albania relies almost entirely on withdrawal. In Greece almost half of the CPR of 61 is for use of "natural" methods, mostly withdrawal. The reported TAR is 0.7 while the estimate is more than twice that level. Either Southern Europe just does not "fit" the general European model or some of the reported abortion rates are too low.

The question becomes how many abortions lie outside the legal registration system. Although abortion was legalized in Italy in 1978, a significant number of clandestine abortions occur. One estimate by the Ministry of Health for 1993 (cited in Bettarini and D'Andrea, 1996) is that 50,000 clandestine abortions were performed in addition to the 140,000 officially reported abortions. Even with this upward adjustment, the TAR would still be much lower than the regression estimate[6]. The prevalence of clandestine abortion is obviously impossible to gauge accurately but it may be high in Italy, where recently it was reported that "nearly 70 percent of Italian gynecologists now refuse to perform abortions on moral grounds, according to the Health Ministry" (Agence, 2008).

A less extreme difference is evident in Spain. The official TAR is 0.4 while the closest regression estimate is 0.6. One estimate (Lete et al., 2003) is that 29 percent of pregnancies in Spain are unwanted.

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[6] The estimates for Italy and Spain have not been included in Figure 1 or in the estimating equations.

Abortion rates have been much higher in Western Asia where a similar large difference between the two estimates is apparent. The rates estimated from the two sources are essentially the same for Northern America as well as for Latin American and the Caribbean. Within Africa the regression approach yields higher abortion rates in Northern, Middle, and Western Africa.

In East Asia, the regression estimate is lower than the Guttmacher-WHO figure. Part of this difference is because MOD seems over-reported in China which comprises 90 percent of the East Asian population. The various differences cannot be understood without information about the individual countries included in the Guttmacher-WHO calculations which is not available in the published article.

Table 3. Comparisons of Guttmacher-WHO recent estimates with the regression estimates* of Total Abortion Rates: 2003

	Regression	Guttmacher-WHO	Difference		Regression	Guttmacher-WHO	Difference
World	0.9	0.9	0.0	**Europe**	1.1	0.8	0.3
Developed	0.9	0.8	0.1	Eastern Europe	1.6	1.3	0.3
Developing	1.1	0.9	0.2	Northern Europe	0.5	0.5	0.0
Africa	1.3	0.9	0.4	Southern Europe	1.5	0.5	1.0
Eastern Africa	1.2	1.2	0.0	Western Europe	0.4	0.4	0.0
Middle Africa	1.5	0.8	0.7	**Northern America**	0.6	0.6	0.0
Northern Africa	1.2	0.7	0.5	**Oceania**	0.8	0.5	0.3
Southern Africa	0.8	0.7	0.1				
Western Africa	1.5	0.8	0.7	**Latin America & Caribbean**	0.8	0.9	-0.1
Asia	0.9	0.9	0.0	Central America	0.9	0.8	0.1
East Asia	0.5	0.8	-0.3	Caribbean	1.0	1.0	0.0
South Central Asia	1.2	0.8	0.4	South America	0.8	1.0	-0.2
Southeast Asia	1.1	1.2	-0.1				
Western Asia	1.6	0.7	0.9				

* Estimates for all of Africa, Asia, Latin America and the Caribbean, and the total developing countries total are based on Equation 7. For the world total and for Oceania, the estimates are based on Equation 3. For the most developed countries the estimates are based on an equation similar to Equation 1 (confined to the 33 most developed countries).

3.3 Maternal Mortality and Abortion

The idea of examining the association of abortion and maternal mortality is a bit ambitious considering that the two variables are probably the least reliably measured of any demographic measures. For what it is worth, the correlation between the maternal mortality estimates and the estimated abortion rates for 110 observations is .73; the correlation of maternal mortality with per capita income is -.69. An interesting correlation is -.73 between MOD and maternal mortality, and also .85 between the TFR and maternal mortality. Three of these four predictors (excluding INCOME) remain significant when examined simultaneously.

4

Discussion

This analysis has many limitations. The most serious is the lack of reliable data on abortion rates in the least developed countries but, of course, this is the main rationale for this work. The prediction equations seem very well suited for the developed countries with a sufficiently high correlation to lend confidence in the reliability of the estimates. The problem lies mainly in the sub-Saharan African countries and in the least developed countries generally, where the estimates of the abortion rates, although plausible, are essentially unverifiable.

The prediction formula that is so appropriate for the developed countries (Equations 1 and 2) yields abortion estimates for the least developed countries that are much too high. More plausible values are estimated with a revised equation (Equation 6) for the less developed countries. But the correlation is lower than the one for developed countries alone, thereby introducing more error in the estimates. Also Equation 6 is based on only 34 observations. The estimates based on Equation 10 seem superior but additional information on education is required.

There is no apparent solution to the basic problem that at present there is simply no way to evaluate the accuracy of the abortion estimates for the least developed countries.

It should be clear from the repeated qualifications and questions raised in this paper that this is hardly the final word on the estimation of abortion rates with the regression approach based on contraceptive prevalence and the fertility rate. Although this approach seems to work well in most of the developed countries, these are the countries in which reliable registration data are more available. It is in the least developed countries where the need is greatest and where the estimating equations need improvement. This paper is very much in the spirit of a work in progress that could benefit from suggestions and additional data.

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Appendix A

Table A. List of source countries for abortion rates

Armenia (2000, 2005)	Estonia (2003)	Peru (1989, 2000)
Australia (1996, 2003)	Finland (1988, 2003)	Philippines (2000)
Azerbaijan (2001, 2006)	France (2003)	Puerto Rico (2003)
Bangladesh (1995)	Georgia (1999, 2005)	Romania (1993, 1999)
Belarus (1995)	Germany (2000)	Russia (2003)
Belgium (2003)	Guatemala (2002)	Singapore (2004)
Brazil (1991)	Hungary (1986, 2003)	Slovenia (2003)
Bulgaria (2003)	Kazakhstan (1995, 1999)	South Korea (1996)
Canada (1984, 2003)	Kyrgyzstan (1997)	Sweden (2005)
China (1985, 2003)	Latvia (1996, 2003)	Switzerland (2000)
Colombia (1990)	Mexico (1990)	Tunisia (2003)
Cuba (2004)	Moldova (1997, 2005)	Turkmenistan (2000)
Czech Rep. (2003)	Netherlands (1982, 2003)	Uganda (2000)
Denmark (2003)	New Zealand (2003)	Ukraine (2000)
Dominican Rep. (1990)	Nigeria (1999)	United States (2002)
Egypt (1996)	Norway (1977, 2003)	Uzbekistan (1996)
England (1988, 2003)	Pakistan (2002)	Vietnam (2000)

Appendix B

Table B. One-year failure rates by method for developing countries

	Mean	Standard Deviation	Number of Observations
Pill	5.5	2.4	55
IUD	1.5	1.0	44
Injections (and implants)	2.6	2.2	35
Condom	6.7	3.7	42
Periodic Abstinence	17.4	6.9	50
Withdrawal	14.0	5.5	50

Appendix C

In order to evaluate the association of unmet need with abortion, we developed a data file of 1,278 provinces based on DHS surveys. These data permit examining unmet need (total as well as need for limiting and for spacing) in association with the estimated abortion rate. The particular equation used was based on developing countries. One difficulty is that contraceptive prevalence appears both in the equation and in a different form in the measurement of unmet need. The equation included MOD and TRAD and the unmet need measures are based on women who are not using any method who either want no more births (LIMIT) or who want to wait at least two years for the next birth (SP). The prediction equation used in this analysis is:

$$TAR = 5.29 - .059\ (MOD) - .025\ (TRAD) - .237\ (TFR)$$

which for 28 countries yielded a correlation of .95.

The correlation between total unmet need and estimated abortion rates is .64 which confirms the hypothesis that greater unmet need is associated with higher abortion rates. The SP component of unmet need shows a higher correlation with the estimated TAR, .67 than the LIMIT component, .27 but this very much depends on the part of the world or the stage of the fertility transition as shown in Table C.

Table C. Correlations of estimated abortion rates and unmet need for provinces by region

		Correlation of Estimated TAR and Unmet Need		
Region	**Number of Provinces**	**Total Need**	**Need for Spacing**	**Need for Limiting**
Sub-Saharan Africa	458	.32	.51	-.10
Asia, North Africa	394	.65	.54	.60
Latin America	254	.70	.40	.75
All Provinces	1,106	.64	.67	.27

In sub-Saharan Africa, unmet need for limiting is still emerging and is still dominated by the spacing component. In Asia and North Africa, the two components are about equally correlated with abortion while in Latin America, the need for limiting dominates.

Appendix D

A strong association between fertility and contraceptive prevalence has been noted in family planning research. An interesting question is how much the association is increased with the addition of the abortion rate. For 67 countries with "known" abortion rates, the correlation between the TFR and the CPR is -.72. Adding the TAR to the estimate of the TFR increases the correlation to .79. If this analysis is repeated for the 33 developing countries, the corresponding values are -.62 and .79. The inclusion of the TAR along with the CPR modestly increases the correlation with the TFR.

A similar analysis based on 1,278 regions of countries in the DHS program shows a correlation of -.79 between the TFR and the CPR. With the estimated TAR added, the multiple correlation is .86.

Appendix E

Table E. Model total abortion rate estimates* in developing countries for combinations of MOD and TFR

MOD	TFR						
	< 3.0	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**
0	3.8	2.9	2.6	2.2	1.8	1.4	1.0
10	3.3	2.6	2.2	1.8	1.4	1.0	0.6
15	3.1	2.4	2.0	1.6	1.2	0.9	0.4
20	2.8	2.2	1.8	1.4	1.1	0.7	0.3
25	2.6	2.0	1.6	1.2	0.9	0.5	0.1
30	2.3	1.8	1.4	1.1	0.7	0.3	
35	2.1	1.6	1.3	0.9	0.5	0.1	
40	1.8	1.5	1.1	0.7	0.3		
45	1.6	1.3	0.9	0.5	0.1		
50	1.3	1.1	0.7	0.3			
55	1.1	0.9	0.5	0.1			
60	0.8	0.7	0.3				
65	0.6	0.5	0.1				
70	0.4	0.3					
75	0.2	0.2					
80	< 0.1						

* Based on Equation 7: TAR = 4.09 - .037 (MOD) - .386 (TFR) N = 34, R = .83.
Estimates for TFR < 3.0 are based on a reduction of Equation 8:
TAR = 3.79 - .049 (MOD) N = 25, R = .91

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