# The Estimation of Unwanted Fertility

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# ABSTRACT

The estimation of unwanted fertility is a major objective of demographic surveys, including DHS surveys conducted in Asia, Africa, and Latin America. Levels and trends in unwanted fertility are important input to the formulation of population policy and the evaluation of family planning program performance. Unwanted fertility is posited to have multiple consequences at levels ranging from the societal down to the pregnancy/child, although the nature and magnitude of such consequences remains an active topic of research. Yet existing methods for estimating unwanted fertility are known to be defective, among other reasons because they rely on attitudinal data whose validity and reliability are suspect. This paper proposes a new estimator of unwanted fertility -- the "two-survey estimator", so-named because in its basic form it draws on data from two successive cross-sectional surveys. This estimator relies on the fertility attitude regarded by most scholars as most trustworthy, namely the stated preference for another child at the time of the survey. Under reasonable assumptions, the two-survey estimator should produce less biased estimates of unwanted fertility than the most widely-used existing methods. The new estimator has the limitation of producing only aggregate-level estimates, but such estimates are the primary datum for policy formulation and program evaluation. The new estimator is presented in this paper, with attention to some specific estimation problems. The new estimator is then applied to recent DHS data from Egypt and Bangladesh. In Egypt, the new estimates of the percentage of recent births unwanted suggest that existing estimates for the period since 1992 are 50%-60% of the true levels of unwanted fertility. In Bangladesh, the new estimates differ little from existing estimates. On balance, the results indicate that the new method produces plausible estimates of unwanted fertility that are an improvement on existing estimates. Planned developments of the two-survey estimator should make it a more useful and widely applicable tool.

## I. Introduction

The estimation of unwanted fertility is a major objective of demographic surveys, including the NSFG in the U.S. and the Demographic and Health Surveys [DHS] conducted in Asia, Africa, and Latin America. Unwanted pregnancies are posited to have multifold consequences, at the societal, household, parental, sibset, and child level. Estimates of unwanted fertility derived from DHS-type surveys are extremely influential. In the U.S., the IOM volume by Brown and Eisenberg (1995) was a notable contribution to public discussion of unwanted fertility rates and their societal and individual consequences. Periodically estimates of unintended fertility make an impression in the media and policy arenas, such as Henshaw's (1998) figure, derived by combining survey data with estimates of induced abortion, that roughly one-half of U.S. pregnancies – 3 million per annum – are unintended. For low-income societies, there have been numerous multi-country analyses (e.g. Bongaarts 1997). More importantly, levels and trends in unwanted fertility are important input to the formulation of population policy at the national level, and they are routinely adduced as evidence for the success (or failure) of family planning programs. For these reasons, estimates of unwanted fertility attract considerable attention in the country-by-country release of DHS findings.

Existing methods for estimating unwanted fertility have important defects that are well-recognized. In this paper we propose a new method for estimating unwanted fertility that, under reasonable assumptions, can be expected to yield less biased estimates than the approaches most widely-used at present. This new method will be termed the "two-survey estimator", because in its basic form it requires data from two successive cross-sectional surveys. The new estimator is applied to data from four recent DHS surveys in Egypt (1992, 1995, 2000, and 2003) and two recent DHS surveys in Bangladesh (1996-97 and 1999-2000).

## II. Background

There is a large literature on the consequences of unwanted fertility for a large variety of outcomes, including health/mortality, cognitive development, mental health, schooling and other human capital investments, and economic well-being. These consequences have been considered at levels ranging from the societal down to the individual. This literature will not be reviewed here. It should be acknowledged, however, that the nature and magnitude of the effects of unwanted fertility is a subject of some dispute. One reason for this dispute is doubt about the measurement of unwanted fertility, i.e. the validity of the classification of pregnancies/births as unwanted (or unintended, including mistimed conceptions) (e.g. Rosenzweig and Wolpin 1993, Trussell *et al.* 1999, Joyce *et al.* 2002,). In developing a new estimator, we assume that the estimation of unwanted fertility will continue to be a

high-priority objective of demographic surveys, especially surveys (such as DHS) conducted in low-income settings and where fertility is above replacement level.

There has also been much discussion of the relative merits of a set of closely-related fertility attitudes (and their corresponding survey items): ideals, desires (or preferences), intentions, expectations. Each of these can be framed with reference to lifetime births/children or with reference to having another birth/child. Thoughtful critical discussions of how these concepts can be measured, what they represent, and their utility for various analytical purposes include Ryder and Westoff (1971), McClelland (1983), Adler (1992) Miller (1994), Miller and Pasta (1995), Petersen and Moss (1997), and Fischer *et al.* (1999). The discussion has been much more extensive and precise with reference to U.S. fertility. There has been far less wrestling with these conceptual distinctions in research on fertility in low-income countries, although see McClelland (1983), Stycos (1984), Lightbourne (1985), and Bongaarts (1990). Ryder and Westoff (1971) conclude that, judged by both conceptual and empirical criteria, the purest fertility attitudinal measures are fertility preferences – whether a recent child was wanted, whether another child is wanted, how many more births are wanted. They also see much value in a measure of lifetime fertility desires, i.e. a question of the sort "if you could have exactly the number of children you want, what number would that be?"

Ryder and Westoff's conclusions were carried into the design of the World Fertility Survey [WFS] program and its successor the DHS. There is undoubtedly scope for improvement in the measurement of fertility attitudes in surveys in developing countries; in particular, measurement strategies that allow for attitudinal *continuums* rather than a few discrete categories, that capture attitudinal qualities such as *intensity* and *certainty*, and that allow for concepts such as fertility intentions to have *multiple dimensions* would be very much in order (Thomson and Brandreth 1995, Bachrach and Newcomer 1999).

Such advances in measurement are not our immediate concern in this research. Rather, we take as given decisions made three decades ago, from which has accumulated an enormous body of empirical data on fertility preferences and desired family size – 40 WFS surveys, several dozen Contraceptive Prevalence Surveys [CPS], and (to date) roughly 200 DHS surveys. Our goal is to develop methods for making optimal use of this existing body of data.

## III. Existing methods for estimating unwanted fertility

At issue is the classification of births/pregnancies as unwanted. Three methods have been commonly employed.

III.a. Retrospective direct question [Method #1].

In most DHS surveys, women have been asked birth-by-birth whether births in a recent reference period leading up to the survey (typically three-to-five years) were wanted at the time of conception. The item is: "At the time you became pregnant with <name>, did you want to become pregnant then, did you want to wait until later, or did not want (more) children at all?" (From English translation of 2000 Egypt DHS, emphasis in original.) Essentially the same question is also asked about current pregnancies at the time of the interview.

On the face of it, this method for detecting unwanted births/pregnancies has much to recommend it. First, it has the considerable virtue of attempting to measure fertility preferences at the time of conception, the phenomenon of interest if the ultimate goal is to assess the potential impact of more perfect fertility control. This is a virtue not enjoyed by the other methods discussed here, which do not explicitly refer to preferences at the time of conception. Accordingly, this method requires no assumption about the stability of fertility preferences over time (instead, as noted below, it assumes accurate recall and honest reporting of desires at the time of conception). Second, both unwanted and mistimed births can be detected; other methods, including the proposed new method, provide estimates of unwanted fertility only. Third, Method #1 can be applied to pregnancies that do not eventuate in a live birth (although DHS surveys do not universally ask about such pregnancies and coverage is known to be incomplete). Finally, because each reported birth in the reference period is classified as wanted or unwanted, this method gives the analyst maximum flexibility in investigating the covariates of unwanted births/pregnancies (causes or consequences).

Unfortunately, this method suffers from an enormous shortcoming, namely the tendency of women to engage in *ex post* revision of the declared wantedness of a birth/pregnancy. This problem has been recognized for many decades, initially with reference to data collection in the U.S. (Ryder and Westoff 1969, Ryder 1973, Miller 1994) and more recently with reference to data collection in low-income settings (Bongaarts 1990, Adetunji 1998). In the U.S., there are accounts of a tendency for women to report births that were unwanted at conception as wanted in a later interview (Ryder 1973), and there are also accounts of the converse tendency (Freedman *et al.* 1980, Lee 1980).[1]

In low-income and non-Western settings, a reluctance to report a past birth as unwanted appears to be the more common source of bias. Usually these past births are living children at the time of the

[1] Rosenzweig and Wolpin (1993) perceive in NLSY data an increased likelihood for a birth to be wanted as time goes by, a conclusion that Joyce *et al.* (2002) effectively refute. But this dispute revolves around a comparison of reporting during pregnancy vs. after birth, not pre-conception vs. after birth, which is the more important comparison for our purposes.

interview. Two types of evidence are indicative of this aversion to declaring births unwanted. First, in most applications to survey data, Method #1 yields a lower fraction of births unwanted than Method #2 below. (This is illustrated empirically in Table 2.[2]) While it is possible that Method #2 is upwardly biased, the discrepancy is more plausibly explained as reflective of downward bias in Method #1. Second, in longitudinal studies where wantedness can be assigned both prospectively (stated preference for another birth in an interview preceding the conception) and retrospectively, there is a marked tendency for women to report births as wanted retrospectively even though prospectively the woman indicated a desire to terminate childbearing. Williams and Abma (2000) present evidence of this kind for the U.S. We can cite three pertinent examples from developing countries.

> (i) In a three-year panel DHS survey in Morocco (Bankole and Westoff 1998), among births to women who expressed a desire for no more births at the first interview, 62% were retrospectively declared to be wanted, whereas less than 10% were re-classified in the opposite direction (from wanted to unwanted).
>
> (ii) In an Indian panel survey (Koenig *et al.* 2004), 75% of births that would be classified as unwanted prospectively were reported as wanted retrospectively.
>
> (iii) In a two-year panel in Egypt, 39% of births that would be classified as unwanted prospectively were reported as wanted retrospectively, whereas less than 10% were re-classified in the opposite direction (Casterline *et al.* 2001).

To be sure, it is possible that some fraction of these re-classifications represent genuine changes in fertility desires between the first interview and the date of conception. The more plausible explanation for the bulk of these apparent inconsistencies, however, is respondents' reluctance to declare children "unwanted".

Tellingly, this explanation has been recognized and accepted by the DHS. While retrospective wantedness data are collected and presented in basic tabulations in the DHS country reports, these data are <u>not</u> the basis for DHS estimation of unwanted fertility rates. Instead the DHS uses Method #2.

### III.b. Comparison of ideal number of children with number of living children [Method #2].

In DHS surveys, women are asked: "If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?" We will follow DHS in terming this "ideal number of children", although in the long tradition of fertility research "desired number of children" would be the more appropriate term. As developed by Lightbourne (1985) in analysis of WFS data, births during a reference period preceding the survey can be classified as wanted or unwanted by comparing the response to this question with the number of

[2] In earlier analysis of DHS data, Bongaarts (1990) calculates an average discrepancy between Methods #1 and #2 of 0.4 unwanted births per woman in a synthetic TFR, with Method #1 yielding the lower average estimate.

living children at the time of the conception. Generally this method classifies a larger number of births as unwanted than Method #1, as shown by Bongaarts (1990) and in Table 2 of this paper (discussed below). This differential is supportive of the greater validity of Method #2, assuming women are in fact reluctant to label children unwanted. Like Method #1, this method yields a classification of individual births, thus allowing for maximum flexibility in investigating the covariates of unwanted fertility.

The method has important defects, however (Bongaarts 1990). First of all, in some societies a non-negligible fraction of survey respondents do not provide a numeric response to the ideal number of children item. This sub-set of women either does not provide a response ("not stated") or gives another type of response ("up to God"). The prevalence of this phenomenon is shown for the four Egypt surveys and two Bangladesh surveys in Table 1. In all four Egyptian DHS surveys, the percentage of women not providing a numeric response exceeds 15% overall, reaching 22% in the 2000 survey. In Bangladesh, non-numeric responses are far less common, amounting to 6% and 3% in the two surveys. The percentage non-numeric in the Egyptian surveys is, admittedly, atypically high, but 10% non-numeric is not rare in those regions where DHS is now most active (especially sub-Saharan Africa). Current DHS practice is to regard a non-numeric response as equivalent to a very large ideal number for the purposes of estimating unwanted fertility, and hence women giving non-numeric responses cannot have unwanted births.[3] For this reason, the fact that the percentage non-numeric tends to increase with parity (Table 1) exacerbates the problem. In Bangladesh, for example, 12.5% of women at parity 6 and above did not provide an ideal number of children in the 1996-97 DHS (as against 6% overall). Under current DHS practice, all the recent births to these women are classified as wanted, despite the fact that higher-order births are more likely to be unwanted. (Roughly 85% of women at parities 4 and above in this Bangladesh survey indicate a desire to have no further children at the time of the interview.)

Second, the stated ideal number of children is known to be upwardly biased because women are reluctant to supply a number that is less than their current number of living children, a phenomenon often termed "rationalization". This point is conceded in DHS country reports, for example: "To the extent that women are unwilling to report an ideal family size that is lower than their actual family size, the wanted fertility rate may be overestimated" (el-Zanaty and Way 2001: 121). A slight modification to the wording of the ideal number of children item seems to have reduced rationalization in the DHS as compared to the WFS (Goldman *et al.* 1989), but the problem persists.

Third, numerous studies have demonstrated that the ideal number of children has relatively low test-retest reliability. A sampling of this evidence: in the Wisconsin Fertility Motivation Study, in a

[3] Of course there are alternative analytical strategies for tackling this problem, including any of several techniques for assigning valid codes to missing values (e.g. multiple imputation). These merit investigation.

one-month follow-up 73% gave the same response to this item in both interviews (Thomson and Brandreth 1995); in a 1.5-year follow-up to the Costa Rica WFS, 44% gave the same response (Stycos 1984); in a three-month follow-up to the Indonesia WFS, 54% gave the same response (MacDonald *et al.* 1978); in a three-month follow-up to the Peru WFS, 44% gave the same response (O'Muircheartaigh and Marckwardt 1981); in the three-year follow-up to the 1992 Morocco DHS, 36% gave the same response (Bankole and Westoff 1998).

Fourth, a variety of factors can render the stated ideal number of children misleading for the purpose of ascertaining whether births are unwanted (Bongaarts 1990): (i) respondents may have preferences regarding sex of children that lead them to proceed beyond their ideal number; (ii) child deaths may lead respondents to have more live births than their stated ideal number; (iii) respondents may choose to curtail childbearing short of an "ideal", in deference to various real-world constraints. Note that these factors distort the assignment of wantedness in different directions, and hence the net direction of bias due to these factors cannot be assumed *a priori*. Each of these factors can result in a discrepancy between the actual wantedness of a birth and the wantedness inferred by comparing the stated ideal number of births with the respondent's number of living children.

Fifth, in contrast to Method #1, Method #2 does not refer explicitly to preferences at the time of conception. It must be assumed that the ideal number of children has been unchanging from the time of conception to the survey interview.

It is likely that the largest sources of bias in Method #2 are the first two – non-numeric responses and the rationalization of past birth history. Both lead to <u>under-estimation</u> of unwanted fertility in most contexts. We note again that Method #2 is used to calculate the unwanted fertility rates presented in DHS country reports, on the DHS website, and in DHS comparative analyses.

### <u>III.c. Prospective assessment via panel survey [Method #3]</u>

When panel data are available, births can be classified as wanted or unwanted according to the woman's prospective preferences. In DHS surveys, women are asked: "Would you like to have (a/another) child, or would you prefer not to have any (more) children?" Further items ascertain how soon women would like to have the next birth. Based on these responses, births occurring in the period between interviews can be classified as unwanted, mistimed, or wanted and on time.

This method has considerable appeal. For one thing, it does not suffer from the biases inherent in Methods #1 and #2, namely the reluctance of women to admit (explicitly or implicitly) that a past birth was unwanted. Second, it relies on the fertility attitudinal item ("Do you want another child?")

which the existing research literature generally regards as most valid and reliable. Validity has been assessed mainly via predictive validity, i.e. the prediction of subsequent fertility, by which criteria prospective preferences perform well, in the U.S. and elsewhere, and certainly out-perform the item on ideal number of births (e.g., Westoff and Ryder 1977, Hermalin *et al.* 1979, McClleland 1983, DeSilva 1991, Bankole and Westoff 1998, Schoen *et al.* 1999, Razzaque 2000, Morgan 2001, DaVanzo *et al.* 2003). Reliability has been assessed via test-retest reliability, which shows prospective preferences to be far more reliable than the ideal number of births (or, for that matter, retrospective wantedness) (e.g., Coombs 1977, Stycos 1984, Thomson and Brandreth 1995, Bankole and Westoff 1998). In particular, in diverse settings women are quite consistent across repeated interviews in maintaining an expressed desire to have no further births. Third, and a corollary of the second, the fraction of respondents not providing a usable response to this item tends to be relatively low. Table 1 shows the percentage of women in the four Egyptian and two Bangladesh surveys who are "uncertain" or "not stated" about their desire for another child. The overall percentages fall below 5% in all six surveys and below 3% in all but one survey. These are noticeably lower fractions of cases missing than for the ideal number of children item, also shown in Table 1. Fourth, like Method #1 but unlike Method #2, this method permits identification of births that are wanted but mistimed. Fifth, in a prospective design the likelihood of detecting pregnancies that do not eventuate in a live birth (miscarriages, induced abortions) is probably higher than in retrospective inquiry, although we are not aware of supporting empirical evidence for this assertion. We suspect success in capturing such pregnancies decreases as the elapsed time between interviews lengthens. Finally, Method #3 shares with Methods #1 and #2 the advantage of classifying individual births/pregnancies, thereby facilitating analysis of the covariates of unwanted fertility.

This method might well be the method of choice were panel data widely available. But they are not, especially for national samples -- DHS surveys are virtually always cross-sectional surveys, with no follow-up. Where panel data are available, sample attrition is a chronic problem. Finally, like Method #2 this method requires an assumption that preferences are stable over time (in this instance, from the survey interview forward to the conception of the birth).

## IV. A new method for estimating unwanted fertility: a two-survey method

### IV.a. The Two-Survey Estimator in brief

While panel data (Method #3) are rarely available for national samples in developing countries, many countries have conducted more than one DHS survey. The most common practice is to conduct DHS surveys at five-year intervals, but in some countries (e.g. Bangladesh and Egypt) they have been

conducted at more frequent intervals. In each survey, women are asked about their desire to have another birth (i.e. their prospective preferences). While individual women are not re-interviewed, the design is prospective at the aggregate level: sub-groups of women in the earlier survey can be identified in the later survey (e.g. parity sub-groups and birth cohorts). This provides the basis for a two-survey estimator of unwanted fertility. To our knowledge, this estimator has not heretofore appeared in the literature.

The logic of the two-survey method is straightforward. Suppose we have access to two successive cross-sectional surveys of comparable design. Consider women of parity j at the 1st survey. Given a birth history in the 2nd survey (as is standard in the DHS), women in the 2nd survey who were at parity j at the time of the 1st survey can be readily identified. The experience of these women from the 1st survey to the 2nd survey can be viewed as follows:

| | | Preferences at 1st Survey | | |
|---|---|---|---|---|
| | | Want More | Want No More | Total |
| Births between Surveys | Birth | **a** | **c** | **B** |
| | No Birth | **b** | **d** | **NB** |
| | Total | **WM** | **NM** | |

The aim is to calculate the proportion of births unwanted, which we will denote **U**; **U = c / B**. This can be obtained as follows. **WM** and **NM** are known from the 1st survey: these are simply the proportions wanting more and wanting no more, respectively, specific to women of parity j. **B** and **NB** are available from the 2nd survey: these are simply the proportions of women having or not having a birth in the period since the date of the 1st survey (with women classified according to their parity j at the date of 1st survey). Finally, and the key to this method, **b** is known from the 2nd survey: this is the proportion of women (classified according to their parity j at the date of 1st survey) who want another birth and report no births since the date of the 1st survey. If the marginal values and the value for one internal cell (**b**) are known, then of course the values for all internal cells in the above table can be derived.

Accordingly, a formula for calculating the proportion of births of birth order b that are unwanted [$U_b$] is:

$$U_b = 1 - \left( ({}_1WM_p - {}_2b_p) / {}_2B_p \right) \qquad (1)$$

where **U** proportion of births unwanted

| | |
|---|---|
| $_1$**WM** | proportion wanting more, as reported in 1st Survey |
| $_2$**b** | proportion wanting more *and* having no births since date of 1st Survey, as reported in 2nd Survey |
| $_2$**B** | proportion having birth since date of 1st Survey, as reported in 2nd Survey |
| **p** | denotes parity at date of 1st Survey, p = 0, . . . . J |
| **b** | denotes birth order, b = 1, . . . . T and **b = p + 1** |

Note the translation from parity to birth order: women of parity **p** will have births of order **b = p + 1** (and higher – see the discussion below of multiple births in the observation period). The overall proportion unwanted [**U**] is a weighted average of the $\mathbf{U_b}$:

$$\mathbf{U} = \mathbf{\Sigma w_b U_b} \qquad (2)$$

where the weights $\mathbf{w_b}$ are the proportion of births in the period between surveys of birth order **b**.

The most important strength of the two-survey method is that it relies on the attitudinal item that is generally thought to be most valid and reliable, namely the prospective preference item. Its other data requirements are minimal: the dates of recent births and, where birth histories and fertility preferences are only obtained from ever-married women, the date of first marriage.

The two-survey method is not without limitations. First of all, it is an aggregate-level method – it does not deliver a classification of individual births as wanted or unwanted -- and this makes the two-survey method less flexible for the analysis of covariates of unwanted fertility. But note that estimated differentials in unwanted fertility can be obtained by applying the two-survey estimator to data stratified by population sub-groups (as defined by type of place of residence, region, educational attainment, household wealth, and so forth).[4] Second, the incidence of mistimed births cannot be ascertained. Third, the two-survey estimator requires an assumption that fertility preferences are stable over time (from the 1st to the 2nd survey).[5] Fourth, this method requires the availability of two successive cross-sectional surveys spaced an appropriate distance apart. Fifth, the two successive surveys must be comparable: in their sample design, in the few required questionnaire items (especially the fertility

[4] Sub-group estimates will be subject to larger standard errors; this makes it all the more important to address the issue of the sampling error of the proposed new estimator, an issue we will be addressing in further work (see Section VI).

[5] The likely direction of bias if this assumption is violated can easily be determined. The most plausible violation in contemporary low-income societies, where fertility desires are in general declining, is a switch between the two survey dates from wanting to not wanting another child. This in turn means that either $_1$**WM** can be regarded as over-estimated or $_2\mathbf{b_p}$ as under-estimated. Either of these leads to an under-estimation of the level of unwanted fertility when employing equation (1).

preference item), and in the conduct of the fieldwork as this bears on the comparability of the required information.

Admittedly this is a serious set of limitations. But note that the second and third are shared by Method #2, the currently sanctioned approach for estimating unwanted fertility rates with DHS data. The two-survey method improves on Method #2 by not relying on the ideal number of births, an item of questionable validity. We believe the fourth limitation – the need for two surveys appropriately spaced – can be relaxed, a possibility mentioned below and one element of our future developmental work. The fifth limitation is ordinarily not considered a problem with successive DHS surveys (and, indeed, the routine use of DHS surveys for estimation of trends presumes close comparability across surveys), but certainly comparability should not be taken for granted in all instances. This leaves the first limitation – aggregate-level estimates only. This is a regrettable feature of the method, but surely an acceptable price to pay if more valid estimates of unwanted fertility can be generated for roughly 40 countries (and perhaps as many as 70 countries). And, indeed, it is aggregate-level estimates of fertility rates that feed directly into policy formulation and program evaluation.

IV.b. Two-Survey Estimator – some technical issues

Implementation of the two-survey method requires the resolution of a number of small technical details. Four are singled out for discussion here.

*Multiple births in reference period*

Equation (1) produces an estimate of the fraction unwanted among the first births experienced by women of parity j in the interval between successive surveys. Some women, however, will experience more than one birth in this interval, especially if the interval exceeds three years (which is not uncommon in the DHS universe). Since $\mathbf{U_b}$ -- the probability that a birth of order b is unwanted – refers to first births in the interval, in effect the wantedness of births of order p+2 (or higher) (i.e. second births or further births to women of parity p at 1st survey) is determined from the estimated wantedness of births of order p+1 (i.e. first births in the interval to women of parity p at 1st survey). Obviously the longer the interval between surveys, the more consequential this assignment procedure. The Egyptian and Bangladesh surveys used for illustration were deliberately chosen to offer a range of inter-survey intervals. Consider the following:

| | Egypt | | | Bangladesh |
|---|---|---|---|---|
| | 1992-95 | 1995-00 | 2000-03 | 1996-99 |
| Gap between surveys (mos.) [a] | 38 | 53 | 39 | 38 |
| Percent women with 1+ births | 34% | 41% | 33% | 32% |
| Percent women with 2+ births | 4% | 10% | 4% | 2% |

a. Average number of months between the two survey dates.

When the interval between surveys is three years, almost ninety percent of the Egyptian women having a birth in the interval have just one birth and roughly ninety-five percent of the Bangladeshi women having a birth have just one birth. When the interval is widened to more than four years, however, almost one quarter of the Egyptian women having a birth in the interval have two or more births.

This suggests that the Two-Survey Estimator is on firmer ground when the interval between surveys is four years or less, although we feel that the assignment procedure for births beyond the first in the interval is defensible. Nevertheless, in future work we will be developing alternative procedures for applying the estimator to instances where the gap between surveys is relatively lengthy.

*Women currently pregnant at survey*

Women pregnant at the survey present some problems. For these women, the prospective preference item explicitly refers to the period after the forthcoming birth of their child: "After the child you are expecting, would you like to have another child or would you prefer not to have any more children?" These women are also asked about the wantedness of the current pregnancy: whether it was wanted at that time, sometime later, or not at all. How should pregnant women be treated at the 1st and 2nd survey?

Considering first women pregnant at the 1st survey, at issue is how to classify the births eventuating from that pregnancy. These births will be represented in the birth histories collected in the 2nd survey. The wantedness of these births could be ascertained, in effect, from the pregnant women's responses at the 1st survey to the item on the wantedness of the pregnancy. But this would mean relying on the retrospective wantedness item, which is of doubtful validity (see Section III.a.) Instead, our solution is to start the reference period not with the date of the 1st survey but rather this date plus a further gestation period, which we take as seven months (because very few women report pregnancies in the first few gestational months). This narrowed reference period excludes births from women pregnant at the 1st survey, leaving births to which the prospective preference item validly applies.

A rather slight problem remains: some of the current pregnancies will terminate in a fetal loss, which means that some women who state a desire to terminate childbearing after the birth of the current pregnancy will instead want another birth, i.e. they are misclassified in **NM**. We have implemented a correction for this problem. The correction is applied to pregnant women at the 1st survey who state a desire for no further births and whose number of children after the birth from the current pregnancy equals their ideal number of births, i.e. the current pregnancy is their last wanted child. A fetal loss rate of 5% is assumed.[6] The fraction of women projected to suffer a fetal loss is then shifted from the "want no more" to the "want more" category. In the event, this adjustment is of little importance, as could be anticipated because the fraction of women affected is small (the adjustment accounts for fetal loss among pregnant women who are pregnant with their last wanted child).

| | Percentage of Births Unwanted | |
|---|---|---|
| | **Egypt** | **Bangladesh** |
| | 2000-2003 | 1996-99 |
| Without adjustment for fetal loss: | 28.9% | 24.5% |
| With adjustment for fetal loss: | 28.5% | 24.3% |

Turning to women pregnant at the 2nd survey, these women complicate the estimation of $_2$**b --** the fraction of women who want another child and have had no birth since the 1st survey. Because the prospective preference item refers to their preferences after the birth of the current pregnancy, some of these women who state a desire to stop childbearing in fact wanted another child up to the 2nd survey interview and hence should be assigned to the subset of women wanting another child at the survey. From the standpoint of the fraction of sample experience at issue, this is a very minor problem – like the problem of fetal loss to women pregnant at the 1st survey discussed above, this predicament applies only to women pregnant at the survey with their last wanted child. To give a sense of the magnitude of the problem, in the 2000 Egypt DHS about 9% of women are currently pregnant and 4% are pregnant and indicate a desire for no more births after the birth of the current pregnancy. At issue is what fraction of this 4% should be shifted to the subset of women wanting another child at the survey. Our solution is to apply a double requirement: women must indicate that the current pregnancy is wanted and their ideal number of births must exceed their current number of living children. Even though the fraction of women affected is very small, it is with regret that we rely on the stated wantedness of the current pregnancy, as there is every reason to believe these data are biased towards the pregnancy being wanted.

[6] We use the life table probabilities of fetal loss from five studies deemed of high quality presented in Woods (1994: 257). These probabilities are applied to the distribution of women by gestational month in the four Egyptian and two Bangladesh surveys to obtain a weighted average proportion of expected fetal loss. This average ranges from 3.0% to 6.5% across the six surveys.

Note that such bias increases $_2$**b**, resulting in upward bias in the estimated fraction of births unwanted (see equation (1)).

*Child deaths between survey dates*

Potentially more consequential, because of the fraction of women affected in some societies (i.e. where child mortality is high), are child deaths between the survey dates. A key parameter for the new estimator is **b** – the proportion of women who had no births in the interval between surveys and who wanted another child at the time of the 1st survey. This parameter is obtained from the 2nd survey; it is the fraction of women who had no births in the reference period and who want another child. But some of these women actually did not want another child at the time of the 1st survey, but subsequently have changed to wanting a child because one (or more) of their children died in the interim. Note these would be deaths that occurred in the reference period to children born prior to the date of the 1st survey. **b** should be adjusted by the fraction of such women who suffered a child death that dropped them below their desired number of children, as assessed by their stated ideal number of children. We have implemented this correction, and it affects the overall estimates as follows:

| | **Percentage of Births Unwanted** | |
|---|---|---|
| | **Egypt** | **Bangladesh** |
| | 2000-2003 | 1996-99 |
| Without adjustment for child deaths: | 28.8% | 24.9% |
| With adjustment for child deaths: | 28.5% | 24.3% |

*Missing information for prospective preferences*

Prospective preferences are not available for some women. One reason is that some women do not provide a usable response when asked, instead are classified as "uncertain" or "not stated". As already noted, fortunately this fraction tends to be low. Table 1 shows the percentage of women missing on prospective preferences, by parity, for the six surveys. The overall percentage falls below 5% in all six surveys and below 3% in four of the six surveys. Unlike the missing data on ideal number of children, there is no strong patterning of the missing data on prospective preferences by parity. In our implementation of the Two-Survey Estimator, those women who were asked the question but did not offer a usable answer will be assumed to want more children; this is usual practice among analysts of DHS data.

Of more concern are women not asked for their prospective preferences, specifically women in the 2nd survey who are not currently in union. If these women were married at the time of the 1st survey,

they are required for the calculation of the Two-Survey Estimator (they should contribute to $_2\mathbf{b}$, the proportion wanting another child who had no birth since the 1st survey). Our current solution is to determine prospective preferences for this set of women by comparing their ideal number of births with their number of living children. For the four applications of the two-survey method to data from Egypt and Bangladesh, the relative number of women affected is as follows:

| | Egypt | | | Bangladesh |
|---|---|---|---|---|
| | 1992-95 | 1995-00 | 2000-03 | 1996-99 |
| $_2\mathbf{b}$ (percent want more and no births) | 17.2% | 12.6% | 17.2% | 20.5% |
| $_2\mathbf{b}$ based on ideal number of births | 2.3% | 3.4% | 2.9% | 2.9% |

## V. Results from applying the Two-Survey Estimator

Estimates of unwanted fertility for four inter-survey periods – three in Egypt and one in Bangladesh – are presented in Table 2. Table 2 shows the estimated percentage of births unwanted by birth order and for all birth orders combined, as derived from three estimation methods: retrospective direct question (Method #1), comparison of ideal number of children with number of living children at conception (Method #2), and the Two-Survey Estimator. A summary of the results, for births of all orders combined, is as follows:

| | Percentage of Births Unwanted | | | |
|---|---|---|---|---|
| | Egypt | | | Bangladesh |
| | 1992-95 | 1995-00 | 2000-03 | 1996-99 |
| Retrospective direct | 20.5% | 13.0% | 11.0% | 13.6% |
| Ideal vs. number living | 24.8% | 17.0% | 17.3% | 25.1% |
| Two-Survey Estimator | 39.2% | 33.2% | 28.5% | 24.3% |

The first method – retrospective direct reports – yields far lower percentages unwanted than either the second method or the new Two-Survey Estimator. This is a common outcome, and is consistent with the argument that women are reluctant to report children as unwanted, resulting in downwardly biased estimates of unwanted fertility.

The second method – comparison of ideal number of children with the number of living children at conception, as developed by Lightbourne (1985) – is the method currently employed by the DHS when estimating the widely-used wanted and unwanted fertility rates. In Bangladesh, this method and the two-survey method produce essentially the same overall estimate of the percentage of births unwanted (differing by only 0.8%). In Egypt, in contrast, the two-survey estimates are substantially higher than those produced by the DHS method. If the two-survey estimates are regarded as valid, then currently accepted estimates of the fraction of births unwanted in Egypt in the period since 1992 are 50%-60% of the true fraction unwanted in this period. Note that the downward bias in the unwanted total fertility rate will be somewhat greater than the bias apparent in Table 2, because total fertility rates give equal weight to births at all ages whereas the distribution of births underlying the overall percentages in Table 2 (and above) is weighted towards younger women (whose births are more likely to be wanted).

The discrepancies between the commonly-accepted estimates for Egypt and the two-survey estimates naturally call into question the credibility of the latter. Is it sensible to believe that the true level of unwanted fertility is so much higher than has been believed? The figures in Table 3, complemented by some further survey tabulations, can be employed to subject the new estimates to a credibility test. Consider, for example, births of order 3 and above during the period 2000 – 2003. The conventional DHS methodology classifies 38% of these births as unwanted, whereas the two-survey estimate is 63%. From Table 3, one learns that in the 2000 survey 80% of women of parity 2 and higher expressed a desire to have no more children. These are the women producing the births of order 3+ during 2000-2003 (plus a very few women of parity 1 in 2000). On the face of it, one could regard 63% of births of order 3+ unwanted (two-survey estimate) as more consistent with the fact that 80% of the women at risk did not want another birth than 38% unwanted (conventional estimate).

It is, nevertheless, quite possible that a large majority of the births of higher order were contributed by the 20% of women who wanted another child. The further important pieces of information in adjudicating between these two quite discrepant estimates of the incidence of unwanted fertility are both obtained from the 2003 survey: first, about 24% of women of parity 2+ at the time of the 2000 survey had a birth in the period leading up to the 2003 survey; and, second, 13% of women of parity 2+ at the time of the 2000 survey state a desire for another birth in 2003 but had no births in the period since 2000. So consider all these pieces of information: (i) 20% of women of parity 2+ in 2000 wanted another child, but (ii) 13% out of this 20% had no child in the interval between surveys. This means that the subset of women wanting another birth in 2000 can account for only 7% (20% - 13%) of

the 24% of women who actually had a birth during those intervening three years. This arithmetic strongly suggests that the percentage of births unwanted must have been far closer to 63% than 38%.

The preceding two paragraphs essentially reproduce the logic of the Two-Survey Estimator. (This numerical exercise does not yield the same estimate as shown in Table 2 because of fine points of calculation, such as those discussed in Section IV.b. above.) If one is prepared to accept the prospective preference item as the most valid of the available fertility attitudes in DHS-type surveys, then we think the two-survey estimates of unwanted fertility presented in Table 2 are far more plausible than existing published estimates. An alternative explanation for the discrepancy evident in Table 2 between existing estimates and the two-survey estimates -- an explanation that cannot be readily dismissed -- is that a substantial fraction of the women who had births in the reference period changed their minds about their desire for another birth between the earlier survey and the time when they conceived.

A final point about the results concerns the lack of discrepancy between the existing and two-survey estimates for Bangladesh. While the new estimates do not alter the accepted understanding of the absolute level of unwanted fertility in recent years in Bangladesh, they do modify our understanding of the relative level of unwanted fertility in Bangladesh, i.e. relative to other societies. In comparative analyses of DHS data, Bangladesh is sometimes singled out for having somewhat high rates of unwanted fertility. Whether the Two-Survey Estimator will challenge this conclusion is not yet certain – this awaits application of the new estimator to a larger body of DHS surveys. Certainly the relative standing of Egypt and Bangladesh changes dramatically: whereas Bangladesh is usually thought to have roughly 50% higher unwanted fertility than Egypt, the two-survey estimates indicate that, if anything, the incidence of unwanted fertility is lower in Bangladesh than in Egypt.

## VI. Extensions of the Two-Survey Estimator

In future work, we plan to explore four extensions of the new estimator that we believe will greatly enlarge its applicability and value. These extensions are briefly noted here.

First, we will extend the method to the estimation of period unwanted and wanted fertility rates. The period-specific proportion of births unwanted is the fundamental output from the Two-Survey Estimator. An important transformation of this proportion, especially for reaching non-research audiences, is the unwanted total fertility rate (and corresponding wanted total fertility rate). This rate is a much-valued product of the DHS. We expect to obtain these rates by applying equation (1) to women classified according to age rather than parity. While the logic of the two-survey estimator would, at first blush, seem to require following women of the same parity from the 1st to the 2nd survey, in fact the

logic is not fundamentally different if women are classified by age at 1st survey, i.e. birth cohort. Proportions of women in each cohort at the 1st survey want more births, proportions of the same cohorts of women at the 2nd survey have had a birth in the interim (or not), and proportions have had no births in the interim despite desiring another birth: all the components of the two-survey estimator apply equally well to women classified by age at 1st survey. Hence the two-survey estimator can produce cohort-specific proportions of births unwanted, and these in turn can be employed in the calculation of wanted and unwanted age-specific fertility rates (strictly speaking, cohort-specific fertility rates); summing these yields wanted and unwanted total fertility rates.

Second, we will address the problem of surveys spaced "too far" apart. Such circumstances threaten the two-survey approach for two reasons. First, the assumption of unchanging preferences (at the aggregate-level) is less tenable. Second, a larger fraction of women experience more than one birth in the interval between surveys. As discussed in Section IV.b. above, strictly speaking equation (1) applies only to the first births to women in the interval between surveys. But equation (1) does not bind one to use the 1st survey as the starting-point for the reference period. With birth histories that provide the month and year of each birth, the analyst has maximum flexibility in defining the reference period for births. But surely **WM** – the proportion wanting more at the start of the reference period, the only piece of information taken from the 1st survey – is constrained to refer to the date of the 1st survey? We do not see why this constraint must hold. All the Two-Survey Estimator requires is a reasonable (and hopefully valid) estimate of **WM** for whatever start-date is designated. A conservative assumption is that **WM** changes linearly between the two surveys. Under this assumption, **WM** for inclusion in equations (1) or (3) can be calculated for any date from the 1st survey to the 2nd survey via simple linear interpolation. (Of course in those instances where surveys are spaced quite far apart -- 8-10 years or greater -- and prospective preferences show substantial change between surveys, we would feel less secure about the assumption of linear change between surveys.)

From the preceding, it is a small step to a one-survey version of the Two-Survey Estimator. The insight in the preceding paragraph is that **WM** – the proportion of women wanting another child at the start of the reference period – need not be taken directly from the 1st survey, nor must **WM** pertain to the date of a survey. As just discussed, **WM** for a date falling between two surveys might be derived via interpolation of 1st and 2nd survey estimates. If one is not bound to $_1$**WM** (prospective preferences as estimated in a 1st survey), is one even constrained to have a 1st survey in hand? It would seem not, provided the analyst has a defensible alternative source of **WM**. One source of **WM** is the 2nd survey. Indeed, were prospective preferences to be unchanging, then $_2$**WM** would be an entirely valid source of **WM**. This leads to the one-survey version of the new estimator. In fact almost certainly preferences are

undergoing change in most low-income countries. But an informal examination of successive DHS surveys in several countries suggests that such change ordinarily occurs rather slowly; differences over five-year periods, for example, are typically slight. This is also the conclusion in Bankole and Westoff (1995) and Bongaarts (1997). If further analysis of DHS data supports this observation, then $_2\mathbf{WM}$ provides a reasonable estimate of **WM** (i.e. prospective preferences at the outset of a reference period leading up to the survey) for relatively brief reference periods preceding a survey (e.g. three years or less).

A one-survey variant on the two-survey estimator would significantly enlarge the applicability and functionality of the proposed new estimation approach. In the one-survey variant, the new estimator could be applied to all DHS surveys (roughly 200) in all countries (about 70), whether or not successive surveys were available. For historical backdrop, it could also be applied to WFS and CPS surveys conducted in the 1970s and early 1980s. Only in those instances where just one survey is available and there is an external basis for suspecting that fertility preferences were undergoing rapid change in the years immediately preceding the survey might one forego applying the new estimator to generate estimates of unwanted fertility.

A fourth and final developmental priority is the calculation of sampling errors. In recent years it has not been customary to place confidence intervals around DHS estimates of wanted and unwanted fertility. But sampling error is an important component of total survey error and should never be entirely neglected when generating survey-based estimates. Especially when estimation is carried out by population sub-group, for the purpose of drawing inferences about sub-group differentials in unwanted fertility, it is essential to take sampling error into account. The Two-Survey Estimator is a complex entity. It contains three quantities from two different surveys (putting aside the one-survey variant). The overall proportions unwanted are a weighted sum of the order-specific proportions, and total fertility rates will be similarly weighted sums, adding further complexity to the calculation of sampling error. Because an analytical solution is likely to be elusive or quite elaborate, we expect to obtain standard errors for the new estimator via re-sampling techniques -- probably the bootstrap (Efron and Tibshirani 1993).

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Table 1. Missing data on fertility desires: Egypt and Bangladesh

Percentage of women providing no response or a non-numeric answer to ideal number of children ("Ideal"), and percentage of women providing no response or uncertain about desire for another birth ("pref")

| Parity | Egypt | | | | | | | | Bangladesh | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | | 1995 | | 2000 | | 2003 | | 1996 | | 1999 | |
| | Ideal | Pref | Ideal | Pref | Ideal | Pref | Ideal | Pref | Ideal | Pref | Ideal | Pref |
| 0 | 14.5 | 0.9 | 13.6 | 0.8 | 22.3 | 0.6 | 19.7 | 0.0 | 5.9 | 2.3 | 3.4 | 1.9 |
| 1 | 10.5 | 1.3 | 7.2 | 2.3 | 13.1 | 3.2 | 9.0 | 3.6 | 3.3 | 1.7 | 1.3 | 1.8 |
| 2 | 10.8 | 3.8 | 7.8 | 4.5 | 11.2 | 8.4 | 9.2 | 9.4 | 3.7 | 3.6 | 1.3 | 2.9 |
| 3 | 13.0 | 2.0 | 8.8 | 3.7 | 15.9 | 6.3 | 14.3 | 6.1 | 2.9 | 3.6 | 1.7 | 2.5 |
| 4 | 17.6 | 2.9 | 15.6 | 2.9 | 25.0 | 2.6 | 22.0 | 3.2 | 4.5 | 2.8 | 2.3 | 1.7 |
| 5 | 24.7 | 2.1 | 20.7 | 1.4 | 29.3 | 3.8 | 27.7 | 3.4 | 7.2 | 2.5 | 4.9 | 1.2 |
| 6+ | 30.3 | 1.9 | 28.8 | 1.6 | 39.4 | 1.7 | 38.1 | 1.2 | 12.5 | 1.7 | 7.3 | 1.8 |
| 2+ | 20.4 | 2.5 | 17.0 | 2.8 | 23.8 | 4.7 | 20.4 | 5.3 | 6.3 | 2.9 | 3.3 | 2.2 |
| | | | | | | | | | | | | |
| Total | 18.8 | 2.2 | 15.6 | 2.6 | 22.2 | 4.3 | 18.7 | 4.7 | 5.7 | 2.6 | 2.9 | 2.1 |
| | | | | | | | | | | | | |
| n women[a] | 9153 | | 13,710 | | 14,382 | | 8498 | | 8450 | | 9720 | |

a. Currently married women

Table 2. Percentage of births unwanted, by birth order: Egypt and Bangladesh
Conventional DHS estimators vs. Two-Survey Estimator

| Birth Order | Egypt | | | | | | | | | Bangladesh | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 - 1995 | | | 1995 - 2000 | | | 2000 - 2003 | | | 1996 - 1999 | | |
| | % not wanted [a] | % > ideal [b] | Two-Survey | % not wanted [a] | % > ideal [b] | Two-Survey | % not wanted [a] | % > ideal [b] | Two-Survey | % not wanted [a] | % > ideal [b] | Two-Survey |
| 1 | 0.0 | 0.0 | 2.1 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.0 | 3.0 |
| 2 | 2.3 | 2.8 | 6.0 | 1.4 | 1.2 | 4.1 | 1.5 | 1.5 | 1.9 | 1.2 | 1.1 | 2.5 |
| 3 | 17.5 | 29.7 | 51.6 | 9.0 | 20.5 | 44.1 | 10.4 | 24.2 | 47.2 | 14.0 | 41.0 | 41.2 |
| 4 | 31.7 | 43.8 | 59.9 | 19.5 | 34.9 | 66.7 | 25.8 | 41.7 | 67.0 | 35.1 | 57.3 | 49.9 |
| 5 | 39.2 | 54.0 | 79.6 | 29.6 | 44.3 | 71.6 | 30.1 | 52.9 | 77.9 | 40.2 | 65.7 | 65.1 |
| 6 | 53.2 | 57.9 | 83.3 | 43.8 | 44.3 | 85.2 | 50.0 | 64.6 | 69.3 | 40.5 | 72.9 | 59.8 |
| 7+ | 62.8 | 54.4 | 90,5 | 54.3 | 45.1 | 89.6 | 46.3 | 47.5 | 92.3 | 48.8 | 76.3 | 62.1 |
| 3+ | 36.9 | 44.5 | 68.9 | 25.5 | 33.9 | 65.2 | 23.7 | 38.0 | 62.7 | 29.8 | 56.1 | 51.3 |
| | | | | | | | | | | | | |
| Total | 20.5 | 24.8 | 39.2 | 13.0 | 17.0 | 33.2 | 11.0 | 17.3 | 28.5 | 13.6 | 25.1 | 24.3 |
| | | | | | | | | | | | | |
| n births | 5600 | | | 8781 | | | 3517 | | | 3519 | | |

a. Direct retrospective report on whether or not another child was wanted at time of conception.
b. Comparison of ideal number of births with number of living children at month of conception.

Table 3. Percentage of women not wanting another birth, according to two indicators: Egypt and Bangladesh

| Parity | Egypt | | | | | | | | Bangladesh | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | | 1995 | | 2000 | | 2003 | | 1996 | | 1999 | |
| | % want no more | % living >= ideal | % want no more | % living >= ideal | % want no more | % living >= ideal | % want no more | % living >= ideal | % want no more | % living >= ideal | % want no more | % living >= ideal |
| 0 | 1.6 | 0.0 | 0.5 | 0.0 | 0.9 | 0.1 | 0.6 | 0.0 | 2.4 | 0.1 | 0.6 | 0.2 |
| 1 | 7.9 | 4.6 | 7.2 | 5.1 | 6.3 | 4.4 | 6.7 | 4.5 | 8.3 | 4.7 | 9.6 | 6.3 |
| 2 | 57.7 | 54.6 | 56.7 | 58.0 | 58.0 | 57.6 | 56.4 | 55.5 | 57.4 | 61.9 | 59.3 | 64.0 |
| 3 | 77.0 | 70.2 | 79.0 | 75.5 | 80.5 | 69.8 | 80.2 | 70.9 | 74.6 | 79.0 | 79.2 | 80.5 |
| 4 | 85.2 | 74.4 | 84.4 | 75.7 | 87.7 | 67.0 | 88.9 | 72.4 | 83.3 | 85.7 | 84.9 | 84.6 |
| 5 | 87.7 | 69.8 | 88.5 | 73.3 | 88.4 | 64.3 | 91.5 | 68.8 | 84.9 | 87.4 | 89.9 | 89.5 |
| 6+ | 89.8 | 64.6 | 89.6 | 66.2 | 91.1 | 55.6 | 91.6 | 57.4 | 85.4 | 85.0 | 89.3 | 87.9 |
| 2+ | 80.1 | 66.1 | 79.5 | 69.0 | 79.9 | 62.2 | 78.8 | 64.3 | 75.7 | 78.4 | 78.0 | 79.3 |
| | | | | | | | | | | | | |
| Total | 66.8 | 54.4 | 65.4 | 56.3 | 65.4 | 50.6 | 63.9 | 51.5 | 57.8 | 58.6 | 59.2 | 58.8 |
| | | | | | | | | | | | | |
| n women [a] | 9153 | | 13,710 | | 14,382 | | 8498 | | 8450 | | 9720 | |

Notes: % want no more: calculated for currently married women; not stated and uncertain classified as wanting another child.
% living >= ideal: not stated and non-numeric responses treated as ideal>actual.

a. Currently married women