A Comparison of Two Methods for Assessing the Impact of Female Sterilization on Fertility: Ecuador, 1979-1989[1]

by

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INTRODUCTION

The simultaneous decline of fertility in many developing countries and the increase in the proportion of women who are sterilized raises the issue of how much of the fertility decline can be attributed to sterilization. Westoff, Goldman, McCarthy, and Mascarin (1979) proposed a methodology for assessing the effect of female sterilization on fertility and illustrated it using survey data from Panama. The same basic methodology has since been applied using data from the United States (Westoff and McCarthy, 1979), Colombia, Costa Rica, The Dominican Republic, and Panama (McCarthy, 1982), Costa Rica (Barrantes and McCarthy, 1982), Puerto Rico (Warren, et al., 1986), Brazil (Rutenberg and Ferraz, 1988), and Ecuador (Stupp, et al., 1991). In this paper we compare the results obtained using this now well-established approach, which will be referred to as the "Births Averted Approach", and a new approach we are proposing, which will be referred to as the "Parity Progression Approach".

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Both approaches estimate the impact of sterilization on fertility by estimating what would have been the Total Marital Fertility Rate (TMFR) if sterilized women had not gotten sterilized. Both approaches yield an estimate of the average number of births averted per ever-married woman, which is calculated as the difference between the hypothetical TMFR, in the absence of sterilization, and the observed TMFR for a given period of time. The approaches differ in the formula used for calculating the TMFR for a period (i.e., for a synthetic cohort of ever-married women based on marital fertility observed during a period of time), and they differ in the assumption made about what would have been the subsequent fertility of sterilized women if they had not been sterilized. The conventional births averted approach assumes that if they had not gotten sterilized, sterilized women would have gone on to experience fertility at the same level as ever-married, non-sterilized women at the same duration since their first union[4]. The parity progression approach assumes that if they had not gotten sterilized, sterilized women would have gone on to experience fertility at the same level of fertility as non-sterilized women who had reached same the parity.

The parity progression approach is being proposed as an alternative

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[4]A variation of the births averted approach is to consider the effect of sterilization on unwanted fertility, by assuming that sterilized women would have experienced the same level of fertility as non-sterilized women who had surpassed their desired family size reached, controlling for time elapsed since the last wanted birth.

to the earlier births averted approach because we believe that it more closely mirrors the decision-making process about surgical sterilization, which we think is more closely related to the number of children a woman has had than to the time that has elapsed since her first union. It is important to note here that both estimates of births averted by sterilization rest on a non-verifiable assumption about the subsequent fertility of sterilized women had they not been sterilized.

DATA

For the two methods described here the data requirements are essentially the same. The analysis is conducted only on ever-married women, with the assumption being that never-married women are not candidates for sterilization. It is necessary to have the date of first union for all ever-married women and to have the date of sterilization for all sterilized women. It is also necessary to have the dates of all live births to all ever-married women during the period of time for which the births averted calculation is to be performed, as is usually obtained in a birth history. For the parity progression approach it is also necessary to be able to determine the birth order of all births, and to obtain the date of birth of the last live birth prior to the period for which the calculation is to be performed.

The data being used for this analysis are from the 1989 Ecuadoran Demographic and Maternal/Child Health Survey (ENDEMAIN), which was

conducted by the Centro de Estudios de Población y Paternidad Responsable (CEPAR) and the Ministry of Public Health, with assistance from the Division of Reproductive Health, Centers for Disease Control. The survey was designed to be representative of women 15 to 49 years of age in the sierra and coastal regions, which represent 96 percent of the population. It excludes the Amazon and Galapagos regions. The survey included a birth history for the 15 years prior to the survey (since January, 1974), as well as dates of first union and sterilization. There were 7961 women interviewed, of whom 5350 had ever been married and are included in this analysis.

Table 1 compares contraceptive prevalence rates from the 1989 survey with the 1979 WFS conducted in Ecuador and shows that total prevalence has risen from 33.6 to 52.8 percent of married women using contraception, with sterilization accounting for 54 percent of the increase in prevalence (7.8 to 18.3 percent sterilized). The Total Fertility Rate (TFR) has declined from 5.4 in the period 1974-79, according to the 1979 WFS, to 3.8 in 1984-89, according to the 1989 survey. Table 1 also illustrates that increases in prevalence of sterilization between 1979 and 1989 have been most pronounced at higher parities and later durations since first union. Increases in the prevalence of other methods, which we will refer to as reversible methods, however, have been greatest at earlier durations since first union and at lower parities. In the analysis which follows we will be concerned with relating the

increase in prevalence of sterilization to the decline in fertility during this period from 1979 to 1989. We will therefore be estimating fertility and births averted by sterilization for two separate five year periods: August 1979 - July 1984, and August 1984 - July 1989.

THE BIRTHS AVERTED APPROACH

THe "births averted" approach was first introduced by Westoff, McCarthy, Goldman, and Mascarin (1979) in an analysis of the impact of sterilization on fertility rates in Panama. They calculated a measure of births averted per ever-married woman, which is the difference between what the total marital fertility rate (TMFR) would have been if sterilized women had experienced the same marriage duration-specific fertility rates during a period as did the non-sterilized women and the actual TMFR for the period.

$$\text{Births Averted} = \text{TNSMFR} - \text{TMFR}, \qquad (1)$$

where TMFR is calculated in the usual manner summing duration-specific marital fertility rates, and TNSMFR, the total non-sterilized marital fertility rate, is calculated by summing duration-specific non-sterilized marital fertility rates (DSNSMFR's) for which the exposure of sterilized women is censored at the duration at which they get sterilized. Births averted can also be calculated separately for each category of duration since first union.

These calculations have been performed separately for the two periods 1979-84 and 1984-89, using data from the 1989 Ecuadoran survey, and the results are shown in Table 2. We only present results for durations up to 25 years since date of first union, since there is very little exposure at later durations that is captured by this survey, which was only of women ages 15 through 49.

The estimated number of births averted per ever-married woman actually declined slightly from .67 in the earlier period to .64 in the more recent period, despite the fact that proportions of women sterilized was documented to have increased substantially between 1979 and 1989 (see Table 1). The reason for this is that while sterilization has risen, the fertility of non-sterilized women has declined. The TNSMFR, which is the sum of the duration-specific birth rates in the absence of sterilization, declined from 5.93 in 1979-84 to 5.01 in 1984-89. We can see from Table 2 that births averted at durations less than 15 years are greater in 1984-89, while births averted at durations 15 through 24 years were greater in the earlier period, 1979-84. This is because the duration-specific fertility of non-sterilized women at later durations declined more over time than did all marital fertility at these durations.

Table 3 shows the percent of woman-years of exposure that was protected by sterilization, within categories of duration since

first union. It also shows the hypothetical percentages of women who would be sterilized, at different durations since first union, in a synthetic cohort of women who experienced the duration-specific sterilization rates that were in effect in each of the periods, 1979-84 and 1984-89. Table 3 demonstrates that while the actual percent of ever-married women who are sterilized has been rising during the decade, the proportions getting sterilized by a given duration (i.e., the "hypothetical percent sterilized") shows little change.

Previous expositions of the births averted technique have calculated a synthetic cohort measure of the number of births that would be averted in a marriage cohort of women that experienced both the sterilization rates and the non-sterilized birth rates (i.e., birth rates in the absence of sterilization) that were in effect in a period. The purpose of this exercise has been to evaluate the potential future births averted in a population that is experiencing rising proportions sterilized. The problem with this approach is that the non-sterilized birth rates (the TNSMFR's) are falling, so that the approach overestimates births averted by not taking into consideration future declines in the fertility of the non-sterilized as the use of reversible methods increases. We have therefore not replicated this aspect of the births averted analysis as is commonly done.

The average number of births averted estimated by this procedure

depends on the assumption that, if they had not been sterilized, sterilized women would have gone on to bear children at the same fertility rates as did ever-married, non-sterilized women at the same marital durations[5]. In all likelihood, there are some sterilized women who are less likely than non-sterilized women to use or have access to other forms of contraception, a fact which is supported by the observation that many sterilized women (43.8 percent in the case of Ecuador in 1989, as shown in Table 4) had not used reversible methods prior to getting sterilized. On the other hand, there probably is another group of sterilized women who would have been more motivated to limit their fertility, even if they had not been sterilized, than are non-sterilized women. It is our contention that these two groups of sterilized women may be usefully differentiated by taking into consideration the parity at which they get sterilized. Those getting sterilized at low parities would probably be motivated to control their fertility by other methods, while sterilization at higher parities may be an indication of poor access to family planning services. This leads us to our second approach.

THE PARITY PROGRESSION APPROACH

In the approach outlined above, marital fertility is disaggregated into categories of duration since first union, for ever-married women. Births averted can be calculated for each duration category

[5]Marital duration will be used to refer to the duration since first consensual union or marriage for women who were ever in a union.

and reaggregated to obtain an estimate of how much larger the total marital fertility rate would have been if nobody had gotten sterilized. An alternative way to disaggregate fertility and to assess the effect of sterilization on fertility is through the calculation of parity progression ratios (PPR's). The advantages of parity progression, as a technique for disaggregating fertility, have been described elsewhere (see Henry, 1953; Ryder, 1982; or Feeney, 1987), and will only be summarised here. Let P0 represent the proportion of ever-married women in a cohort who ever have a first birth, P1 the proportion of those with a first birth who progress to a second birth, and more generally P_i the proportion of those women with $\underline{i}$ births who progress to $\underline{i+1}$ or more births. The total fertility rate (TMFR) can then be expressed as:

$$TMFR = P0 + (P0)(P1) + (P0)(P1)(P2) + \ldots + (P0)(P1)\ldots(P_m), \quad (2)$$

where $\underline{m+1}$ is the maximum parity reached by the cohort. Each term in this sum represents the average number of births of a given order per woman (P0 is the average number of first births, (P0)(P1) is the average number of second births, etc.). Since sterilization terminates a woman's fertility at a given parity it will be useful to examine the effect of sterilization on individual parity progression ratios, as well as on the summary TMFR measures.

In order to compare the results of this method with the births averted approach we need to calculate <u>period</u> parity progression

ratios. The approach we take is to construct a period parity progression ratio from observations of the proportions of women progressing from parity i to $i+1$ during a specified period, broken down by categories of duration since the occurrence of birth i. The experience of women at different categories of duration during the reference period is concatenated together to create a synthetic parity cohort. We define each P_i as the proportion of women at parity i who would progress to parity $i+1$ if they experienced the duration-in-parity specific fertility rates that were in effect in a specific period:

$$P_i = 1 - (1-q(i,d0))(1-q(i,d1))(1-q(i,d2))\cdots(1-q(i,dm)), \quad (3)$$

where the $q(i,d)$[6] values are the probabilities of having birth $i+1$ within successive duration intervals after birth i. Each of the factors in expression (3), $(1-q(i,dn))$, is the conditional probability of surviving through duration category dn without progressing to parity $i+1$, given that the woman has not already progressed to parity $i+1$ before reaching duration dn. In practice, we first calculate birth rates, $m(i,dn)$, as the ratios of births of order $i+1$ in duration category dn to woman-months of exposure in parity i and duration category dn, during the specified period, and

[6]In the examples presented here we use 3 month wide duration intervals for durations 0 to 36 months, 6 month intervals for durations 36 to 60 months, 12 month intervals for durations 60 to 84 months, and a last 36 month interval for duration 84 to 120 months. Exposure and births beyond 120 months after the previous birth are not included in the calculations.

then convert the m(i,dn) rates to the q(i,dn) probabilities to be used in Expression (3). In this way, only births and exposure occurring within the reference period enter into the calculations, as is the case when calculating age or duration-specific fertility rates for a period. The calculations are analagous to those used in calculating the synthetic cohort life table function, l_x, from period death rates, ${}_nm_x$.

The effect of sterilization on PPR's will be evaluated by recalculating expression (3), but censoring the fertility exposure of sterilized women at the parity and duration in parity at which they were sterilized. In effect, we are assuming that if sterilized women had not been sterilized they would have experienced the same fertility as did non-sterilized women who were at the same parity and duration since their last birth during the reference period. There is no way of knowing if this assumption is correct, but it does provide a useful alternative to be compared to that employed by the conventional births averted approach, if only because it is more explicit about which non-sterilized women constitute the appropriate comparison group. As noted before, we think that achieved parity at the time of sterilization may be a better indicator of potential fertility than is duration since first union, and that the decision of whether or not to get sterilized is much more closely linked to parity than to time since first union.

Table 5 summarizes the Ecuadoran data used for the application of

the parity progression approach. It presents total woman-years of exposure spent within parities 0 through 11, and total woman-years of non-sterilized exposure (i.e., after sterilized exposure has been censored) during the two periods 1979-84 and 1984-89. It also presents births, categorized by order, that occurred in each of these periods. All the calculations presented here extend only through parity 11, which is terminated by the twelfth birth for a given woman. There was insufficient exposure at higher parities to include them in the calculations.

Table 6 shows examples of the proportions of women in synthetic parity cohorts who would progress from parity 0 to parity 1 and from parity 6 to parity 7, by the time elapsed since reaching parities 0 and 6 respectively, if they experienced the duration-in-parity specific fertility rates that were in effect during the 1984-89 period. We have calculated both the proportions progressing without censoring sterilized women at time of sterilization and with censoring. The proportions progressing with censoring are thus interpreted as the proportion that would progress to the next parity if the sterilized women had gone on to experience the same fertility as did non-sterilized women at the same parity. We can see that progression from first union (parity 0) to first birth is both fairly rapid with 90 percent progressing within 3 years and complete with 98 percent progressing within 10 years. All period parity progression ratios reported here are the proportion that would progress within 10 years if subjected to the period duration

in parity specific birth rates.

It is evident from Table 6 that sterilization has no effect on the progression from parity 0, which begins with entry into the first union, to parity 1. Since nobody gets sterilized before the first birth (i.e. nobody has their exposure at parity 0 censored) the proportion progressing after each duration is identical without and with censoring. This can be contrasted with parity 6, where 72 percent of those reaching parity 6 progress to parity 7 when sterilized exposure is not censored, but 83 percent progress to the next parity when sterilized exposure is censored. The interpretation is that in the absence of sterilization 83 percent of women reaching parity 6 would progress to parity 7, instead of the 72 percent that is observed with sterilization present.

Table 7 presents the period parity progression ratios calculated, both without and with sterilized women being censored at the time of sterilization, for parities 0 through 11 and for the periods 1979-84 and 1984-89. In all cases this is the proportion of women who would progress within 10 years if they experienced the duration in parity birth rates that were in effect during the period. We observe that in both periods the proportions progressing in the absence of sterilization would have been higher than was actually the case with sterilization present for parities 2 and above. We also note that between 1979-84 and 1984-89 the progression ratios for parities 3 and above have declined fairly substantially,

reflecting the fertility decline during the period. This is true for the ratios calculated with sterilized exposure begin censored, as well as for the ratios without censoring, indicating that non-sterilized marital fertility has declined. In the earlier period progression ratios for the non-sterilized (with censoring) range between .808 and .930 at parities 4 and above, while in the later period there is a gradual decline from .824 to .621 at parity 11. We thus see that, even in the absence of sterilization, there was a decline in marital fertility at higher parities during the 1980's.

Table 8 presents estimates of order-specific marital fertility, that were calculated using the parity progression ratios presented in Table 7 in Expression (2). The order-specific rates are interpreted as the average number of births of a given order per ever-married woman. The order-specific rates are obtained by multiplying together the parity progression ratios for parities 0 through one less than the birth order number. For example in 1979-84, an average of .63 fourth births per ever-married woman was obtained by multiplying the progression ratios (.984)(.928)(.858)(.798). The order-specific rates can also be interpreted as the proportion of all ever-married women who reach a given parity (e.g., 63 percent of ever-married women would reach parity 4 if subjected to the period parity progression ratios prevailing in 1979-84).

Table 8 thus allows us to examine the effect of sterilization on birth order specific fertility. The difference between the order-specific fertility calculated without censoring sterilized women and that calculated with censoring can be interpreted as the number of births of a given order averted by sterilization. We can see that in the earlier period the number of births averted at orders 7 and above is consistently between .14 and .16 births at each order, while in the later period births averted by sterilization declines as parity increases. This is because in the later period fewer women are reaching higher parities, even in the absence of sterilization. Note, for example that according to the 1979-84 progression ratios, 40 percent of women (52 percent in the absence of sterilization) reach parity 6, which is reduced to just 27 percent (41 percent in the absence of sterilization) according to the 1984-89 parity progression ratios. As a consequence of this decline in fertility, the births averted by sterilization in 1984-89 is concentrated at the middle birth orders, 5 through 9, while in the earlier period it is at the higher birth orders, 7 and above.

Table 8 also presents information on cumulative order-specific fertility and births averted by sterilization. The cumulative order-specific rates are the average number of births up to and including births of a given order. While total births averted up through birth order 12 are greater for 1979-84 than for 1984-89 (1.20 versus 0.96), cumulative births averted at all birth orders

up through order 9 are greater for the later period, 1984-89. The impact of sterilization on fertility has thus shifted to earlier phases of childbearing, as women are getting sterilized at lower parities. The fact that overall births averted through birth order 12 declined from 1979-84 to 1984-89 is attributable to the finding that even in the absence of sterilization fewer women were reaching the highest parities in the more recent period.

Table 8 also illustrates the importance of the choice of a cutoff parity to be used in calculating a Total Marital Fertility Rate (TMFR). We have chosen to limit computation to births through order 12, based on an arbitrary criterion of using only parities with at least 75 person-years of exposure. This results in estimated TMFR's of 5.34 and 4.30 for 1979-84 and 1984-89, respectively, and hypothetical TNSMFR's of 6.54 and 5.26 when sterilized exposure is censored. It is clear that for the period 1979-84, if exposure at higher parities had been incorporated into the calculations the estimated number of births averted could have been substantially greater, given that 10 percent of women in that period's synthetic cohort reach parity 12. For 1984-89, this is less of an issue as only 2 percent of women in the synthetic cohort reach parity 12 so that there is less scope for further impact at higher parities. Much the same issue arises in the conventional births averted approach where a cutoff duration since first union must be chosen.

THE METHODS COMPARED

Table 9 presents a comparison of the aggregate results from the two methods. For each method and each period it shows: the Total Non-Sterilized Marital Fertility Rate (TNSMFR), which is the hypothetical TMFR that would prevail if sterilized women had not been sterilized; the actual TMFR; and births averted by sterilization, which is the difference between the TNSMFR and the TMFR. We note fairly close agreement between the two methods in the actual TMFR's: 5.26 and 5.34 for 1979-84 and 4.37 and 4.30 for 1984-89. Given that the two methods for calculating the TMFR, using duration-specific marital fertility and using parity progression ratios, are so different we would not necessarily expect such close agreement in the estimates of TMFR they produce. Had we used either a terminal marriage duration other than 25 years or a terminal birth order other than 12, the agreement may not have been so close.

The hypothetical TMFR's that would have occurred in the absence of sterilization (i.e., the TNSMFR's) are considerably different for the two methods. The conventional births averted technique, in which it is assumed that the sterilized women would have gone on to experience the same fertility rates as did non-sterilized women at the same duration since first union, estimates TNSMFR's of 5.93 and 5.01 for 1979-84 and 1984-89, respectively. The parity progression approach, in which it is assumed that the sterilized women would have gone on to experience the same fertility rates as did non-

sterilized women at the same parity and duration in parity, estimates higher TNSMFR's of 6.54 and 5.26 for 1979-84 and 1984-89, respectively. As a consequence, the estimates of the average number of births averted by sterilization produced by the parity progression technique, 1.20 for 1979-84 and 0.96 for 1984-89, are higher than the estimates of births averted produced by the marriage duration technique, 0.67 and 0.64 for the two periods. There is really no way of empirically verifying which of the two assumptions is better or which estimate of births averted is correct. We do, however, now know that on average the fertility of nonsterilized women at the same parities as sterilized women is greater than the fertility of nonsterilized women at the same duration since their first union as sterilized women. The choice of which estimate to accept reduces to making a judgement about the relative soundness of the two assumptions.

In previous assessments of female sterilization on fertility using the births averted approach, the focus of attention has been on the estimate of births averted by sterilization in a single five-year period before the survey. We believe it is also useful to compute estimates for separate periods of time so that trends in marital fertility and non-sterilized marital fertility can be examined. It is particularly instructive to note the large decline in the fertility of non-sterilized women during a period in which most of the increase in contraceptive prevalence is due to increases in sterilization. The fact that non-sterilized fertility is declining

lessens the potential impact of sterilization on fertility despite the rising prevalence of sterilization over time. Using the parity progression approach we find that non-sterilized fertility declined by 1.28 births per woman compared to a lesser decline of 1.04 births in total marital fertility, so that there is a reduction of 0.24 births averted by sterilization between the two periods. As noted earlier, this is because a smaller proportion of women in the later period are reaching the very high parities, 9 and above, where the largest impact of sterilization on fertility was registered in the earlier period.

DISCUSSION

We have proposed a new, parity progression method for assessing the effect of female sterilization on fertility, and compared the results obtained by that method to those obtained by a previously proposed duration since first union-specific method, using data from Ecuador. The methods differ in the manner in which they disaggregate marital fertility and in the assumption they make about what the subsequent fertility of sterilized women would have been if they had not been sterilized.

We have proposed the parity progression approach because we believe it more closely mirrors the decion-making process about surgical contraception, which is more closely related to the number of children a woman has had than to the time that has elapsed since she first entered a union. We also are convinced that the potential

fertility sterilized women would have experienced, had they not been sterilized, would be more similar to that of non-sterilized women at the same parity than to that of non-sterilized women at the same marriage duration. This is based on our assertion that women getting sterilized at low parities are strongly motivated to control their fertility and would have sought out reversible methods which are most prevalent at lower parities, while women getting sterilized at high parities have not controlled their fertility in the past and would exhibit the same low utilization of reversible methods as seen among high parity women. Unfortunately, there is no empirical means of verifying this assertion.

The new method makes it possible to consider the effects of sterilization on individual parity progression ratios and on the proportions of ever-married women progressing to any given parity. It provides estimates of the average number of births per woman that were averted by sterilization in a period, and makes it possible to disaggregate the estimate of births averted by birth order.

Unlike previous expositions of the births averted methodology, we have presented estimates of marital fertility, non-sterilized fertility (i.e., what marital fertility would have been in the absence of sterilization), and births averted by sterilization for different periods of time. This makes it possible to consider how the births averted by sterilization can diminish over time, despite

rising prevalence of sterilization, because of simultaneous declines in non-sterilized fertility due to increased use of reversible methods of contraception.

We believe this work points out a future avenue of research that attempts to make similar calculations of births averted by a variety of contraceptive methods. The contraceptive use calenders included in increasing numbers of fertility and family planning surveys make it possible to identify periods of non-exposure attributed to specific methods similar to what has been done here for sterilization. This should lead to an assessment of the impact of contraception on fertility that combines information on patterns of use and the stages in women's childbearing careers at which particular methods come into use.

Related to this last point, we have included Table 10 to illustrate how the parity progression approach can be used to examine changes in birth interval distributions over time. We have calculated the median time elapsed from achieving a given parity to the next birth for synthetic cohorts of women who experienced duration in parity specific birth rates in a period. The calculation has been done for both periods of time and for all marital fertility and for non-sterilized fertility that would have occurred in the absence of sterilization. Within each period we can see that the median birth intervals are shorter when sterilized exposure is censored, illustrating how sterilization lengthens the median interval to the

next birth from a given parity. This effect is most pronounced at higher parities. By comparing the results for the two periods when the post-sterilization exposure of sterilized women is censored we can also see how the decline in non-sterilized fertility due to use of reversible methods results in a lengthening of the median intervals from one period to the next, independent of the effect of sterilization. A similar decomposition of fertility by censoring periods of exposure that are protected by different methods can be used to assess which methods have the greatest impact on fertility.

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Table 1

Percent of Currently Married Women Using Contraception by Selected Methods, and Percent Distribution of Married Women by Selected Characteristics: Ecuador, 1979 and 1989

	1979[7]			1989[8]			Percent of Married Women	
	Contraceptive Method			Contraceptive Method				
	All	Steril.	Other	All	Steril.	Other	1979	1989
All Women	33.6	7.8	25.8	52.8	18.3	34.5	100.0	100.0
Age								
15-19	13.7	0.0	13.7	25.0	0.0	25.0	6.9	5.7
20-24	28.6	0.6	28.0	39.1	0.5	38.6	18.0	16.3
25-29	36.6	2.6	34.0	55.3	6.4	48.9	20.5	20.8
30-34	42.5	11.4	31.1	63.0	22.3	40.7	18.1	19.1
35-39	41.7	15.2	26.5	61.3	31.7	29.6	15.2	17.0
40-44	35.3	15.8	19.5	58.5	34.4	24.1	11.7	12.2
45-49	19.6	9.8	9.8	44.8	34.5	10.3	9.7	8.9
Years Since First Union								
0-9	30.2	2.0	28.2	46.2	4.6	41.6	45.4	45.1
10-19	41.7	12.8	28.9	61.2	26.4	34.8	32.3	34.6
20-29	31.3	13.2	18.1	54.8	35.3	19.5	19.5	18.3
30+	11.9	6.4	5.5	41.5	34.0	7.5	2.8	2.0
No. Living Children								
0	7.8	0.0	7.8	16.8	0.3	16.5	7.2	6.5
1	26.9	0.3	26.6	43.3	1.0	42.3	14.7	17.4
2	42.1	3.0	39.1	59.3	7.1	52.2	18.0	20.8
3	42.1	10.4	31.7	65.2	27.0	38.2	15.3	18.1
4	35.5	10.3	25.2	60.8	33.3	27.5	12.2	13.4
5	39.8	17.5	22.3	57.0	36.3	20.7	9.6	8.2
6+	30.2	11.7	18.5	46.8	27.9	18.9	23.1	15.7

[7]1979 Encuesta Nacional de Fecundidad (WFS) Ecuador.

[8]1989 Encuesta Demográfica y de Salud Materna e Infantil.

Table 2

Duration-Specific Marital Fertility Rates, Non-Sterilized

Marital Fertility Rates, and Births Averted by Sterilization
Per 1000 Ever-Married Women

Ecuador

	1979-84			1984-89		
Duration	DSMFR[9]	DSNSMFR[10]	Births Averted[11]	DSMFR	DSNSMFR	Births Averted
0-4	380	385	5	356	361	5
5-9	241	258	17	202	220	18
10-14	175	205	30	143	178	35
15-19	146	187	41	105	144	39
20-24	111	151	40	69	99	30
Total (Per Woman)	5.26	5.93	0.67	4.37	5.01	0.63

[9]Duration Specific Marital Fertility Rate = 1000*Births/(Woman Years of Exposure) during a given time period and within a given duration since first union.

[10]Duration-Specific Non-Sterilized Marital Fertility Rate = 1000*Births/(Non-sterilized woman years of exposure) during a given time period within a given duration since first union.

[11]Births Averted = DSNSMFR - DSMFR. This assumes that if sterilized women had not been sterilized they would have gone on to experience the same fertility rates as did the non-sterilized women at the same durations since first union.

Table 3

Comparison of Actual Percent Sterilized by Duration Since First Union with Hypothetical Percent Sterilized Implied by Sterilization Rates for the Period, 1979-84 and 1984-89

Duration In Years	Actual[12] Percent Sterilized 1979-84	1984-89	Hypothetical[13] Percent Sterilized 1979-84	1984-89
0-4	1.5	1.5	1.7	1.3
5-9	6.7	8.3	8.4	8.3
10-14	14.6	19.5	20.0	20.0
15-19	21.9	27.0	31.7	31.3
20-24	26.5	29.9	40.0	38.8
25-29	28.7	32.2	44.9	42.3

[12]Actual percent sterilized in the period is calculated from the ratio of woman-years of sterilized exposure in that duration in the numerator and total woman-years of exposure in that duration in the denominator.

[13]Hypothetical percent sterilized is calculated as the proportion of women who would be sterilized at a given duration in a marriage cohort of women who experienced the duration-specific sterilization rates for a given period. The sterilization rates for the period were calculated as the ratio of sterilizations to woman-years of non-sterilized exposure at a given duration in the period.

Table 4

Percent of Married, Surgically Sterilized Women, Aged 15-49, Whose First Method of Contraception was Sterilization, by Selected Characteristics: Ecuador, 1989

	Percentage	No. of Cases
All Women	43.8	876
Area		
Urban	36.1	617
Rural	62.2	259
Education		
None	76.7	43
Primary	53.0	472
Secondary	27.9	287
Superior	28.4	74
Year of Sterilization		
Before 1975	61.0	77
1975-1979	53.7	149
1980-1984	42.8	304
1985-1989	36.7	346

Table 5

Exposure* to Ever-Married Women, Non-Sterilized Exposure, and Births by Parity: Ecuador, 1979-84 and 1984-89

Parity (i)	1979-84 Marital Exposure	1979-84 Non-Sterilized Exposure	1979-84 Births of Order (i+1)	1984-89 Marital Exposure	1984-89 Non-Sterilized Exposure	1984-89 Births of Order (i+1)
0[14]	1514	1510	913	1784	1780	1077
1	3012	3012	873	3837	3835	930
2	2913	2817	643	3799	3638	697
3	2366	2077	433	3323	2705	469
4	1645	1391	341	2217	1627	288
5	1308	1049	241	1624	1181	235
6	992	804	197	1196	894	179
7	755	608	148	903	674	112
8	499	411	89	691	527	88
9	291	237	55	443	366	59
10	170	143	31	282	228	39
11	93	77	22	169	147	23

* Exposure given in person-years

Table 6

Proportions of Women Progressing to Next Parity, by Time In Parity, For Parities 0 and 6, Without and With Censoring At Time of Sterilization: Ecuador, 1984-89

Years In Parity	Parity 0 Without Censoring	Parity 0 With Censoring	Parity 6 Without Censoring	Parity 6 With Censoring
0	0.000	0.000	0.000	0.000
1	0.438	0.438	0.017	0.018
2	0.786	0.786	0.242	0.271
3	0.904	0.904	0.443	0.505
4	0.933	0.933	0.579	0.667
5	0.954	0.954	0.621	0.716
6	0.968	0.968	0.659	0.760
7	0.970	0.970	0.687	0.793
10	0.980	0.980	0.720	0.830

[14]Exposure at parity 0 commences at the date of first union.

Table 7

Period Parity Progression Ratios[15], Without and With Sterilized Women Being Censored at Time of Sterilization Ecuador, 1979-84 and 1984-89

	1979-84		1979-84	
Parity	Without Censoring	With Censoring	Without Censoring	With Censoring
0	0.984	0.984	0.980	0.980
1	0.928	0.928	0.910	0.910
2	0.858	0.873	0.829	0.848
3	0.798	0.862	0.724	0.802
4	0.823	0.887	0.702	0.824
5	0.770	0.858	0.714	0.825
6	0.804	0.890	0.720	0.830
7	0.790	0.870	0.658	0.776
8	0.728	0.808	0.650	0.753
9	0.825	0.919	0.634	0.695
10	0.813	0.930	0.640	0.722
11	0.786	0.871	0.590	0.621

[15]Parity progression ratios for a period are calculated by combining synthetic cohort probabilities of progressing to a given parity within intervals of duration since achieving the previous parity. The ratios presented take into account all exposure and births falling within the period categorized by intervals of duration up to 120 months since the previous birth. We use 3 month intervals from 0 through 36 months, 6 month intervals from 36 through 60 months, 12 month intervals from 60 to 84 months, and a final 36 month interval from 84 to 120 months.

Table 8

Order-Specific Marital Fertility and Cumulative Order-Specific Fertility, Without and With Censoring at Time of Sterilization Ecuador, 1979-84 and 1984-89

1979-84

Birth Order	Order-Specific Fertility: Without Censoring	Order-Specific Fertility: With Censoring	Births Averted	Cumulative Order-Specific Fertility: Without Censoring	Cumulative Order-Specific Fertility: With Censoring	Births Averted
1	0.98	0.98	.00	0.98	0.98	.00
2	0.91	0.91	.00	1.90	1.90	.00
3	0.78	0.80	.02	2.68	2.69	.01
4	0.63	0.69	.06	3.31	3.38	.07
5	0.51	0.61	.10	3.82	3.99	.17
6	0.40	0.52	.08	4.22	4.51	.29
7	0.32	0.47	.15	4.54	4.98	.44
8	0.25	0.40	.15	4.79	5.38	.59
9	0.18	0.33	.15	4.97	5.71	.74
10	0.15	0.30	.15	5.12	6.01	.89
11	0.12	0.28	.16	5.24	6.29	1.05
12	0.10	0.24	.14	5.34	6.54	1.20

1984-89

Birth Order	Order-Specific[16] Fertility: Without Censoring	Order-Specific[16] Fertility: With Censoring	Births Averted	Cumulative Order-Specific Fertility: Without Censoring	Cumulative Order-Specific Fertility: With Censoring	Births Averted
1	0.98	0.98	.00	0.98	0.98	.00
2	0.89	0.89	.00	1.87	1.87	.00
3	0.74	0.76	.02	2.61	2.63	.02
4	0.54	0.61	.07	3.15	3.23	.08
5	0.38	0.50	.12	3.52	3.73	.19
6	0.27	0.41	.14	3.79	4.15	.36
7	0.19	0.34	.15	3.98	4.49	.51
8	0.13	0.27	.14	4.11	4.75	.64
9	0.08	0.20	.12	4.19	4.95	.76
10	0.05	0.14	.09	4.25	5.09	.84
11	0.03	0.10	.07	4.28	5.19	.91
12	0.02	0.06	.04	4.30	5.26	.96

[16]Order-specific marital fertility is a synthetic cohort estimate of the average number of births at that order per ever-married woman. It is obtained by multiplying together the parity progression ratios for parities 0 through one less than the birth order number. The total marital fertility rate (TMFR) is calculated as the sum of the order-specific marital fertility rates.

Table 9
Comparison of the Total Marital Fertility Rate (TMFR) and Total Non-Sterilized Marital Fertility Rate (TNSMFR) from the Two Methods Ecuador, 1979-84 and 1984-89

Method A: Using Duration-Specific Marital Fertility Rates

	1979-84 (A)	1984-89 (B)	Change (A)-(B)
TNSMFR	5.93	5.01	0.92
TMFR	5.26	4.37	0.89
Births Averted By Sterilization (TNSMFR - TMFR)	0.67	0.64	0.03

Method B: Using Parity Progression Ratios

	1979-84 (A)	1984-89 (B)	Change (A)-(B)
TNSMFR	6.54	5.26	1.28
TMFR	5.34	4.30	1.04
Births Averted By Sterilization (TNSMFR - TMFR)	1.20	0.96	0.24

Table 10

Median Time to Next Birth, by Parity, Based on Duration in Parity Specific Fertility Rates, With and Without Censoring at Time of Sterilization: Ecuador, 1979-84 and 1984-89

Median Duration in Months

	1979-84		1984-89	
Parity	Without Censoring	With Censoring	Without Censoring	With Censoring
0	13.9	13.9	13.6	13.6
1	29.1	29.1	35.5	35.5
2	32.9	32.4	40.6	39.8
3	36.4	34.0	51.2	43.0
4	34.6	31.9	54.4	40.2
5	40.2	33.9	42.0	35.4
6	35.2	32.5	41.2	35.8
7	35.6	31.1	46.2	40.5