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Voluntary sterilization: its demographic impact in relation to other contraceptive methods

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PREFACE

An earlier draft of this paper was presented at the Workshop on Methodological Aspects of Demographic Analysis of Sterilization, held at the East-West Center in Honolulu during 17–21 September 1979 and sponsored jointly by the International Union for the Scientific Study of Population (IUSSP) Committee on Comparative Analysis of Fertility and the East-West Population Institute. Funds for the publication of this Paper were provided by the Office of Population, Agency for International Development.

ABSTRACT This paper compares the demographic impact of sterilization with that of other methods by means of a model that calculates births averted in discrete time intervals after contraceptive acceptance by cohorts of equal size accepting different methods. The method is distinguished by a discontinuation rate parameter, and the potential fertility imputed to contraceptors is age-specific natural fertility adjusted for acceptors' greater than average fecundity. Empirical data for applying the model are Louis Henry's average natural fertility schedule (based on 13 noncontracepting populations) and World Fertility Survey findings on proportion of women who think they are noncontraceptively sterile.

The findings suggest that because of a trade-off between duration of contraception and potential fertility, the differential in births averted between younger women using pills and IUDs and older couples resorting to sterilization is less than one might suppose. For example, women in their twenties using a method they discontinue at an annual rate of 40 percent avert within five years after acceptance as many as half the number of births as women aged 30–34 resorting to sterilization. The shorter the time interval from acceptance, the narrower is the differential.

Weighting the cohort (or per-acceptor) results by the relative numbers of couples in developing countries who might be interested in the various age-method mixes attenuates the advantages of sterilization for a decisive demographic impact. Although impressive proportions of older couples say they want no more children, the young age structure independently dampens the potential demographic impact of sterilization. Because of their superiority in numbers and fecundity, women under age 30 account for 70 percent of all births, and those under age 35 for 86 percent, according to an analysis of the maternal age distribution of births in 1975 in 33 developing countries with antinatalist policies.

A suggested strategy for maximizing the demographic impact of a family planning program is to emphasize sterilization initially, if feasible, in order "to skim the cream of the motivated" but not to wait too long before shifting the emphasis to renewable methods appropriate for birth spacers.

This paper focuses on sterilization as a contraceptive method for reducing fertility in countries concerned with high rates of population

growth. Three factors determine the demographic impact of one segment of contraceptive use: the effectiveness of the method, the duration of uninterrupted use once adopted, and the potential fertility of the couple some nine months after the period of use. Quantification of these three factors permits calculation of total births averted by a couple. If potential fertility is equated with fertility expected in the absence of birth control, the number of births averted can be thought of as the *gross* demographic impact of the contraceptive method. If methods are seen as competing, with interest directed at the differential in births averted among methods, the increment in births averted by a more effective or more enduring method can be denoted as its *net* demographic impact. The analytic part of this paper deals with gross demographic impact, but the net impact of sterilization is also considered.

Sterilization obviously has unique virtues for contraceptive purposes, but to succumb to the temptation to infer that its virtues afford the possibility of achieving a rapid decline in fertility is to court overly ambitious demographic goals. Biological aspects of age-specific fecundity and empirical data on sterilization clientele suggest (1) that the demographic impact of voluntary sterilization is less than one might suppose, (2) that fertility norms have to be quite low before sterilization appeals to the appreciable number of couples required for a substantial demographic impact, and (3) that when fertility norms are low, sterilization is largely a substitute for other methods of contraception. China, with its apparent ability to apply community-level social pressure to fulfill national goals, is perhaps an exception to these remarks, but few countries have the political power and structure to radiate to the local level the influence necessary for such pressure.

Researchers are currently optimistic about the outlook for developing reversible contraceptive sterilization techniques, but the consensus is to regard current procedures as conferring permanent, irreversible sterility.[1] From a demographic perspective, it is the irreversibility of surgical contraceptive techniques that distinguishes sterilization from other methods of fertility control. A second distinguishing characteristic of demographic consequence is the effectiveness of sterilization in

1 This view was often expressed and widely endorsed by participants at the Fourth International Conference on Voluntary Sterilization held in Seoul, Republic of Korea, 7–10 May 1979, under the sponsorship of the International Project of the Association for Voluntary Sterilization, headquartered in New York.

protecting against pregnancy, although other modern contraceptive methods—pills, intrauterine devices (IUDs), injectables, and even conventional barrier methods if properly used—are also highly effective in preventing conception (Tietze, 1970). These two attributes—effectiveness if performed, and duration for life once performed—are the salient factors for assessing the demographic impact of sterilization in comparison with other methods.

Sterilization prevalence

In some parts of the world contraceptive sterilization is becoming very popular among couples of reproductive age (CRA). Serious constraints to its adoption still exist, including traditional attitudes, lack of medical expertise and facilities in major parts of the world, legal and administrative restrictions, misconceptions about the nature of sterilization, and the anxiety that any operative procedure, no matter how minor, inevitably generates; but sterilization is now said to be the dominant method in use. Although the statistics on contraceptive use are generally weak, an expert on these matters recently reported that sterilization now accounts for one-third of all contraceptive practice in the world, whereas in 1970 the figure was 14 percent (Lubell, 1979). These proportions are tenuous in that they presuppose an estimated increase in China in sterilized CRA from 4 million in 1970 to 36 million in 1978. Also attenuating the global one-third proportion is the attribution of 70 million of the 90 million estimated sterilized CRA in the world in 1978 to three countries—China, 36 million; India, 22 million; and the United States, 12 million. These precautionary remarks are meant to forestall the notion that sterilization accounts uniformly for one-third of contraceptive practice around the world. Nevertheless, one should not lose sight of the impressive agreement among a variety of sources on the widespread surging interest in this method of birth control, its growing respectability, the improvement in female as well as male procedures that allow them to be performed on an outpatient basis, and the relaxation of legal restrictions (albeit sometimes accompanied by administrative rulings to guard against unwarranted sterilization).

Components of analysis of demographic impact

Given the irreversibility of contraceptive sterilization, resort to this method of fertility control is *prima facie* evidence of the couple's determination to have no more children. Couples who adopt this method do so in the belief they are still fertile, but few are likely to quantify

the number or timing of the births they avert. Yet the quintessence of measuring the demographic impact of contraceptive practice, be it by sterilization or any other method, is quantification of the number of births a couple would have had in the absence of contraception. Moreover, for demographic purposes, it is not sufficient to know the number of births by which contraception reduces a couple's ultimate total fertility. Measurement of demographic impact requires apportionment of the averted births into time intervals of calendar or fiscal years, so that planners can assess the impact on fertility, the crude birth rate, age structure, and other demographic variables. If interest is further to measure net as well as total or gross demographic impact of a method (or a family planning program), then assessments are required of both the extent to which total births averted by the users of the method (or program) were incremental to those that would have been averted without the method (or program) and the extent to which availability of this method (or program) stimulated other method (or nonprogram) contraception.

Measurement of the demographic impact of contraception is thus a complex, technical exercise that is exacerbated by the speculative and controversial question of the potential fertility of a couple had no method or an inferior method been used. Sterilization has the advantage over other methods in that, given its effectiveness and duration, sterilized couples maximize their possible contribution to fertility decline. If individual couples maximize their demographic impact by contraceptive sterilization, is it not logical to leap to the conclusion that on a societal level, too, antinatalist policies can best be achieved by promoting sterilization?

This intuitive logic overlooks the relative number and age composition of the potential clients of voluntary sterilization compared with clients of reversible methods in societies with high fertility norms. The level of the parameters may differ but the array of factors governing voluntary acceptance of sterilization is the same in developing as in developed countries: a strong conviction that the couple has all the children it wants; a sense of assurance that the children will outlive their parents; sufficient understanding that the procedure does not interfere with sexual capacity or enjoyment; disaffection with hormonal, intrauterine, barrier, and traditional methods; easy access to, and the sophistication to take advantage of, trustworthy facilities and personnel for the operation; willingness to submit to a surgical procedure; and the expectation of very short-term inconvenience and minor, if any, side effects. Cost is an additional factor unless steril-

ization is free or subsidized. (For a comprehensive discussion of voluntary sterilization, see Green, 1978.) Although findings from the World Fertility Survey (WFS) and other surveys have long disclosed that high proportions of CRA say they want no more children, the interpretation that these data imply the existence of a vast potential market for sterilization fails to take into account this formidable vector of factors to be satisfied before a couple will consider submitting to voluntary sterilization (Brackett, 1979).

Age as a determinant of the demographic impact of contraception

Age is important in the measurement of contraception's demographic impact because it serves as the prime determinant of and a proxy for births averted. It is well known that female fertility characteristically increases from zero at age of menarche to a maximum sometime in the early or mid-twenties, then declines progressively with increasing age to virtually zero by age 50 (Coale and Trussell, 1974). Thus, after the age of peak fecundity, biology dictates that the older the contraceptive user, the lower is her potential fertility, and the fewer the births she will avert, even if she is presumed initially to be fecund.

Since number of children is highly correlated with age, contraceptive sterilization attracts people likely to be older than the average CRA and almost certainly older than couples interested in spacing rather than limiting births. Empirical data support the expectation that sterilized couples are older than couples who rely on other methods. The data assembled in Table 1 compare the wife's age at sterilization acceptance with that of acceptors of other methods in the family planning programs of several developing countries. It can be seen that women accepting sterilization (female or male methods) have about two more children and are at least five years older than women accepting pills or IUDs. It should occasion no surprise that in high-fertility societies, couples want to have at least four living children before they will consider limiting family size.[2]

For measuring demographic impact, the decisive age factor is not age at acceptance but rather age during contraceptive use, although of course the former influences the latter. In the case of renewable methods or methods that for one reason or another are discontinued at

2 In 1976 the Indian government headed by Indira Gandhi began employing coercive tactics to sterilize couples with two or three children in order to achieve a slower rate of population growth. That government was defeated in the 1977 elections, largely because of the unpopularity of those tactics, which the opposition party successfully exploited in the election campaign.

TABLE 1 Wife's age and number of living children at time of sterilization compared with acceptors of other methods in national family planning programs

Country and method	Acceptance period	Wife's age (median)	Number of living children
COLOMBIA			
Sterilization	1975	33.6	4.9
Orals	1975	24.7	2.2
IUDs	1975	26.1	2.5
HONG KONG			
Sterilization (female)	1977	33.9	3.2
Orals	1977	24.5	<1
INDIA			
Sterilization (male)	1976–77	33.2	3.8 (1975–76)
IUDs	1976–77	28.3	2.6 (1975–76)
INDONESIA			
Sterilization			
Male	10–12/1977	37.0	4.7
Female	10–12/1977	33.6	5.1
Orals	10–12/1977	26.0	2.4
IUDs	10–12/1977	26.5	2.5
MALAYSIA			
Sterilization	1977	32.8	5.0
Orals	1977	25.5	2.1
IUDs	1977	29.3	2.9
NEPAL			
Sterilization			
Male	1975–76	31.5	4.4
Female	1975–76	32.2	4.5
Orals	1975–76	30.3	3.4
IUDs	1975–76	28.7	3.2
PHILIPPINES			
Sterilization			
Male	1977	31.4	3.8
Female	1977	31.7	4.4
Orals	1977	26.7	2.5
IUDs	1977	27.0	2.6
THAILAND			
Sterilization			
Male	1977	34.0	3.4
Female	1977	29.5	3.5
Orals	1977	26.4	2.1
IUDs	1977	26.0	2.2

TABLE 1 *(continued)*

Country and method	Acceptance period	Wife's age (median)	Number of living children
TUNISIA			
Sterilization (female)	1975	36.4	5.4
Orals	1975	28.8	3.3
IUDs	1975	29.2	3.6

SOURCE: Nortman and Hofstatter (1978, 1979).

high rates, the average age of current users (let it be called prevalence age) is not likely to differ very much from that of current acceptors (incidence age). This is not so for a permanent, irreversible method. As successive cohorts of sterilization acceptors accumulate and age over time, even if cohort size increases and acceptance age decreases, as long as fertility norms are still fairly high, the prevalence age is likely to exceed the incidence age. In India, for example, women are, on average, age 33 when their husbands undergo vasectomy; but by 1977 wives among sterilized CRA averaged about age 38 because of the aging of earlier cohorts of sterilization acceptors who were still of reproductive age (Dandekar, 1977).

It is of interest that even in low-fertility societies, where sterilization is popular among younger as well as older couples, the age differential between sterilized couples and users of other methods is appreciable. In the United States, for example, in 1973 when sterilization already accounted for almost one-fourth of all contraceptive use, the average age of the wife among sterilized couples was 35.4 years compared with 26.8 years among women taking pills and 29.9 years among women using IUDs and diaphragms.[3]

Births averted: a trade-off between method duration and potential fertility

Births averted by contraception are generally calculated as the product of potential fertility and duration of contraceptive use. (Use duration can be adjusted for overlap with pregnancy, with postpartum infertility, etc., but such refinements will not significantly affect the ensuing discussion.) It therefore follows from the above observations on the age of sterilized couples that the impact of sterilization on a developing country's birth rate is a trade-off between method effective-

3 Computed from Ford (1978).

ness and duration of its use on the one hand, and relatively low potential fertility on the other hand.

One way to compare sterilization with other methods is to ascertain the higher potential fertility required of users of other methods to compensate for higher discontinuation rates in order to avert the same number of births. The result is a function not only of the discontinuation rate specified but also of the time interval selected for calculating the averted births. Within a fairly short time interval after acceptance, sterilization will not yet have had time to manifest its advantage over other methods. On the other hand, too long a time period is not warranted because couples adopting reversible methods do not forever renounce contraception upon terminating a particular segment of use. On the contrary, method resumption and switching are common among ever-users of contraception after fairly short periods of nonuse, or after lactation if a birth has occurred.

To illustrate this point, let us examine the relation between the duration of use provided by different discontinuation rates and corresponding potential fertility to avert a fixed number of births during months 13 through 24, or the second year, following acceptance. (This is an appropriate interval to consider because, on the plausible assumption that acceptors are not pregnant at acceptance, the nine-month gestation period and the possible overlap of initial use with postpartum infertility as well as with waiting time to conception mean that few births are likely to be averted during the first year following acceptance.) Taken as the standard, sterilization acceptors are assigned a relative potential fertility of 1.00 in the twelve-month period of averted births under review. Instead of permanent continuation, however, a 2 percent annual rate of discontinuation is somewhat arbitrarily imputed to them to allow for marital dissolution; likewise, the proportion of the sterilized cohort for whom the method takes effect is assumed to be .98 rather than unity to allow for improperly performed surgery and failure of the couple to follow medical instruction regarding waiting time before resuming intercourse.

Other methods are distinguished not by name but by specific discontinuation rates. Given these rates, it is simple to calculate the proportion of the period from months 4 through 15 (nine months earlier than the births-averted period) that is protected from pregnancy risk by contraceptive use. With the number of births averted equal to the product of potential fertility and contraception nine months earlier, the relative potential fertility of equal-size cohorts adopting different methods (i.e., different discontinuation rates) to avert the same num-

ber of births in year 2 after acceptance follows readily. Table 2 presents the results; its notes explain the methodology in mathematical terms. It can be seen that the potential fertility of acceptors of methods discontinued at annual rates of 10, 15, 20, 25, 30, and 40 percent must exceed that of sterilization acceptors by 9, 14, 18, 29, 34, and 52 percent respectively in order to yield the same demographic impact as sterilized couples do in the second year following contraceptive adoption.

TABLE 2 Relative potential fertility of a contraceptive acceptor cohort that will avert an equal number of births in year 2 following acceptance of contraceptive methods discontinued at different rates

Continuation schedule[a]			Use over period that averts births in year 2[b]	Index of births averted[c]	Relative potential fertility[c]
Proportion starting use (1)	Annual discontinuation rate (2)	Mean duration of use (years) (3)	(4)	(5)	(6)
.98	.02	49.0	.965	.965	1.00
.95	.10	9.5	.882	.965	1.09
.95	.15	6.3	.850	.965	1.14
.95	.20	4.75	.819	.965	1.18
.90	.25	3.6	.748	.965	1.29
.90	.30	3.0	.721	.965	1.34
.85	.40	2.1	.634	.965	1.52

NOTE: Implicit in the calculation is the assumption that conception during contraceptive use results in immediate discontinuation of the method, so that all use is effective and there is no overlap of pregnancy and use. This limitation is not considered to affect the results appreciably.

a The continuation schedule is assumed to conform to the modified decay curve, $C = ae^{-rt}$, where C is the proportion of an initial acceptor cohort remaining at time t, r equals the proportion discontinuing per unit of time, a equals the proportion remaining after an immediate dropout of $1 - a$, and e is the natural logarithm constant 2.718 . . . . The mean duration of use = a/r.

b If t_0 represents acceptance time, (t measured in years), then use (U) in the interval $t_{.25} \leqslant U \leqslant t_{1.25}$ averts births in months 13 through 24 after acceptance, with a nine-month allowance for gestation. U is readily calculated from

$$U = \int_{.25}^{1.25} ae^{-rt}\,dt = (a/r)\,(\exp[-.25r] - \exp[-1.25r]).$$

c The number of births averted is the product of use and potential fertility. With a potential fertility rate of 1.00 assigned to sterilization, its continuation schedule averts .965 births. Dividing column 5 by column 4 yields column 6, the relative potential fertility required to achieve the same number of averted births as sterilization.

Differentials in age-specific fertility rates

As orders of magnitude, let me suggest that IUDs and orals accepted in the first segment are discontinued at annual rates of 25 and 40 percent respectively.[4] A preliminary inquiry can now consider, on the basis of differentials in age-specific fertility rates (ASFRs), which strategy is likely to have the greater short-term (next-year) demographic payoff: one designed to attract younger women to IUDs and pills or one that offers sterilization to couples wanting no more children.

In an analysis of ASFRs among 13 populations not practicing birth control, Henry (1961:85) found the average rates presented in Table 3.

TABLE 3 Average age-specific female marital fertility among 13 noncontracepting populations

Age group	Rate per 1,000	Index	
		Ages 30–34 = 100	Ages 35–39 = 100
20–24	435	117	146
25–29	407	110	136
30–34	371	100	124
35–39	298	80	100
40–44	152	41	51

SOURCE: Henry (1961:85).

Let us assume for the moment that acceptors have a potential fertility typical of their age group. Then the data in Table 3 suggest that women aged 20–24 using modern renewable methods would avert at least as many births in the short run as women aged 35–39 taking sterilization. This also applies to women aged 25–29 or 30–34 taking IUDs. On the other hand, compared with women sterilized at ages 30–34, women aged 20–24 would have to limit discontinuation to less than 20 percent per year, and women aged 25–29 to less than 11 percent per year, to achieve the same demographic impact in year 2 after acceptance.

The above analysis is inadequate in several respects. First, it fails to take into account the empirical knowledge that acceptors are more fecund than their noncontracepting age counterparts, a factor that

4 These rates are generally of poor statistical quality. The follow-up surveys necessary to establish the empirical data are both expensive and difficult, and hence infrequently undertaken. Moreover, discontinuation rates have been found to vary widely over time and space, and by acceptor age, making generalizations crude averages.

narrows the age differentials in the potential fertility of acceptors. Second, cumulating averted births over annual intervals up to, say five, instead of two, years after acceptance may be of interest, with a caveat in interpreting such findings not to ignore that discontinuers of renewable methods are often repeat acceptors over a five-year period. Finally, the analysis thus far has been limited to births averted on a cohort or per acceptor basis. Yet to be considered (but deferred to a later section) is the age distribution of couples of reproductive age, which prompts different, not equal, numbers of couples to adopt different methods.

Births averted by cohorts of equal size accepting various contraceptive methods

Henry (1961) has noted that because of cultural differences, fertility differentials are great even among populations practicing very little contraception. Hence, estimates of births averted by contraception based on any one set of fertility rates, hypothetical or otherwise, could be wide of the mark if applied to a particular population. For a reasonable generalization of the gross demographic impact of different methods of contraception, I postulate average age-specific female marital fertility rates from Henry's 13 countries. To reflect the potential fertility of contraceptive users, however, these rates require adjustment to take account of the contraceptors' higher than average fecundity.

Although more fecund than average, acceptors are likely to include some sterile couples. I obtained a quantitative estimate of the extent to which sterile couples might enroll in a contraceptive program, doing this by averaging the World Fertility Survey findings for 11 countries on the age-specific proportions of married women who considered themselves sterile for noncontraceptive reasons. (As expected, these proportions are less than Henry's estimate of natural secondary sterility.) Adjustment of the Henry rates by dividing them by the proportion of the age group that considers itself fecund (the complement of the WFS proportion sterile) yielded a plausible potential fertility schedule to assign to contraceptive acceptors. To take account of the aging of acceptors with the passage of time, I assumed their potential fertility (based on age at acceptance) to wane over time at the same rate of decline as in the Henry fertility schedule. The data and the process are given in the Appendix Table.

As before, I computed births averted in specified years after acceptance as the product of potential fertility and the proportion of the

time interval nine months earlier protected by contraception from the risk of pregnancy. (For the mathematics of the continuation of contraceptive use schedule, see the notes to Table 2.)

The methodology described above yielded the following cumulative number of births averted over time, up to 60 months from acceptance, among 1,000 couples adopting sterilization but subject to a 2 percent per annum attrition rate (to allow for marital dissolution):

Time lapse from sterilization	Wife's age at sterilization	
	30–34	35–39
24 months	358	292
36 months	694	547
48 months	1,010	766
60 months	1,306	951

It is not appropriate to add the two age-group columns for an estimate of total births averted in a ten-year period by women aged 30–34 at time of sterilization. The reason is that the older age group has a higher proportion fecund at acceptance than the younger age group would have had at ages 35–39 in the absence of contraceptive sterilization at ages 30–34.

Births averted by young women using methods other than sterilization, that is, methods with higher discontinuation rates, are shown in Table 4 and in Figures 1 and 2, not in absolute numbers but by means of an index equal to 100 of the above data on the births averted by women in their thirties adopting sterilization.

Would one have guessed that a cohort of women starting contraception in their twenties but discontinuing the practice at the rate of 40 percent per year, without any resumption of such practice by the discontinuers, would avert as many as half the births in a five-year period as women who are sterilized in their early thirties? Or that they would avert about two-thirds the number of births averted by sterilized women if the discontinuation rate among younger women declined to 25 percent? Compared with births averted by women sterilized in their late thirties, the births younger women avert, even by methods with characteristically high attrition rates, are indeed impressive. With a discontinuation rate of under 25 percent, women starting a method at ages 20–24 will avert more births over a five-year period than women sterilized at ages 35–39. Even at ages 25–29, renewable methods achieve a favorable demographic impact compared with sterilization among older couples. Moreover, it should be stressed again, the data in Table 4 relate to first-segment use only of an accepted method;

TABLE 4 Index of cumulative births averted at specified time periods from acceptance of contraceptive methods discontinued at different annual rates

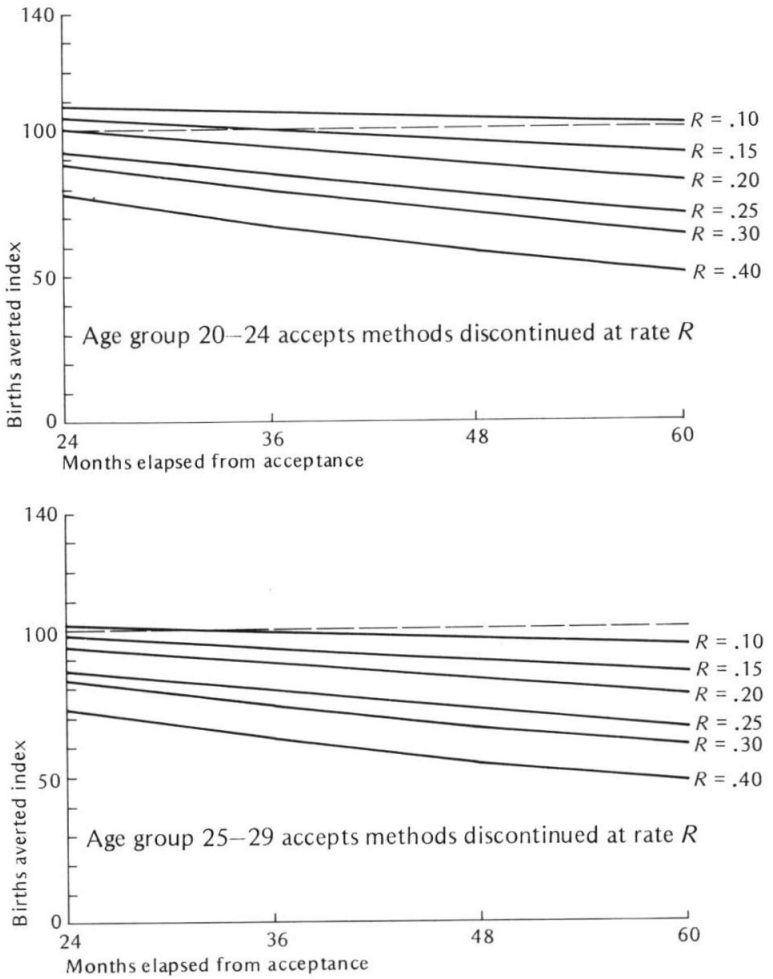
(Index based on births averted by sterilization acceptors = 100)

Acceptor age and method[a]		Months from acceptance			
		24	36	48	60
INDEX BASE: AGE GROUP 30–34					
Age 20–24					
Method					
a	*r*				
.95	.10	108	105	103	101
.95	.15	104	99	95	91
.95	.20	100	94	87	82
.90	.25	92	84	77	71
.90	.30	88	79	71	64
.85	.40	78	67	58	51
Age 25–29					
Method					
a	*r*				
.95	.10	102	99	96	94
.95	.15	98	93	89	85
.95	.20	94	88	82	77
.90	.25	86	79	72	66
.90	.30	83	74	66	60
.85	.40	73	63	54	48
INDEX BASE: AGE GROUP 35–39					
Age 20–24					
Method					
a	*r*				
.95	.10	132	134	136	138
.95	.15	127	126	125	125
.95	.20	123	119	115	113
.90	.25	112	106	101	97
.90	.30	108	100	93	88
.85	.40	95	84	76	70
Age 25–29					
Method					
a	*r*				
.95	.10	125	126	127	129
.95	.15	120	118	117	117
.95	.20	116	112	108	105
.90	.25	106	100	95	91
.90	.30	102	94	88	83
.85	.40	90	79	71	65

a Method is defined by the parameters a and r in a continuation schedule conforming to the modified decay curve, $c = a \exp(-rt)$. For an explanation of these parameters and the methodology for calculating births averted, see the notes to Table 2.

FIGURE 1 Index of cumulative births averted over time by a contraceptive acceptor cohort discontinuing adopted method at rate R per year

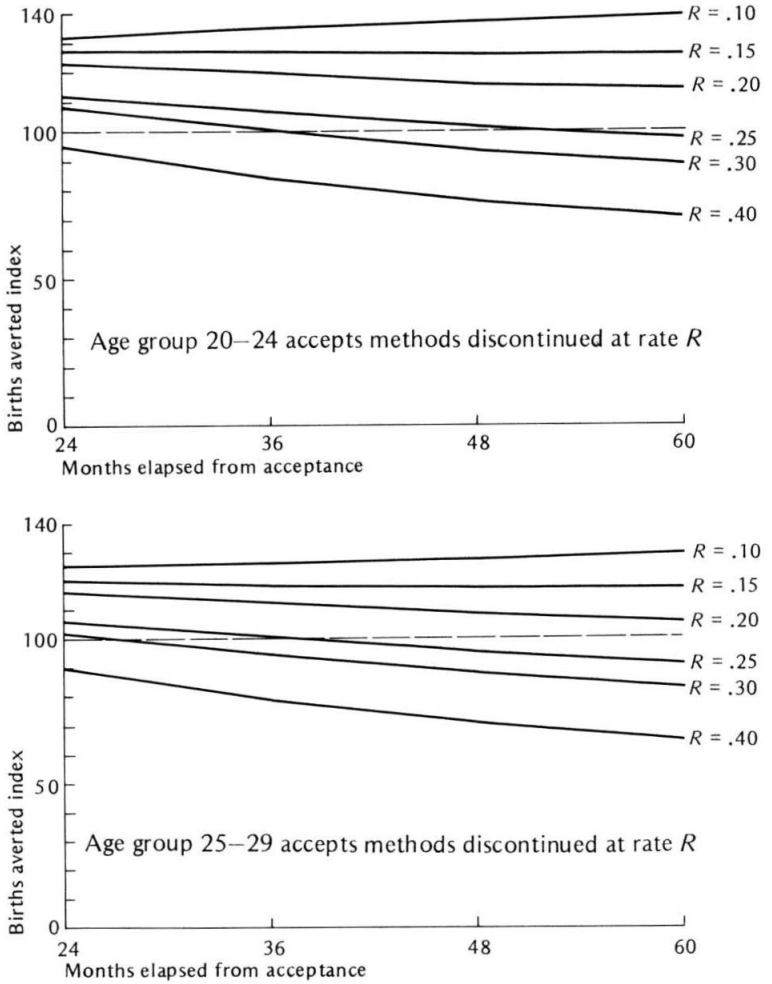
(Index base: births averted by sterilization acceptors aged 30–34 = 100)



SOURCE: Table 4.

FIGURE 2 Index of cumulative births averted over time by a contraceptive acceptor cohort discontinuing adopted method at rate R per year

(Index base: births averted by sterilization acceptors aged 35–39 = 100)



SOURCE: Table 4.

they exclude the possibility of resumption of contraception among the discontinuers and therefore of additional births that might be averted within the period under review.

Also of interest is the time trend of the demographic impact of first-segment use of renewable methods versus sterilization, evident in Figures 1 and 2. As expected, with an increase in time, the demographic impact of discontinuable methods adopted by younger women diminishes relative to that of sterilization among older couples, yielding downward (negative) sloping lines. (An exception is the 10 percent discontinuation rate shown for the sterilization base age group 35–39 (Figure 2), which has an upward (positive) slope; but a 10 percent annual discontinuation rate is rarely encountered for first-segment acceptance.) Also to be noted is the increase in the negative slope as the discontinuation rate increases, although the departure from equally negative slopes appears slight. That is, the lines appear quite parallel and the four time points for each method are a very good fit to a straight line (constant slope).

On the whole, it is striking how closely younger women practicing contraception for relatively short periods of time approximate the births averted by women who resort to sterilization sometime in their thirties. The explanation for this finding is quite simple. It lies in the biological finding that younger women are more fecund than older women and that their fecundity wanes less rapidly over time. Hence, the possibility exists in the trade-off between fecundity and contraceptive use over a not too long time period for younger women to approximate with renewable methods the demographic impact of older women rendered permanently infertile by voluntary sterilization.

Age composition of women of reproductive age

The analysis thus far of births averted by several mixes of age and method has been on a per acceptor or cohort basis. While of theoretical interest, for this analysis to be meaningful in the real world, the cohort findings have to be weighted by the relative number of couples likely to adopt the different age-method mixes. It is primarily this weighting aspect that attenuates the advantages of sterilization for a decisive demographic impact.

These weights derive not only from the proportion of couples who want no more children but also, perhaps more importantly, from the age composition of women of reproductive age (WRA), because different methods are appropriate for different age groups. The developing countries have a young age structure, a heritage of high fertility

coupled with recent mortality declines. Thus WRA tend to be heavily weighted with younger women not likely to be interested in sterilization. The rise in the age at marriage associated with modernization produces an age structure among married WRA less adverse for fertility decline than among total WRA, but average age at first marriage has to be quite high for the two age distributions to differ appreciably.

Data on married women by age in developing countries are not very reliable, and with shifting marriage patterns are likely to be out of date. For whatever it is worth, just to indicate the relative orders of magnitude in the different age groups, the age distribution of married WRA in several developing countries is presented in Table 5 as an index number based on age group 30–34 = 100.

Among the 11 countries shown in Table 5, the Republic of Korea is outstanding in having more married women in their thirties than in their twenties, and very few married women under age 20. In view of this age structure among married CRA in Korea, it is good strategy to promote sterilization, as Korea is now doing in its national family planning program. In five other countries–Malaysia, the Philippines, Taiwan, Thailand, and Tunisia–the number of married women in their twenties appears about equal to the number in their thirties. In these countries, too, a potential market may exist for sterilization worthy of consideration for a demographic impact. In the other countries, as in-

TABLE 5 Index of married women in specified age groups: age 30–34 = 100

Country and year	15–19	20–24	25–29	30–34	35–39	40–44
Colombia, 1973	37	105	114	100	97	76
Costa Rica, 1973	42	108	113	100	94	78
India, 1971	74	114	116	100	85	66
Indonesia, 1971	50	88	116	100	92	62
Korea (Republic), 1976	4	51	95	100	84	64
Malaysia, 1970	31	86	95	100	80	66
Mexico, 1975	44	105	114	100	84	69
Philippines, 1970	25	87	107	100	92	71
Taiwan, 1975	14	89	107	100	97	85
Thailand, 1970	36	85	98	100	90	70
Tunisia, 1975	16	98	115	100	113	102

SOURCES: Unless otherwise noted, computed from United Nations (1977, table 41). Korea: Republic of Korea (1977, table 17). Taiwan: Republic of China (1976, table 10). Tunisia: correspondence from C. Tarifa, director, Institut National de la Statistique.

deed in most developing countries, the predominance of young women among CRA suggests that birth spacers as well as birth limiters are necessary for a decisive demographic impact.

Age composition of mothers

A final consideration regarding the potential supply of clients for sterilization versus other contraceptive methods is the age composition of women giving birth each year. An analysis of the maternal age distribution of births in 1975 in 33 developing countries that have official policies to reduce population growth rates showed that on average (median) women aged 30 and over accounted for 30 percent of all births, while women aged 35 and over produced 14 percent of all births.[5] Since these are appreciable proportions, the elimination of fertility after age 30, or even after 35, would have a decisive demographic impact. However, to pin hopes on zero fertility after age 30 or 35 is obviously unrealistic.

In the course of the demographic transition, fertility declines faster at older ages; and sterilization, especially with the recent improvement in techniques, is an attractive method that can make a significant contribution. Nevertheless, to judge by the average current age of women among sterilized couples, to emphasize this method unduly in trying to achieve demographic targets in developing countries is to give secondary consideration to the couples who produce some 80 to 85 percent of the births.

Implications for family planning program strategy

On the basis of the experience of developed countries, it can be argued that whatever the *gross* demographic impact of sterilization, its *net* contribution is small. The empirical evidence for this view is the achievement of low birth rates in the presently developed countries long before contraceptive sterilization became available or popular. The argument also rests in the reasonable proposition that couples sufficiently motivated to resort to sterilization would find other effective means of controlling fertility if they could not be sterilized. By this line of reasoning, sterilization is largely a substitute for other methods, having an inherently wide differential between its *gross* and its *net* demographic impact.

5 Computed from data in the Population Council data bank by applying the average of age-specific fertility rates in 1970–75 and 1975–80 to the female population age structure in 1975. For a list of the 33 countries, see Nortman and Hofstatter (1979, table 6).

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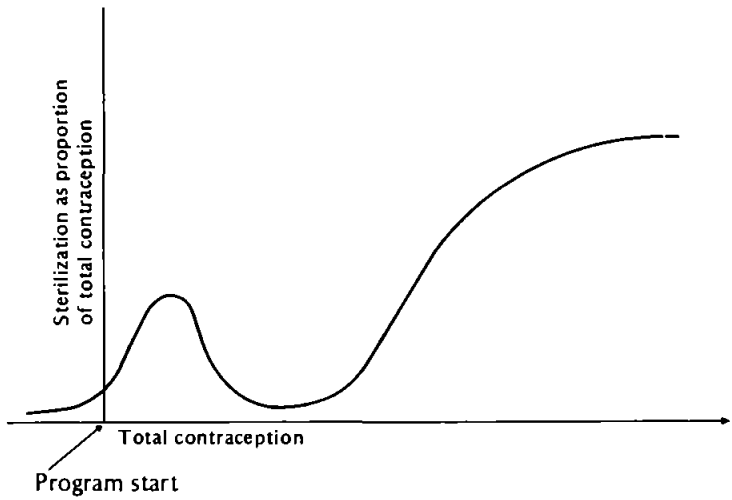
Sound as the above reasoning is, the demographic impact of sterilization in developing countries is constrained more by the limited clientele interested in this method than by the differential between the gross and net effects. As long as fertility norms remain high, couples of reproductive age ready to accept sterilization are likely to continue to be relatively few in number and several years older than the average CRA, yielding a smaller than desired demographic impact, whether measured in gross or net terms.

The recent advances in sterilization techniques, especially for women, are gratifying and doubtlessly are stimulating family planning program administrators to promote this method of fertility control. At the same time, choice of methods is dictated not by clinical or demographic efficiency but by the culture and level of development of the society. Methods are inappropriate if the required medical infrastructure is lacking, or the housing facilities and literacy level necessary for their use are inadequate, or they are in some way repugnant to the religious or esthetic sensitivities of the population.

In recognition of the cultural and economic situations of their countries, governments emphasize different methods in their national family planning programs. All profess to offer a wide variety to give couples freedom of choice, but in reality one or two methods predominate in the offerings. Some countries have promoted sterilization at an early stage of their program as a strategy designed "to skim the cream of the motivated" and maximize the demographic impact. Others have gone the route from the IUD to pills or introduced both simultaneously. Disillusion with IUDs and pills, as well as with failure to reach the large rural masses of the population, are encouraging governments to rely on community-based distribution of conventional methods and to place less reliance on medical personnel and facilities.

In developed countries sterilization is increasing as a proportion of total contraceptive practice. In developing countries premature stress on sterilization—that is, while fertility norms are still high—is likely to be counterproductive. A suggested strategy to maximize demographic impact is presented in Figure 3, which shows the relation between sterilization as a proportion of total contraceptive use and the overall level of contraception. The strategy calls for offering sterilization, if feasible, at the start of a program when the overall contraceptive use level is low; to introduce and emphasize spacing and renewable methods once the "cream of the motivated has been skimmed" by sterilization; and finally, when fertility norms have fallen and contraceptive practice is endemic, again to encourage or allow sterilization to replace other methods.

FIGURE 3 Strategy on sterilization as a component of total contraception to maximize demographic impact



APPENDIX TABLE Derivation of potential fertility of contraceptive acceptors

Acceptor age group	Henry fertility rates[a]	WFS findings on percentage naturally sterile[b]	Potential fertility of acceptors in specified year from acceptance time[c]					
			Year 1[d]	Year 2	Year 3	Year 4	Year 5	Year 6
20–24	435	2	444	438.2	432.4	426.6	420.8	415.0
25–29	407	3	420	412.6	405.1	397.7	390.2	382.8
30–34	371	4	386	370.8	355.6	340.4	325.2	310.0
35–39	298	11	335	302.2	269.4	236.5	203.7	170.9
40–44	152	25	203	162.4	121.8	81.2	40.6	0

a Source: Henry (1961:85).

b An average of the proportions among currently married women who think themselves sterile for noncontraceptive reasons in the published reports for Bangladesh, Colombia, Dominican Republic, Indonesia, Korea (Republic), Malaysia, Nepal, Pakistan, Panama, Sri Lanka, and Thailand. Among those sterilized for contraceptive reasons a few would have become sterile in any case, and this factor would inflate slightly the proportions in the table. Ignoring this factor does not significantly affect the results, however.

c The rates for year 6 are regressed from the year 1 rates in the same proportion as the decline in the average (Henry) rates. Rates for the in-between years are linear interpolations of the rates in years 1 and 6. Zero fertility is assumed at age 45.

d Since acceptors can be assumed to be nonpregnant at acceptance, very few births are expected in year 1 because of the waiting time to conception and the nine-month gestation in the absence of contraception. The year 1 rates are the point of departure for calculating the potential fertility of contraceptive acceptors over time.

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