



FEMALE STERILIZATION IN PUERTO RICO AND ITS DEMOGRAPHIC EFFECTIVENESS

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ABSTRACT. An island-wide sample of 1,272 ever-married Puerto Rican women 20-49 years of age were interviewed during the summer of 1976 to examine possible changes in the trends and differentials in female sterilization and to determine its demographic effect.

The data obtained in this survey showed a moderate increase in the rate of female sterilization since 1968. As in previous studies, the prevalence of sterilization increases with age among young women but after age 30 it remains almost stationary. A similar pattern is observed with respect to duration of marriage. The percentage of sterilized is higher among

urban residents and varies inversely with socioeconomic status. Apparently, sterilization is being performed at an older age and with a larger number of children than previously although the differences are relatively small.

Correlation analysis demonstrates that while high fertility is an important determinant of sterilization, it has a depressing effect on fertility in the long run. It was shown that more than half of the decline in the crude birth rate that occurred in Puerto Rico since 1940 could be attributed to the effect of female sterilization.

SURGICAL sterilization as a method of birth control is increasing in importance around the world. Sterilization does not require specific knowledge of its use nor a high level of continued motivation as it is the case with other methods. In addition, it is probably the most effective method of birth control. For all these reasons, sterilization seems to be the most suitable method in countries where there is a high level of illiteracy and ignorance. Thus, under the auspices of governmental family planning programs several million sterilizations have been performed in India, Pakistan, Korea, Thailand and other countries of Asia (1).

In spite of these efforts, only in a few countries has sterilization reached significant proportions. Recent data from the Population Reference Bureau (2) show that in Asia there are at least four countries in which the proportion of women in the fertile ages util-

izing sterilization (both male and female) as a birth control method has surpassed 15 percent. (Singapore, South Korea, Thailand and Hong Kong.) In Latin America, figures of 10 percent or more have been reported in Panamá (22 percent), Costa Rica (19 percent), El Salvador (18 percent) and the Dominican Republic (12 percent). For the United States this proportion has been estimated at 30 percent (2).

In relative terms, Puerto Rico has the highest rate of sterilization in the world. In 1968, approximately 36 percent of the female population 15-49 years of age was utilizing this method (female and male sterilization). This practice began in Puerto Rico early in the 1930's and increased rapidly during the next three decades. Studies undertaken at the end of the decade of the 1940's showed that around seven percent of all women in the reproductive ages were sterilized (3, 4). In a survey carried out in 1953-54 its prevalence was estimated at 16 percent (5) which indicates that sterilization increased considerably during the last years of the 1940 decade and the first years of the fifties.

As a result of a preoccupation of some physicians about the possible association between cancer of the uterus and female sterilization, an island-wide survey was carried out in 1965 under the auspices of the De-

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partment of Health of Puerto Rico. Although the suspected relationship was not established, the study revealed that more than one-third of all mothers 20-49 years of age reported having been sterilized (1).

This astonishing finding was questioned by some physicians and social scientists in Puerto Rico. Thus, in a survey which was carried out in 1968 utilizing the same sampling frame as the 1965 study, a more detailed questionnaire about sterilization was included. The results of this study were almost identical to those obtained in 1965 in almost all comparable aspects (6).

The accumulated evidence indicates that female sterilization increased more than five times during a period of 20 years. On the other hand, vasectomy (male sterilization) in Puerto Rico is as low as it is in most countries of the world. According to the 1968 survey less than two percent (1.7) of the husbands of the females interviewed were reported to be sterilized (6).

In 1974, the Department of Health of Puerto Rico decided to initiate a more active family planning program. In order to have a scientific basis for the implementation of the new policy, a private research corporation was contracted to conduct a Knowledge, Attitude, Practice (KAP) study. The survey was carried out in 1974 and one of the most surprising findings was the sharp decline observed in the prevalence of sterilization. According to the results of this study the proportion of sterilized women 15-49 years of age was estimated at 26 percent as compared with the figure of 34 percent obtained in 1968 (7). It seems that the increased utilization of the contraceptive pill after the middle of the 1960's has displaced other traditional methods and, to a certain degree, sterilization. The percentage of current users of contraceptive methods remained almost constant from 1968 to 1974 (7).

The results of this survey, however, are somewhat doubtful due to a serious bias which was introduced into the sampling procedure. According to the sampling plan one adult was randomly selected for interview from those persons present in the households included in the sample. Those absent from the household at the time of the interview (6:00 pm to 8:00 pm) had no probability at all of being included in the sample (7). The most obvious error introduced by this sampling bias was an over-representation of female and old people.

The first attempt in trying to determine the effect of sterilization on fertility in Puerto Rico was made by Hill, Stycos and Back in their study of 1953-54 (5). Comparing the median number of pregnancies by years of marriage between sterilized and non-sterilized women they found no significant differences. They concluded that sterilization had little effect upon fertility because it was performed when there were already too many children in the family

(5). Presser, utilizing the data collected in 1965 by the Department of Health of Puerto Rico, utilized a similar approach (1). She compared sterilized against non-sterilized women in terms of their average number of total births (including stillbirths). She estimated as three the average number of births averted through sterilization (1).

Both studies had several shortcomings that might have obscured the relationship between sterilization and fertility. In the first place, the index of fertility utilized was probably not the best in trying to clarify this association. The decision to become sterilized is more a function of the number of children ever born and of living children than of the number of pregnancies (5) or of the number of all births including stillbirths (1). Presser, recognized this fact but was unable to refine her estimates due to the data collection methods of the Department of Health. In addition, there tends to be a greater memory bias in relation to pregnancies which have terminated in fetal deaths and stillbirths than with pregnancies which have ended in livebirths.

The other methodological problem in these studies was that the authors had to compare the fertility of sterilized women against that of non-sterilized ones without taking into account the effect of the use of other contraceptives by these two groups of women. The data collected by the Department of Health for 1965 did not include information about the use of other types of contraceptives.

Puerto Rico's documented experience as the country with the highest rate of female sterilization in the world, offers a unique opportunity to examine this topic in greater detail. The present research will go into a deeper analysis of female sterilization on the island and will try to answer some of the questions which previous studies leave unanswered. Specifically, this study has the following objectives:

1. to examine possible changes in the trends and differentials in female sterilization in Puerto Rico as a result of the utilization of other modern contraceptives (Pill, IUD, etc.)
2. to determine the demographic effectiveness of sterilization as a method of fertility control.
3. to explore the effect of high fertility in the decision for sterilization.

During the summer of 1976, the Department of Health of Puerto Rico undertook a survey to evaluate the effectiveness of the family planning program of the agency. For this purpose, data was collected by interviews for an island-wide sample of native Puerto Rican women between 15 and 54 years of age. The sampling frame used was the one utilized by the Department of Health on a quarterly basis for estimating health problems, needs and accessibility of health care for the island as a whole (8). In order to have an adequate number of cases, the households included in the quarterly surveys of January, March and July

of 1975 constituted the total sample. All native women resident in the selected households were interviewed during the months of June and July of 1976. In this study only ever-married women 20-49 years of age will be considered. For this group of 1,272 women information about their personal characteristics, pregnancy and marital history, and experience in the use of contraceptives was collected.

THE PREVALENCE OF STERILIZATION

A definition of the population "at risk" for sterilization is a difficult problem. Westoff (9) discussed the following four denominators: all ever-married women; all ever-married women who want no more births; currently married women who want no more births, and currently married fecund women who want no more births. They concluded that the last two populations are clearly more "at risk" for sterilization but considered some of the limitations of excluding formerly married and infecund women. They also claimed that women who expressed not wanting more births is a better denominator than all women (either ever married, currently married or currently fecund women), overlooking some problems related to this type of datum. In the first place, the expressed desire for more (or for no more) children may depend upon a given situation, and may change easily and rapidly. Quite different results might be obtained from this question if it is asked during a pregnancy, a post-partum situation or several months after the outcome of the pregnancy. This is clearly evidenced by the fact that many sterilized women have changed their minds by the time they were interviewed, and expressed they would like to have more children. In the second place, the response to this question is strongly influenced among sterilized women by the irreversible nature of their situation. Many sterilized may feel it is useless and to some extent questionable, to express they would like to have more children after they decided not to have any more.

On the other hand, Westoff (9) did not take into consideration that childless women are not exposed to contraceptive sterilization. Neither in the 1968 survey for Puerto Rico (6) nor in the 1976 study were there such cases. In the data Westoff presented for Panamá (Table I) there were only 14 sterilized with less than two children and probably all of them corresponded to women with one child.

In the present study, the proportion of sterilized among all ever married women and among mothers will be used as indicators of the prevalence of this contraceptive method in the Island. These percentages will show how widespread is this practice among different groups in the population and to what extent are women in the reproductive ages completely protected against the childbearing risk.

Thirty seven (37) percent of all ever-married women and thirty nine (39) percent of all mothers 20-49 years of age reported to be sterilized in the 1976 survey (Table I). This means that the rate of female sterilization continued to increase in Puerto Rico. According to Presser, 32 percent of all ever married women 20-49 years were sterilized in 1965 (1) while a rate of 35 percent was reported for 1968. Male sterilization seems to have also increased since 1968. In that year only 1.7 percent all currently married women reported that their husband was sterilized. According to the 1976 survey, 41 out of 1,098 currently married women 20-49 years of age informed about their husband's sterilization. This is equivalent to 3.7 percent.

As in previous studies, female sterilization was in 1976 more frequent among urban residents. Almost 40 percent of all ever-married women residents in the urban area were sterilized as compared with 33 percent for the corresponding group of rural women (Table I).

The percentage sterilized is considerable in all age groups increasing rapidly in the first age groups and flattening out after age 35. Among women 30 years of age and over the proportion sterilized was 46 percent for all ever-married and 47 percent for mothers. A similar relationship is observed with respect to duration of marriage. It rises sharply during the first 10 years of married life and after that it increases slowly with some irregularities (Table I).

TABLE I

PERCENT STERILIZED AMONG EVER MARRIED WOMEN AND MOTHERS 20-49 YEARS OF AGE BY RESIDENCE, AGE AND DURATION OF MARRIAGE, PUERTO RICO, 1976

CHARACTERISTIC	EVER-MARRIED		MOTHERS	
	Number	Percent Sterilized	Number	Percent Sterilized
Total	1,272	36.7	1,190	39.2
Residence *				
Urban	640	39.7	592	42.6
Rural	621	33.5	581	35.6
Age				
20-24	168	11.3	148	12.8
25-29	247	21.5	221	24.0
30-34	239	47.3	227	49.8
35-39	233	44.2	224	46.0
40-44	195	43.3	188	44.7
45-49	190	49.5	185	51.6
Duration of Marriage **				
0-4	189	4.8	167	5.4
5-9	276	23.9	259	25.4
10-14	257	46.3	247	48.2
15-19	204	48.0	202	48.5
20-24	185	45.4	181	46.4
25 and over	149	59.5	146	60.3

* Eleven cases whose residence was unknown are excluded.

** When more than one marriage it is the sum of the duration of each one. Twelve cases whose duration of marriage was unknown are excluded.

Some of the irregularities observed in these trends (age and duration of marriage) are probably the result of the "ups" and "downs" in the availability of sterilization services in public hospitals where the majority of these interventions are performed free of charge. The government policy with respect to family planning has fluctuated considerable since 1940. During the period of 1973-76, for example, great emphasis was put on sterilization in the family planning programs of the Department of Health. Even sterilization quotas were established. Since then the Department of Health has not only changed its emphasis in relation to the specific methods but also about the family planning activities itself.

The rate of sterilization is higher among women of low socioeconomic status (Table II). With respect to

tions or wives of white collar workers show the lowest rate of sterilization. Sterilization is also associated with the working status of the women, being lower among those who were in the labor force.

It seems that sterilization is a much popular contraceptive method among the lower socioeconomic groups. As shown on Table II the use of other contraceptives is directly associated with the socioeconomic status of the women as measured by schooling and occupation.

The proportion of sterilized shows a curvilinear relationship with the number of children ever born. It increases with parity up to four children and then declines steadily as the number of children increases (Table III). Similar relationships have been observed

TABLE II

PERCENT STERILIZED AMONG EVER MARRIED WOMEN, MOTHERS AND EVER USERS OF CONTRACEPTIVE METHODS
20-49 YEARS OF AGE BY SOCIOECONOMIC CHARACTERISTICS, PUERTO RICO, 1976

CHARACTERISTIC	EVER-MARRIED		MOTHERS		EVER USERS OF METHODS	
	Number	Percent Sterilized	Number	Percent Sterilized	Number	Percent Sterilized
Women's schooling						
0-3	165	41.2	161	42.2	118	57.6
4-7	308	40.3	299	41.5	254	48.8
8-11	392	42.1	281	43.8	333	49.5
12	308	30.5	282	33.3	261	36.0
13 or more	184	26.6	153	32.0	145	33.8
Women's occupation*						
In labor force	331	30.8	297	34.3	272	37.5
White collar	195	27.7	171	31.6	159	34.0
Blue collar	136	35.3	126	38.1	113	42.5
Not in labor force	940	38.6	892	40.9	766	47.4
Husband's occupation *						
White collar	336	33.0	303	36.6	279	39.8
Services	155	34.2	142	37.3	124	42.7
Manual workers	541	37.9	520	39.4	530	53.0
Agricultural	89	47.2	86	48.8	67	62.7

* White collar includes professional, technical and kindred workers: managers and administrators, sales and clerical workers. Blue collar includes services and manual workers. Agricultural includes farmers, farm managers, and farm laborers and foremen. The husband's occupation refers to usual occupation of the present husband. For this reason divorced, separated and widows were excluded.

women's schooling there are no significant differences in the proportion sterilized among those who had not completed high school (0-11 years of schooling) but it declines sharply among high school graduates. Similarly, women with white collar occupa-

in the past (1,6) as well as in the recent study in Panamá (9). Obviously, women with few children are proportionally more interested in methods for spacing their births than in this terminal method. They are also on the average, young women who have been exposed to

such efficient methods as the Pill and IUD which were not available in the past. On the other hand, women with a large number of children belong to

26 years (1, 6). The data obtained in the present study indicate that the median age at sterilization has increased to 28 years (Table IV). A similar conclusion

TABLE III

PERCENT OF STERILIZED WOMEN 20-49 YEARS OF AGE BY NUMBER OF CHILDREN EVER BORN, PUERTO RICO, 1976

NUMBER OF CHILDREN EVER BORN	NUMBER OF WOMEN		PERCENT STERILIZED
	All	Sterilized	
1	171	9	5.3
2	297	102	34.3
3	284	136	47.9
4	132	77	58.3
5	112	61	54.5
6	56	29	51.8
7	45	17	37.8
8 or more	93	34	36.6

time cohorts for which the small family concept was still not widespread nor sterilization services not as available as they are today.

THE TIMING OF THE STERILIZATION

Previous studies have demonstrated that Puerto Rico was the country where sterilization was performed at the earliest age. In the surveys undertaken in the mid 1960's the median age at sterilization was

is obtained when women operated during the 1960's are compared with those sterilized more recently. It should be kept in mind, however, that the increase observed in the cohort data has been somewhat exaggerated by the exclusion from the sample of old age women (50 years and over). This has the effect of excluding some women of the earlier cohort (1960-69) to whom sterilization was performed at advanced ages.

TABLE IV

PERCENT DISTRIBUTION OF STERILIZED WOMEN 20-49 YEARS OF AGE BY AGE AT STERILIZATION AND DATE OF STERILIZATION, PUERTO RICO, 1976

AGE AT STERILIZATION	DATE OF STERILIZATION		ALL WOMEN*
	1960-1969	1970-1976	
Under 20	0.0	0.4	3.2
20-24	34.8	14.7	24.8
25-29	31.8	28.9	32.8
30-34	20.6	31.0	22.9
35 and over	12.8	25.0	16.3
All Women	100.0	100.0	100.0
Median Age	27.4	31.0	28.3
Number of Cases	141	232	467

With respect to duration of marriage it seems that sterilizations are performed early during the married life of the woman. More than one fourth of the operations occurred during the first five years of marriage and two thirds of the group of sterilized women were operated during the first ten years. The median duration of marriage at sterilization was 8.0 years (Table V).

TABLE V

DURATION OF MARRIAGE AT STERILIZATION FOR
STERILIZED WOMEN 20-49 YEARS OF AGE,
PUERTO RICO, 1976

DURATION OF MARRIAGE IN YEARS	NUMBER OF STERILIZED	PERCENT
0-4	119	25.9
5-9	188	40.9
10-14	86	18.7
15 or more	67	14.5
All Women	460	100.0
Median	8.0	---

In Puerto Rico only mothers resort to sterilization for contraceptive reasons. Very few are sterilized with only one child and probably most of these cases are for therapeutic reasons. As shown in Table III this operation is more frequent among women with two and three children. Of the group of sterilized over one half had had two or three children at the time of intervention. The median number of children ever born was 2.89 a figure slightly greater than that of 2.75 obtained in the 1968 study (6).

Presently obtained survey data on age at sterilization, years of married life and number of children ever born when compared with that of studies undertaken in the mid sixties show a shift in the timing of sterilization. Apparently, it is being performed somewhat later and with a larger number of children than previously, as a result of the increased utilization of other modern methods of birth control (e.g. the pill).

The increase in the rate of sterilization observed during the last decade was probably due to an increase in sterilizations among older women as a result of the great emphasis put on this method in the government family planning programs during the period of 1973-76. A considerable proportion of women who for many years had been on the waiting list of the public hospitals, were sterilized.

THE INTERRELATIONSHIP BETWEEN STERILIZATION AND FERTILITY

Sterilization and fertility are clearly interrelated. While this birth control method can exert a significant effect in reducing the level of fertility in a population, high fertility might be an important factor in the woman's decision for sterilization.

To assess the effect of fertility on sterilization recently sterilized women might be compared against non-sterilized women in terms of their number of children ever born taking into account such expositional variables as age and duration of marriage. This might be accomplished by limiting the groups to be compared to young women (e.g. under 30 years of age). Another way to examine this relationship is to compare the number of children born to sterilized women by age and duration of marriage at the time of the operation against the number of children born to the non-sterilized in the same categories of age and duration of marriage.

Among the group of ever married women included in the sample, the sterilized have a much higher fertility than non-sterilized. The sterilized had an average of 4.0 children ever born as compared with a figure of 3.0 children among the non-sterilized (Table VI). This difference is considerable among women under 30 years but decreases as age increases and is reversed in the age group 45-49. A similar association is observed with respect to duration of marriage. The sterilized has a greater number children than non-sterilized, most particularly among women with less than 15 years of married life but beyond that point the relationship changes (Table VI). The fact that the average number of children ever born among young women with relatively few years of marriage is considerably larger for sterilized than for non-sterilized tends to indicate that high fertility is an important motivating factor for sterilization.

A similar situation is observed when sterilized and non-sterilized women are classified according to their previous contraceptive experience. Among women who had used other contraceptive methods as well as among those who had not used them, the sterilized had a larger number of children specially among young women with relatively few years of marriage (Table VII). It seems that among those women who have tried to cope with their fertility through the use of other contraceptives those who have failed have resorted to sterilization. The fact that never users of contraceptives had the lowest fertility might be due to the inclusion in this group of a great proportion of infecund and subfecund women, an area which was not explored in this survey.

TABLE VI

AVERAGE NUMBER OF CHILDREN EVER BORN FOR STERILIZED AND NON-STERILIZED WOMEN 20-49 YEARS OF AGE BY WOMEN AGE AND DURATION OF MARRIAGE, PUERTO RICO, 1976

AGE IN YEARS	STERILIZED*		NON-STERILIZED*	
	Average	(Cases)	Average	(Cases)
20-24	3.16	(19)	1.51	(149)
25-29	3.19	(53)	1.95	(193)
30-34	3.62	(112)	3.11	(125)
35-39	4.29	(103)	3.88	(129)
40-44	4.71	(84)	3.88	(110)
45-49	4.32	(94)	5.21	(94)
DURATION OF MARRIAGE IN YEARS				
0-4	2.64	(9)	1.08	(189)
5-9	3.03	(66)	2.03	(210)
10-14	3.45	(120)	2.95	(135)
15-19	3.95	(99)	4.35	(104)
20-24	4.30	(84)	4.82	(100)
25 and over	5.12	(87)	7.25	(59)

* Figures in parenthesis are the number of cases.

TABLE VII

AVERAGE NUMBER OF CHILDREN EVER BORN FOR WOMEN 20-49 YEARS OF AGE BY PREVIOUS USE OF OTHER CONTRACEPTIVES AND WHETHER STERILIZED OR NOT BY AGE OF WOMAN AND DURATION OF MARRIAGE, PUERTO RICO, 1976

VARIABLES	HAD USED OTHER CONTRACEPTIVES*		HAD NOT USED OTHER CONTRACEPTIVES*	
	Sterilized	Not Sterilized	Sterilized	Not Sterilized
Age of Women				
20-29	3.19 (63)	1.54 (274)	3.11 (9)	1.16 (68)
30-34	3.80 (81)	3.37 (98)	3.13 (31)	2.18 (27)
35-39	4.37 (57)	4.36 (98)	4.20 (46)	2.35 (31)
40-44	5.02 (40)	4.37 (65)	4.43 (44)	3.18 (45)
45-49	5.07 (27)	5.79 (42)	4.01 (67)	4.75 (52)
Duration of Marriage				
0-9	3.05 (63)	1.75 (296)	2.75 (12)	1.10 (103)
10-14	3.43 (87)	3.24 (107)	3.52 (33)	1.86 (29)
15-19	4.28 (58)	4.53 (83)	3.59 (41)	3.62 (21)
20-24	4.91 (34)	5.35 (60)	3.96 (50)	4.02 (40)
25 and over	7.35 (26)	7.94 (31)	4.72 (61)	6.50 (28)

* Figures in parenthesis are the number of cases.

A comparison of sterilized women by age and duration of marriage at the time of the operation against the corresponding groups of non-sterilized women for the group of sterilized does not correspond to any fixed time period the great majority of them were performed prior to 1976 (the survey year).

TABLE VIII

AVERAGE NUMBER OF CHILDREN EVER BORN TO STERILIZED WOMEN BY AGE AND DURATION OF MARRIAGE AT THE TIME OF THE OPERATION AND TO NON-STERILIZED WOMEN BY CURRENT AGE AND DURATION OF MARRIAGE, PUERTO RICO, 1976

AGE GROUPS*	STERILIZED**		NON-STERILIZED**	
20-24	3.11	(116)	1.51	(149)
25-29	3.52	(153)	1.95	(193)
30-34	4.53	(107)	3.11	(125)
35-39	5.64	(50)	3.88	(129)
40-44	7.26	(23)	3.88	(110)
DURATION OF MARRIAGE*				
0-4	2.72	(119)	1.08	(189)
5-9	3.54	(188)	2.03	(210)
10-14	4.55	(86)	2.95	(136)
15-19	6.34	(41)	4.35	(104)
20-24	7.56*	(18)	4.82	(100)

* For sterilized women it is the age and duration of marriage at sterilization; for non-sterilized it is the current age and duration of marriage. Very few cases were reported of sterilizations among women 40-44 years of age or with 25 years of marriage or more.

** Figures in parenthesis are the number of cases.

women demonstrate that the sterilized had a much higher number of children than the non-sterilized in all categories (Table VIII). It should be kept in mind that some of these differences might be due to secular changes in fertility having occurred in Puerto Rico during the last decade. Although the time of the op-

Partial correlation analysis showed that there was no significant association between being sterilized and the number of children born to the woman. This was to be expected as these variables are positively associated among young women and among women with few years of marriage while a negative rela-

TABLE IX

PARTIAL CORRELATION COEFFICIENTS BETWEEN NUMBER OF CHILDREN EVER BORN AND BEING STERILIZED CONTROLLING SOME VARIABLES FOR EVER MARRIED WOMEN BY BROAD AGE GROUPS

CONTROL VARIABLES	ALL EVER MARRIED 20-49 YEARS	UNDER 30 YEARS	30 YEARS AND OVER
None (simple r)	0.147	0.396	-0.010
Duration of marriage	-.026*	.259	-.075
Duration of marriage and age at first marriage	-.032*	.246	-.101
Duration of marriage, age at first marriage and schooling	-.026*	.254	-.094
Number of cases	1,272	415	857

* Not significant at the 0.05 level; all others significant at the 0.01 level.

tionship is observed among older women and among those with many years of married life. Table IX shows that the partial correlation coefficients between fertility and being sterilized are positive and high among women under 30 years of age. The simple correlation coefficient (r) between these two variables was 0.40. It is somewhat reduced when duration of marriage and age at first marriage are controlled but still a strong association prevails. No significant changes are observed when schooling and other socioeconomic variables are taken into consideration (Table IX). These results tend to confirm the

This is specially true in Puerto Rico where this operation is performed early in the married life of the woman and at a very young age. The data shown in Tables VI and VII confirm this hypothesis. Sterilized women of completed fertility (44-49 years of age) or with 15 years of marriage or more had on the average a smaller number of children than the non-sterilized. A correlation analysis restricted to women 30 years of age and over also shows that the number of children ever born is negatively associated with being sterilized. Although the correlation coefficients are significant only a small proportion of the variance in

TABLE X

PARTIAL CORRELATION COEFFICIENTS BETWEEN NUMBER OF CHILDREN EVER BORN AND BEING STERILIZED* FOR EVER MARRIED WOMEN AND MOTHERS UNDER 30 YEARS OF AGE FOR THREE LEVEL OF WOMAN'S SCHOOLING, PUERTO RICO, 1976

YEARS OF SCHOOLING	EVER-MARRIED		MOTHERS	
	Coefficient	Number of Cases	Coefficient	Number of Cases
0-6	0.144**	87	0.142**	82
7-11	.274	157	.222	143
12 or more	.301	171	.339	144
All	.246	415	.227	369

* Controlling for duration of marriage and age at first marriage.

** Not significant at the 0.05 level. All other coefficients significant at the 0.01 level.

hypothesis that high fertility is an important determinant for sterilization.

As years of school completed is an important correlate of fertility in Puerto Rico, the group of women under 30 years of age was divided into three levels of schooling (0-6, 7-11 and 12 or more years of school completed). In each group the relationship between number of children ever born and being sterilized was examined. Being sterilized continued to be positively correlated with fertility in all three levels of schooling but the association loses strength as the level of schooling declines (Table X). Apparently, high fertility plays a more important role in the decision of sterilization among the more educated.

While excessive fertility seems to be an important motivating factor for sterilization, sterilization must have a depressing effect upon fertility in the long run.

fertility is explained by this independent variable (Table X).

The reason for this weak association is probably the inadequacy of using this dichotomic variable (whether sterilized or not) to assess the long run effect of sterilization on fertility, particularly when excessive fertility is an important determinant of sterilization. Logically, time elapsed since sterilization should be a more adequate indicator for these purposes. When the number of years elapsed since the operation is considered as the independent variable the depressing effect of sterilization becomes clearer (Table XI). As expected this negative association is somewhat stronger for mothers than for ever married women. But more important, the strong negative relationship prevails even when the whole group of women or mothers of all ages (20-49 years) is considered.

TABLE XI

PARTIAL CORRELATION COEFFICIENTS BETWEEN NUMBER OF CHILDREN EVER BORN AND NUMBER OF YEARS ELAPSED SINCE STERILIZATION* FOR EVER MARRIED WOMEN AND MOTHERS, PUERTO RICO, 1976

CONTROL VARIABLE	WOMEN 20-49 YEARS **		WOMEN 30 YEARS OR MORE**	
	Ever Married	Mothers	Ever Married	Mothers
Duration of marriage	-0.263	-0.295	-0.275	-0.311
Duration of marriage and age at first marriage	-.270	-.302	-.293	-.324
Duration of marriage, age at first marriage and schooling	-.264	-.295	-.288	-.322
Number of Cases	1,272	1,190	857	821

* For non-sterilized women the number of years elapsed since sterilization is zero.

** All coefficients significant at the 0.01 level.

THE DEMOGRAPHIC EFFECTIVENESS OF STERILIZATION

In the previous section it was demonstrated that excessive fertility is an important determinant of sterilization. On the other hand, it was shown that sterilization had a strong depressing effect on fertility over time. The question that this type of analysis failed to answer was, what has been the overall effect of sterilization on Puerto Rican fertility? In other words, what has been its quantitative contribution in the reduction of the crude birth rate observed during the last decades?

To assess this effect another methodological approach was utilized which although simple is more meaningful and tangible from a demographic point of view than that of correlation analysis. Expected conventional measures such as crude birth rates, age specific birth rates and total fertility rates were computed on the assumption that sterilization would not have been used in Puerto Rico as a contraceptive method. These expected values were then compared with the recorded corresponding measures. For this purpose it was assumed that sterilized women are not exposed to the childbearing risk and that all live births occurring in a given year correspond to non-sterilized women.

The first step in this procedure was to estimate the total ever married sterilized and non-sterilized female population by age groups utilizing the proportions of ever married sterilized women obtained in the survey (Table I). With these denominators age specific fertility rates were computed for the non-sterilized female population (the registered births by age of mother were the numerators). This set of age specific fertility

rates was applied to the total ever married female population by age groups to obtain the expected number of births for a given year in the absence of sterilization. Finally, this expected number of births was utilized to compute the conventional age specific fertility rates, the total rate and the crude birth rate.

This method was utilized for 1968 and 1976 the only two years for which the needed survey data were available but crude estimates were obtained for 1953 and 1947-48. The most untenable assumption in this procedure is that sterilized women if not operated would have behaved from the child-bearing point of view as the non-sterilized group. The evidence obtained in this study indicates that sterilized women represent a higher risk group when compared with non-sterilized. Thus, the effect of sterilization on fertility, as obtained by this method, will be somewhat underestimated.

The results of these computations are summarized in Table XII. According to this procedure, the crude birth rate in 1976 would have been of 31.4 if the group of sterilized women would have been exposed to the same child-bearing risks of the non-sterilized. This represents a 7 points reduction in the crude birth rate of a 22 percent reduction. Similarly, the total fertility rate was reduced from an expected value of 3.98 to 2.93 or by 26 percent. The effects of sterilization on fertility were somewhat lower in 1968 due to the lower rate of prevalence of the operation in that year. As expected, the depressing effect of sterilization varies directly with its prevalence as can be observed from the results for the four years compared

TABLE XII

RECORDED CRUDE BIRTH RATES AND TOTAL FERTILITY RATES AND EXPECTED VALUES ON THE ASSUMPTION THAT STERILIZED WOMEN IF NOT OPERATED, WOULD HAVE BEEN EQUALLY EXPOSED TO THE CHILDBEARING RISKS AS THE EVER MARRIED NON-STERILIZED GROUP, PUERTO RICO, 1976, 1968, 1953 AND 1947-1948

	1976	1968	1953*	1947-48*
Crude Birth Rate				
Expected	31.4	32.4	41.5	45.8
Recorded	24.3	25.5	36.5	43.7
Percent reduction	22.3	21.3	12.0	4.6
Total Fertility Rate				
Expected	3.98	4.42	5.67	6.12
Recorded	2.93	3.31	4.98	4.78
Percent reduction	26.4	25.1	13.9	5.6
Percent of sterilized women (15-49 years)	35.4	34.1	16.5	6.6

* Rough estimates based on incomplete data.

SOURCES: José L. Vázquez Calzadà, "La Esterilización Femenina en Puerto Rico," *Revista de Ciencias Sociales*, Universidad de Puerto Rico Vol. XVII, No. 3 (Sept. 1973), Reuben Hill, et. al., *The Family and Population Control*, Chapel Hill, 1959, Paul K. Hatt, *Backgrounds in Human Fertility in Puerto Rico*, Princeton, 1952.

in Table XII. It is also evident that its reductive effect is much lower than its overall rate of prevalence. Thus, in 1976 when it was estimated that 34 percent of all ever married women 15-49 years of age were sterilized the number of births averted in that year amounted to only 22 percent. This is due to the fact that the highest proportions of sterilized women are found in the oldest age groups where the childbearing risks are lower.

To evaluate the role of sterilization in the decline of Puerto Rican fertility the year of 1940 was chosen as a point of departure. This is the first year for which all the needed data were available and by that time the prevalence of sterilization was almost zero. In that year the estimated crude birth rate was 46.7 and the total fertility rate 5.9 children (10).

For this purpose age specific fertility rates for ever married women were computed for 1940. This set of rates was applied to the 1976 ever married female population and an expected crude birth rate of 44.6 was obtained (Table XIII). Thus, around two points in the decline of the crude birth rate from 1940 to 1976 can be attributed to changes in the age-marital structure of the population. To evaluate the effect of sterilization the rates for ever married women of 1940 were applied to the non-sterilized ever married female population of 1976. This expected number of births (by age of mother) represents what would have been the situation in Puerto Rico in 1976 with the

level of fertility of 1940 and the rate of female sterilization of 1976. Under this premise the crude birth rate for 1976 would have been 33.6 (Table XIII). This means that approximately 11 points of the decline in the crude birth rate can be attributed to sterilization

TABLE XIII

RECORDED CRUDE BIRTH RATES AND TOTAL FERTILITY RATES FOR 1940 AND 1976 AND EXPECTED VALUES FOR 1976 UNDER TWO ASSUMPTIONS

	CRUDE BIRTH RATE	TOTAL FERTILITY RATE
1940, recorded	47.6	5.92
1976, recorded	24.3	2.93
1976, expected if		
1. All ever married women 1976 exposed to the 1940 risks	44.6	5.82
2. Non sterilized ever married women 1976 exposed to the risks of 1940	33.6	4.19

(44.6 versus 33.6). The rest, the difference between 33.6 and the recorded rate of 24.3 for 1976 was due to other factors including the use of other contraceptives. Similarly, approximately 58 percent of the decline in the total fertility rate which occurred between 1940 and 1976 was apparently due to the effect of sterilization.

In spite of the crudeness of this procedure, it clearly demonstrates the important role that female sterilization has played in the reduction of the level of Puerto Rican fertility. It also shows that its depressing effect is greater among populations with high levels of fertility.

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RESUMEN

Una muestra representativa de 1,272 mujeres puertorriqueñas casadas alguna vez de 20-49 años fueron entrevistadas durante el verano de 1976 con el propósito de examinar posibles cambios en las tendencias y patrones relativos a la esterilización femenina y de determinar el efecto de este método anticonceptivo sobre la fecundidad.

La información obtenida demuestra que la tasa de esterilización tuvo un aumento moderado durante la última década. Al igual que en estudios anteriores la prevalencia de la esterilización aumenta con la edad entre mujeres jóvenes, pero a partir de los 30 años se mantiene casi estacionaria. Una tendencia similar se observa con relación a los años de vida matrimonial.

El por ciento de mujeres esterilizadas es mayor entre residentes de la zona urbana y varía inversamente con el nivel socioeconómico. Aparentemente, la esterilización se está efectuando en la actualidad a una edad más avanzada y con un número mayor de hijos que anteriormente aunque las diferencias no son muy marcadas.

Un análisis de correlación demostró que, aunque una fecundidad alta es un factor importante para esterilizarse, la esterilización tiene un efecto reductor sobre la fecundidad a largo plazo. Se demostró que más de la mitad del descenso en la tasa de natalidad ocurrido desde 1940 puede atribuirse al efecto de la esterilización.

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