

## Age and Infertility

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**Direct evidence on age patterns of infecundity and sterility cannot be obtained from contemporary populations because such large fractions of couples use contraception or have been sterilized. Instead, historical data are exploited to yield upper bounds applicable to contemporary populations on the proportions sterile at each age. Examination of recent changes in sexual behavior that may increase infecundity indicates that sexually transmitted infections, the prime candidate for hypothesized rises in infertility, are unlikely to have added to infecundity to any great extent. These results imply that a woman in a monogamous union faces only moderate increases in the probability of becoming sterile (or infecund) until her late thirties. Nevertheless, it appears that recent changes in reproductive behavior were guaranteed to result in the perception that infecundity is on the rise.**

INFERTILITY HAS BEEN RECEIVING ATTENTION IN BOTH THE popular and the scientific press. Some reports suggest that infertility is higher than was thought or that levels have been increasing. Until quite recently, a woman's fecundity was thought to decline slightly from age 20 to the early 30's, but more sharply after 35 (1). Then, in 1982, a French study questioned the conventional wisdom and generated widespread publicity (2). It reported results from women with no identifiable reproductive impairment who had been artificially inseminated because their husbands were azoospermatic. Some 74% of women below age 30 conceived within 12 insemination cycles, while the figures fell to 65 and 56% for women aged 30 to 34 and 35 to 39, respectively. An accompanying editorial and subsequent popular articles suggested that women who were delaying childbearing to establish a career would have to alter their plans and have their babies early if they were to have them at all (3). It was assumed that the figures reported were an accurate assessment of unavoidable decline in fecundity due to biological aging and that the drop from 74 to 65% of the women conceiving within a year represented a major change.

Our purpose is to review and evaluate evidence regarding the extent to which populations are subject to fecundity decline because of aging and to examine whether infecundity, particularly at young ages, has been increasing (4-8). We will argue that currently available data do not indicate any rise in reproductive impairment. We will nevertheless suggest that, perhaps seemingly paradoxically, the changes in patterns of childbearing and fertility control that took place during the last quarter century made it predictable and almost inevitable that infertility or, more precisely, infecundity would be perceived as a problem requiring increased attention.

Terminology can be a source of confusion. The English word "fertility" refers to actual production of children, whereas "fecundity" is the capacity to bear a child. Nevertheless, the term infertility is

used in the medical literature to denote reduced capacity to conceive, although the definition of "reduced capacity" is often imprecise. We, wherever possible, focus on infecundity rather than infertility and try to distinguish between reduced capacity to bear a child and sterility. When only couples can be considered, the demographic convention of attributing their joint reproductive status to the woman is followed, with the awareness that female fecundity may thereby be underestimated.

The extent of infecundity is difficult to study in contemporary developed countries. Most couples use contraception or have voluntarily chosen surgical sterilization to terminate childbearing (9). Those who have not opted for some form of fertility control are likely to be self-selected for lower fecundity; it is risky to generalize from their experience to the entire population. One alternative is to examine childbearing in historical populations in which family limitation was not practiced. Historical declines in fecundity attributable to childbearing or aging were likely to have been greater than they are today for several reasons. Lowered fertility and better care during pregnancy and childbirth have reduced risks of reproductive impairment. Also, effective treatment for many conditions that interfered with reproduction is now available. Thus historical data should permit an assessment of upper bounds on the inevitable biological declines due to aging. Then, if infecundity has increased in recent times, so that declines with age are greater today than in the past, the causes must be either environmental agents or an increase in the prevalence of diseases of the reproductive tract.

### Historical Evidence

*Fertility change with age.* One indicator of decline in fecundity is the way birth rates among married women change with age in populations in which little or no family limitation is practiced, such as those identified by Henry (10). Although the level of fertility varies, the age patterns of decline (Fig. 1) are quite similar; the fall is not large until after age 35. Menken and Larsen estimated a model that imposed a common age pattern but allowed the level of marital fertility to differ among populations (5, 11). Fertility, compared with that of women 20 to 24, is reduced on average by 6% for women 25 to 29, 14% for those 30 to 34, and 31% for women 35 to 39, with much greater decline thereafter.

Fertility rates decline not only with age of spouses but also with marriage duration, presumably because of a combination of decreased sexual activity and reproductive impairment associated with more pregnancies (12, 13). Mineau and Trussell (13) separated these effects by estimating a multiplicative model,  $F(W, H, D) = B w(W) h(H) d(D)$ , in which the fertility rate,  $F$ , for couples married  $D$  years

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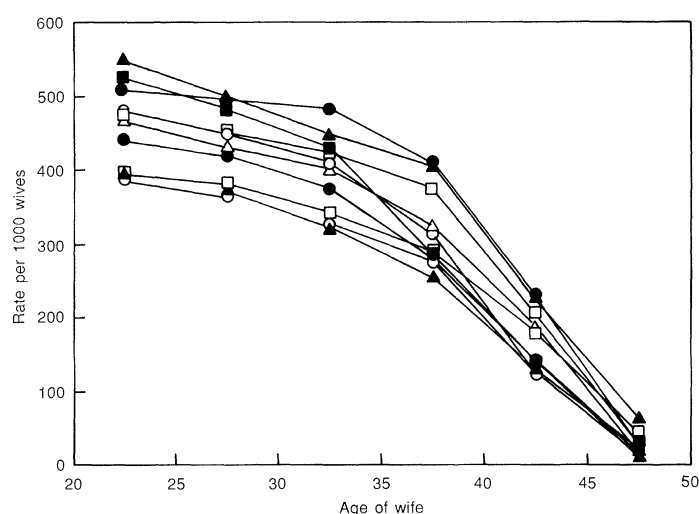


Fig. 1. Marital fertility rates by 5-year age groups (5). The ten populations (in descending order at age 20 to 24) are Hutterites, marriages 1921-30 (▲); Geneva bourgeoisie, husbands born 1600-49 (■); Canada, marriages 1700-30 (●); Normandy, marriages 1760-90 (○); Hutterites, marriages before 1921 (□); Tunis, marriages of Europeans 1840-59 (△); Normandy, marriages 1674-1742 (●); Norway, marriages 1874-76 (□); Iran, village marriages, 1940-50 (▲); Geneva bourgeoisie, husbands born before 1600 (○).

in which the wife was age  $W$  and the husband age  $H$  was the product of a baseline value  $B$  and effects of female age,  $w(W)$ , male age,  $b(H)$ , and marriage duration,  $d(D)$ . Tables 1 and 2 show estimates for a Mormon group in which standard demographic analyses demonstrate that family limitation was unlikely. The results are clear-cut: little change in female fertility between the end of adolescence and the mid-30's (14). Even women in their late 30's bore children at 90% of the base rate. Male fertility declined slowly; at 50 to 54 it was 73% that of the early 20's. Hence the age of fecundity of couples is determined primarily by aging of women and marriage duration.

**Fertility change due solely to aging.** In the findings summarized above, the effects of reproductive impairments related to the conditions of childbearing in the past cannot be separated from those of normal biological aging. Women who are delaying motherhood are certainly more concerned with the latter. In the past nearly all couples expected to have children. The proportion having at least one live birth in their lifetime, among women whose marriages survived at least until they reached age 50, calculated according to age at marriage, is an index of reproductive capacity near that age (15). It underestimates the true proportion fecund at the age of marriage because some women, fecund at marriage, become sterile before ever having a birth.

This index is useful only in populations in which deliberate fertility control is rare and late marriage is relatively common and usually not preceded by premarital conceptions. Menken and Larsen located data for seven population groups meeting these criteria (16). The proportions having at least one child and the estimated common age pattern are shown in Fig. 2. The risk of childlessness (Table 3) rises from 6% for 20 to 24 year olds to 9% for those 25 to 29, to 15% for women who marry in their early 30's, and then increases much more sharply.

**Estimates of sterility.** Henry suggested that sterility could be estimated for all women of a given age from the proportion who bore no more children between that age and the end of reproductive life, say age 50 (17). This figure is usually greater than the proportion truly sterile at that age; it must, however, equal the proportion sterile at a particular later age. This later "reference" age

has been estimated by several investigators (17, 18), most recently Trussell and Wilson (6), who then analyzed female sterility in rural England simultaneously by age of the mother and her age at marriage.

The proportion of women, according to age at marriage, who bore no children between a particular age and age 50 was computed and plotted against the appropriate reference age (6) to yield the estimated age pattern of sterility (Fig. 3). A clear pattern emerged: the earlier the age at marriage, the higher the estimated level of sterility at any subsequent age. It is likely that previous childbearing increased the risk of sterility, although the tendency for long-married couples to have less frequent sexual relations may have inflated the estimates. The pattern of sterility due solely to the process of aging (Table 2) was obtained by combining the initial estimates for each marriage cohort and agrees quite well with the earlier estimates. In both cases, the rise in sterility with age may be overestimated because of selection factors (16).

**Diagnosis of infertility by failure to conceive within a year.** The historical evidence indicates that the proportion of women who were sterile increased rather slowly and almost linearly from the mid-1920's until the early 1940's. But women normally do not become sterile instantaneously; instead there is a period of declining fecundity. Under current medical practice, the diagnosis of impaired fecundity (including sterility) is based on a couple's having had unprotected intercourse for a year without conceiving (19). This "test" for infertility is certainly sensitive because no sterile woman will be misclassified as fecund, but it is not very specific because many nonsterile women will be counted as infertile. Trussell and Wilson found that more than 23% of women in the rural English parishes who married between ages 20 and 24 failed to have a live birth within the first 2 years of marriage; yet only 4.6% never had a child (6). Hence, of these women, almost all of whom would have been classified as infertile today, only 20% were unable eventually to have a child.

Other analyses of historical data also suggest that a sizable proportion of nonsterile couples may take a long time to conceive. Bongaarts estimated the monthly probability of conception in a

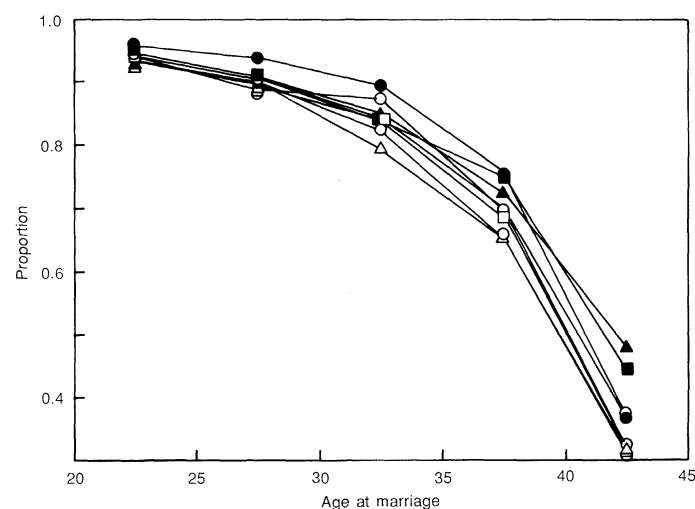


Fig. 2. Proportions having at least one child by 5-year age group at marriage and estimated typical pattern (5). The populations (in descending order at age 35 to 39) are Germany, 14 village genealogies, marriages 1750-1899 (●); England, family reconstitution of 16 rural parishes (mid-16th to early 19th centuries) by the Cambridge Group for the History of Population and Social Structure (■); Ireland, 1911 census (▲); typical pattern (—); England, family reconstitution for Quakers (○); Quebec, rural women born before 1876 (□); Scotland, 1911 census (○); and Quebec, 1946 census, rural women born 1876-85 (△).

Table 1. Relative fertility rates, controlling for the effects of marriage duration and age of spouse, according to the age of the wife or the husband: Mormon genealogical data, wives born between 1840 and 1859 (13). Rates are relative to the base value, 471 births per 1000 wives, estimated for couples married less than 5 years when both the husband and the wife are 20 to 24.

Age (years)	Relative rate	
	Wife	Husband
15-19	0.96	0.90
20-24	1.00	1.00
25-29	1.03	0.99
30-34	0.99	1.04
35-39	0.90	0.97
40-44	0.62	0.83
45-49	0.14	0.82
50-54		0.73
55-59		0.48

number of populations of newlyweds, who mostly were young and presumably close to the peak of their reproductive capacity (20). Even for a highly fecund group, it can be estimated that the mean time to conception is more than 8 months and that at least 14% take more than a year to conceive. Correspondingly more women at older ages, where fecundity is lower, would take a long time to conceive. This evidence is corroborated by a recent study of couples who were diagnosed, in part by the 1-year test, as having fertility problems. A rather high proportion, 41%, of those whose infertility problems were treated subsequently conceived; but so did 35% of the untreated women (21).

Clearly, use of the 1-year criterion as a measure of infertility confounds inability ever to conceive with difficulty in conceiving quickly. As a diagnostic tool, its advantage is that those with infertility problems have the opportunity to start treatment early. Nevertheless, because a substantial fraction of nonsterile couples takes more than a year to conceive, use of this criterion may generate needless anxiety in couples who hope to become parents and leads to unnecessary and costly medical treatment in a substantial proportion of cases.

The French study cited earlier (2) used the same infecundity criterion: the proportion conceiving in 12 cycles. Bongaarts has suggested that the reported proportions are very low for all ages, probably because artificial insemination is less likely than normal coitus to induce conception (22). In an English study of women who stopped using contraceptives because they wanted to conceive, more than 80% of never-pregnant and close to 90% of parous women who had been using methods other than the pill (and whose average age was 29, roughly comparable to the French group), became pregnant within a year (23). Only 69% of the French women conceived within the same period. The discrepancy is even greater because all pregnancies were counted in the French study but only pregnancies leading to a live birth in the British.

In sum, the historical and medical evidence indicates that female fecundity declines in a moderate but steady fashion from the mid-twenties until the late thirties or early forties, after which there is a sharp upturn in infecundity and in sterility.

## Contemporary Evidence

*Reproductive behavior in the United States.* Delayed childbearing and low fertility are not new phenomena; nor is delayed marriage. In fact, delayed childbearing has characterized much of Western Europe since the 17th century and late and low fertility was common in the United States in the late 1930's. Subsequently, in the United

States, both marriage and childbearing moved to progressively younger ages, culminating in the baby boom, and then reversed direction decisively. For white women, the swings in childlessness have been substantial, yet the proportions childless were certainly no greater in 1981 than in 1941, and for women over 30 they were not as high (24). For nonwhite women over 30, childlessness has dropped since the early 1950's (24), possibly because of a decline in infecundity (25).

The high childlessness and low fertility of white women 45 years ago were not attributed to infecundity. Delayed childbearing was accomplished by postponement of marriage far more than by contraception, and the women who delayed marriage for the most part also delayed sexual relations. Today for much of the population frequent sexual activity long precedes marriage; the timing of parenthood within marriage has also become more variable. Thus, it is necessary to consider whether the revolution in sexual practices that has taken place concomitantly with delayed childbearing can have affected fecundity.

*Possible causes of increased infecundity among the sexually active.* By far the greatest known danger to fecundity is the scarring of the fallopian tubes that may follow pelvic inflammatory disease (PID). The primary cause of PID is sexually transmitted infections such as gonorrhea and that caused by *Chlamydia*. The overall increase in PID in the United States is the main indirect evidence that infecundity may be rising (26). Between 1965 and 1975, reported cases of gonorrhea tripled and then remained at the level of about 1 million per year for the next 5 years (27). Sexually transmitted infections do not invariably lead to PID, however, so that even if all sexually transmitted infections were reported, one could not accurately assess the extent of PID. The first U.S. data on this subject recently became available. In the 1982 National Survey of Family Growth, women were asked whether they had ever had PID. The proportions answering affirmatively rose with age to a maximum of 20% for women in their early 30's and then declined (28). Pelvic inflammatory disease does not necessarily lead to reproductive impairment. The most reliable data on the extent to which it can induce sterility come from a Swedish study by Westrom, who found that 22.5% became sterile after one or more laparoscopically verified

Table 2. Relative fertility rate by marriage duration, controlling for the effects of husband's and wife's age. Data, underlying model, and base value are the same as described for Table 1.

Marriage duration (years)	Relative rate
0-4	1.00
5-9	0.84
10-14	0.77
15-19	0.79

Table 3. Estimated proportions of women who are sterile.

Menken-Larsen (5)		Trussell-Wilson (6)	
Age at marriage (years)	Risk of childlessness	Reference age*	Proportion sterile
20-24	5.7	23.4	4.6
25-29	9.3	28.5	9.1
30-34	15.5	35.1	16.6
35-39	29.6	40.6	25.4
40-44	63.6	45.2	62.2

\*An estimated 4.6% of women who were married when they were 20 to 24 were sterile when they were 23.4 years old (the reference age corresponding to age at marriage 20 to 24). See Trussell and Wilson (6) for the determination of reference ages.

Table 4. Proportion of married women with impaired fecundity or who are infertile, by the age of the woman from three surveys (33).

Age (years)	Impaired fecundity*	Infertile†
15–19		
20–24	10.8	7.0
25–29		8.9
30–34	25.2	14.6
35–39		21.9
40–44	55.1	28.7

\*The data were published for 10-year age groups in 1976 and 1982 (7, table 4) and are averaged. The numerator is composed of those (i) surgically sterile for noncontraceptive reasons, (ii) nonsurgically sterile, (iii) subfecund (self-reported difficulty in conceiving or delivering a child), and (iv) who failed to conceive in the previous 3 years while married and not using contraception. The denominator excludes those couples surgically sterilized for contraceptive reasons. †The data for the three surveys (7, table 6) were averaged. The numerator consists of those who had not conceived in the previous year while married and using no method of contraception. The denominator excludes couples who had been surgically sterilized for any reason.

infections (29). Therefore a given increase in incidence of sexually transmitted infections will cause a much smaller increase in sterility. Even if 20% of U.S. women had experienced laparoscopically verifiable PID, they would contribute at most 4.5 excess percentage points to the proportion sterile.

Use of intrauterine devices (IUD's) is associated with increased risks of PID and of sterility. However, only relative risks comparing sterility in IUD users and nonusers are reported and not the impact on population levels of fecundity impairment (30). Nevertheless, because such a small proportion of women use IUD's [down from a high of 6.7% in 1973 to a low of 4.0% in 1982 (31)], the impact cannot be large. The risks of sexually transmitted infections and PID also increase with the number of sexual partners of either the man or the woman. The persistent suspicion that women who have undergone abortions may have problems in later pregnancies is not supported by recent research (32).

Clearly reproductive impairment is related to age because the older a woman, the longer she has been exposed to risks of PID and other hazards. Yet just as clearly this association with age is only indirect; women or couples who avoid these health problems or treat them adequately face only moderate increased risks of sterility or infecundity associated with aging.

*Estimates of infertility or fecundity impairment in the United States.* One major change in reproductive behavior in the United States is the enormous increase in surgical sterilization, now the method most commonly used by married couples to control fertility. The proportion of couples in which at least one partner has been surgically sterilized rises dramatically with the age of the woman, from 44% of married women aged 30 to 34 to 58% of those 35 to 39 to more than two-thirds of those 40 to 44, according to 1982 figures (8). It is impossible to know how many of these couples would be infecund or sterile if they had not been sterilized (whether for contraception or health reasons). Similarly, it is difficult to determine the fecundity status of contraceptive users. The remaining women, who are neither contraceptive users nor sterilized, are almost certainly self-selected for fecundity impairment. Despite the evident difficulties, estimation of the extent of reproductive impairment based on survey data from representative samples of women has been attempted (7, 8). In our opinion, these estimates are almost surely biased by selectivity problems and reporting errors and cannot be expected to yield accurate information on the increase in fecundity problems with age either for all women or those who have postponed childbearing.

The data come from three fertility surveys, the National Fertility Survey of 1965 and the National Surveys of Family Growth (NSFG) taken in 1976 and 1982 (33). Women were asked whether

it was possible for them to get pregnant (again) and whether they expected any problem or difficulty in conceiving or delivering a baby. Fertility histories and information on sterilizing operations were obtained. Married women were divided into three groups: surgically sterile if they or their husbands had been sterilized; impaired fecundity; or fecund. The impaired fecundity category included those who were nonsurgically sterile, subfecund (as determined by stating there were difficulties in conceiving or delivering a child) or who had failed to conceive in the previous 3 years while being married and not using contraception ("long intervals"). Mosher (7) reports that, when those sterilized primarily for the purpose of preventing pregnancy are excluded and those sterilized for other medical reasons are added to the impaired fecundity category, there is little change between 1976 and 1982, the 2 years for which the appropriate data are available, either for nulliparous or parous women, in the proportion whose fecundity is impaired.

The figures (Table 4) are difficult to interpret. First, they are subject to a number of biases. They may overestimate impaired fecundity either because "difficulty in conceiving or delivering a baby" may be a very subjective concept inviting overreporting or because women with long intervals may have concealed an induced abortion. They may underestimate impairment because contraceptive users may have fecundity problems but be unaware of them. Thus these estimates may be problematic even for the group on which they were based: women who had not been sterilized for contraceptive reasons. Second, the exclusion of the contraceptively sterile makes generalization of these results to all women even more problematic, since again arguments can be made for biases in both directions: highly fecund women may be more likely to choose sterilization to terminate childbearing or women for whom childbearing is considered difficult or dangerous may opt for sterilization. The proportion sterilized increases steeply with age and increased at each age during the period examined (1965–1982), further complicating interpretation. Finally, these results cannot be generalized to assess the level of impairment associated with postponed motherhood since women who are delaying childbearing are unlikely to be typical of all women who are not sterilized for contraceptive reasons.

A second index of reproductive impairment was computed for married women who were not surgically sterile. They were categorized as infertile if they had not conceived within the previous year while using no contraception, and fertile otherwise. Only for wives 20 to 24 was there a statistically significant increase in infertility, from 3.6% in 1965 to 6.7 and 10.6% in the two later surveys. Averages of the results for the three surveys are shown in Table 4. Mosher concludes that among couples who were not surgically sterile "the proportion infertile has not changed dramatically at given ages since 1965" (7). He found that about one in seven couples are infertile at ages 30 to 34 of the women; at ages 35 to 39, the figure is about one in five; at ages 40 to 44, about one in four. These estimates of infertility among women over 30 are lower than the estimates of sterility for the past (Table 2). They are based only on nonsterilized women and count all those using contraception as fecund. Since large proportions of nonsterilized women over 30 use contraception (34), these figures must seriously underestimate infertility among all women and among those who postpone childbearing.

These attempts to analyze impairment may be useful for estimating the number of women who might use infertility services; however, they offer little information useful to those who are concerned about the effects of delaying childbearing. It appears that the historical estimates are much less subject to biases and, indeed, are likely to be overestimates of sterility; if so, they offer evidence that the fall in fecundity with age is reasonably modest, at least until the late 30's.

## Why Is Infecundity Receiving So Much Attention?

Even if there has been no change in age-specific prevalence of infecundity, there are several reasons why it might be overestimated today in the public imagination and perhaps even the scientific literature. First, until recently the major fertility problem has been the control of unwanted childbearing, so that infecundity problems were overshadowed. Second, there is a compositional explanation: among the smaller group of women who would like to have children now, a higher proportion may indeed have infecundity problems. Third, new methods for treatment of infecundity are being introduced, and research on its causes has increased. Finally, current medical practices tend to lead to exaggerated diagnosis of infertility.

More than 20% of births to married women in the 5 years before the 1965 National Fertility Survey were unwanted and another 45% were unplanned (in that they came sooner than intended by the parents) (31). The main concern was prevention of unwanted births, and the popular idea evolved that modern means of fertility control would open the way for people to have exactly the number of children they want. Today fertility control is highly effective. Less than 7% of births to married women during the 5 years before the 1982 NSFG were unwanted, although more than 22% were mistimed (31). Unwanted fertility has virtually disappeared in much of the population, with significant exceptions, sexually active teenagers being the most troubling. Of course, all problems of fertility control have not been solved: satisfactory, effective, and safe methods are not always available; the large numbers of abortions are a measure of failure to control fertility in other ways; many may have chosen sterilization as the best among unsatisfactory alternatives.

A consequence of the success in preventing unwanted births is that fertility now appears to be more within individual control. With great effort, fertility has been "turned off": people had come to believe that controlling fertility was the real problem and to expect that having children was easy. It is hardly surprising, then, that couples frequently believe there are problems if a wanted child is not conceived within a few months. Moreover, because of the reduced incidence of unintended pregnancies as compared with the past, a higher fraction of all couples now have the opportunity to observe just how long it takes to realize their intention to conceive.

A second reason for greater attention is compositional: inevitably, with the recent rapid decline in fertility, because more women are controlling fertility effectively so that fewer are pregnant at any one time, a larger proportion of the women who appear in doctors' offices for pregnancy-related reasons are coming not for prenatal care but for help with conceiving. The situation is exacerbated by two further trends. Women are delaying initial attempts to become pregnant to older ages, when indeed they may be less fecund, and proportionately more women in the childbearing years are older since the baby boom cohorts are reaching this stage of life. Therefore doctors may well find that more of their patients have fertility problems.

Ways of handling infecundity problems have also changed. In the past, people were more likely to have had the option of adopting children who resembled themselves sufficiently so that they could choose whether anyone else, even the child, need know that they were not the biological parents. The contraceptive revolution, combined with the increased tendency for unwed mothers to raise their babies, has drastically changed the availability of adoptive children and focused attention on the problems of disappointed couples. The increase in interracial and international adoption has made infecundity problems far more obvious and far more openly discussed. The new treatments for infecundity and new and innovative means of providing infants for the childless—test tube babies,

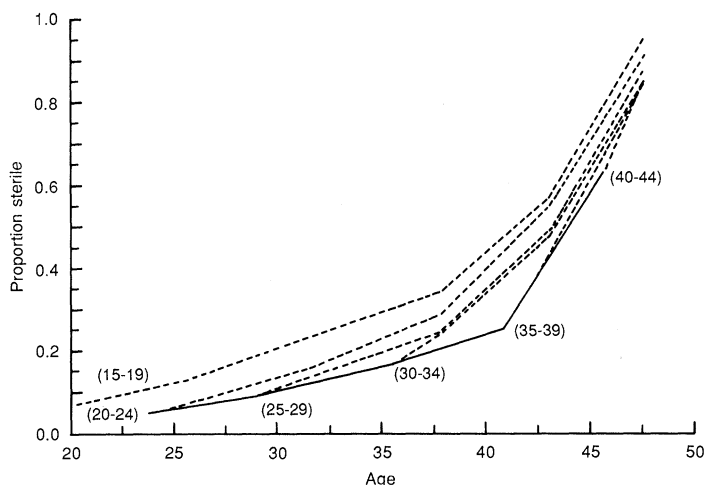


Fig. 3. Proportion sterile by age at marriage (in parentheses) and age (6): 16 English rural parishes. The solid line is the estimate of the proportion sterile when sterility is due solely to aging.

surrogate mothers, new surgical interventions for infecundity, and reversal of sterilizing operations—call attention to fertility problems without necessarily signaling changes in their incidence.

Finally, there is almost certainly excess diagnosis of fertility problems. The standard 1-year criterion for infertility is arbitrary and has not been satisfactorily justified. We question whether the benefits of using so nonspecific a test outweigh the financial and emotional costs. There are other reasons for excess diagnosis related to our health care system. The number of physicians with interests in infecundity has increased dramatically. As the number of births declined between 1962 and 1975, the demand for obstetrical services also declined. It is hardly surprising that many obstetricians expanded their interest in other fields, including infecundity (35). This increased interest serves to stimulate consultation between physicians and patients about perceived or potential fertility problems.

## Conclusions

Clearly, infecundity is a problem requiring attention, but that attention should be directed toward disease and not distorted by an exaggerated impression of the effects of normal biological aging. The need for better ways to diagnose reproductive impairments is clear, as is the need to obtain better information on sexually transmitted diseases and to understand whether and to what extent they affect subsequent fertility. The evidence indicates that the woman who deliberately postpones childbearing and either abstains from sex or participates in a monogamous relationship does not face great risks of infecundity. For her, the time required to conceive a wanted child almost certainly increases with age and the risk of being unable to bear a child seems to rise from about 5 or 6% at ages 20 to 24 to at most 16% when she is 30 to 35.

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  14. These estimated rates by age for females control for the effects of male age and marriage duration. Because older women generally have been married longer and have older husbands, the fertility rates observed for all women decline much more rapidly than these rates.
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  16. See Menken and Larsen (5) for detailed description of data sources. Between 11 and 35% of women in these populations married after age 30. Two problems, both of which may lead to overestimates of fecundity decline with age, merit attention. For some women the marriage may not be the first, although widow remarriage is uncommon in all of these populations. The proportion infertile of all unions, however, overestimates infertility in first marriages, particularly at the older ages, since some women who have no children in a remarriage will have at least one from an earlier union. Of more concern is premarital pregnancy. Women who married early may have been more fecund and therefore more likely to have an accidental nonmarital pregnancy. The decline with age at marriage in proportions becoming mothers would then be greater than the natural decline in fecundity. When premaritally pregnant women (as determined by a birth within 7 months of marriage) were excluded from the English data, however, the age patterns were virtually unchanged. Data on all women were used for comparability with census tabulations.
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# The Galactic Center: Is It a Massive Black Hole?

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Studies of active galactic nuclei constitute one of the major efforts in astronomy. Massive black holes are the most likely source for the enormous energy radiated from such nuclei. Observations reviewed here suggest unusual activity and the possible existence of a massive black hole

in the nucleus of our galaxy. Because of its proximity to Earth, our galactic nucleus can be observed in unsurpassed detail and may serve as the Rosetta stone both for deciphering active galactic nuclei and for confirming the existence of a massive black hole.

THE TERM "BLACK HOLE" IS ONE OF THE MORE POETIC scientific terms and has wide appeal to the imagination of the general public (1). It is also a basic consequence of General Relativity and most theories of gravity. Black holes could arise in at least three astronomical settings. (i) Primordial black holes forming out of the ultrarelativistic gas at the early stages of the Big Bang are permissible in principle but very difficult to observe (2). (ii) A more realistic stellar black hole may form as the remnant of a supernova explosion at the end of the life of a sufficiently massive star—the

outer layers of the star being ejected into interstellar space and the core collapsing into a volume smaller than its event horizon (2, 3). (iii) A massive black hole may also form from the coalescence of a star cluster (4). Although the detailed mechanisms are not clear, the formation of massive black holes may be an inevitable outcome of the evolution of galactic nuclei (Fig. 1) (5). Such massive black holes

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