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Contraceptive Failure, Method-Related Discontinuation And Resumption of Use: Results from the 1995 National Survey of Family Growth

By James Trussell and Barbara Vaughan

Context: Half of all pregnancies in the United States are unintended. Of these, half occur to women who were practicing contraception in the month they conceived, and others occur when couples stop use because they find their method difficult or inconvenient to use.

Methods: Data from the 1995 National Survey of Family Growth were used to compute life-table probabilities of contraceptive failure for reversible methods of contraception, discontinuation of use for a method-related reason and resumption of contraceptive use.

Results: Within one year of starting to use a reversible method of contraception, 9% of women experience a contraceptive failure—7% of those using the pill, 9% of those relying on the male condom and 19% of those practicing withdrawal. During a lifetime of use of reversible methods, the typical woman will experience 1.8 contraceptive failures. Overall, 31% of women discontinue use of a reversible contraceptive for a method-related reason within six months of starting use, and 44% do so within 12 months; however, 68% resume use of a method within one month and 76% do so within three months. Multivariate analyses show that the risk of contraceptive failure is elevated among low-income women and Hispanic women. Low-income women are also less likely than other women to resume contraceptive use after discontinuation.

Conclusions: The risks of pregnancy during typical use of reversible methods of contraception are considerably higher than risks of failure during clinical trials, reflecting imperfect use of these methods rather than lack of inherent efficacy. High rates of method-related discontinuation probably reflect dissatisfaction with available methods.

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Unintended pregnancy is a major public health problem that affects not only the individuals directly involved but also society.[1] Half (48%) of all pregnancies in the United States are unintended: There were three million in 1994, the last year for which data are available. Half (48%) of all women aged 15-44 have had at least one unintended pregnancy.[2]

Most couples who want to avoid pregnancy practice contraception. Nevertheless, half (53%) of women with unintended pregnancies were using a family planning method in the month they conceived.[3] Many of these women may have become pregnant because

their method was not highly effective or was difficult for them to use consistently and correctly.

In the analyses described in this article, we used data from the 1995 National Survey of Family Growth (NSFG) to estimate life-table probabilities of contraceptive failure (pregnancy during contraceptive use) during typical use, of discontinuation for a method-related reason and of resumption of contraceptive use after discontinuation of a reversible method. We present estimates of contraceptive failure and discontinuation separately for each reversible method. However, separate estimates of resumption of use following method discontinuation for any reason are shown only for the pill, the male condom and sterilization; all other methods are combined in one category.

We also examined risk factors for contraceptive failure, contraceptive discontinuation for a method-related reason and resumption of contraceptive use after discontinuation of the prior method. Finally, we estimated the number of contraceptive failures the typical woman would experience in her lifetime.

Our analyses of contraceptive failure and discontinuation of contraceptive use for a method-related reason fit squarely into a rich substantive and methodological literature on these subjects. This article breaks new ground in four respects. First, we have expanded the standard set of risk factors for contraceptive failure (method, age, race and ethnicity, parity, income, previous method and desire for children in the future) to include two new time-varying factors: current marital status and current work or study status. Second, we systematically examined this set of nine factors to determine their effects on the risk of discontinuation for a method-related reason. Third, we examined resumption of contraceptive use following discontinuation for any reason. Finally, we have presented a unified set of results for contraceptive failure, discontinuation for a method-related reason and resumption of use following discontinuation.

DATA

The 1995 NSFG contains extremely detailed information about methods of contraception used by the 10,847 female respondents aged 15-44 during a focal period from January 1991 until their interview (at varying dates in late 1995).[4] For instance, there are 17 questions about method use for each of the up to 58 months in the focal period; there are, however, no summary variables describing the beginning and ending dates of method use. There is similar detail in questions about periods of no exposure to risk of pregnancy, and about time spent in union; the codebook is more than 6,300 pages long.

Thus, the construction of even straightforward variables for analysis entails examination of many source variables. The complexity of the survey has also resulted in some deficiencies in the data quality, such as missing data caused by erroneous skip patterns or failure to include questions for some classes of respondents.

DEFECTS IN DISCONTINUATION DATA

The most serious problem in the NSFG data is the substantial underreporting of induced abortion. Estimates of the extent of underreporting can be obtained by

comparing the number of abortions derived from surveys of abortion providers conducted by The Alan Guttmacher Institute with the number reported in the NSFG. The overall level of abortion underreporting in the 1995 NSFG for the four-year period 1991-1994 is estimated to be 55% in the main interview, 48% in the computer-assisted self-interview for sensitive topics and 41% when the main interview is combined with the self-report.[5] It is likely that some induced abortions are misreported as spontaneous abortions,[6*] but because others are not reported at all, the sum of reported induced and spontaneous abortions is without doubt too low.

The consequence, all else being equal, is an underreporting of contraceptive failure and perhaps of method-related discontinuation. It is likely that what appears in some instances to be continuous use of a contraceptive method in fact contains a contraceptive failure (an important cause of discontinuation) or that what appears to be a simple switch of methods in fact resulted from contraceptive failure.

Although attempts have been made to correct for such underreporting in the NSFG by using surveys of abortion patients to ascertain contraceptive use prior to the abortion,[7] the correction for underreporting of abortion would tend to result in overestimates of contraceptive failure because women in abortion clinics probably overreport use of a contraceptive at the time of conception, thus shifting responsibility for the pregnancy from themselves (and their partner) to contraceptive failure.[8]

Likewise, in personal interviews for the NSFG, women probably tend to overreport contraceptive use at the time of an unintended conception. Evidence for this suspicion is provided by a first-year probability of pregnancy of 6% during use of the IUD (a method with little scope for user error) among married women in the 1976 and 1982 NSFGs. This probability is much higher than rates observed in clinical trials of IUDs[9] (see Appendix for further evidence).

Thus, while induced abortions (and contraceptive failures leading to induced abortions) are underreported, contraceptive failures leading to reported conceptions are probably overreported. These two sources of bias operate in opposite directions and thus would tend to cancel each other; therefore, adjustment for underreporting of induced abortion would make the pregnancy rates too high.[10]

The effect of abortion underreporting on estimates of contraceptive discontinuation is not clear. If an abortion prompts a change of method that is reported, there will be no effect. If, in contrast, an unreported abortion occurs during an interval of reported continuous contraceptive use of the same method, estimates of discontinuation will be biased downward.

Another deficiency in the data is that women who were pregnant at the time of the interview were not asked when the pregnancy began or when they expected to deliver. For pregnancies that resulted from contraceptive failure, this omission means that the date of failure cannot be ascertained. Therefore, in analyzing contraceptive failure and discontinuation, we have terminated our observation of all women in the 10th month prior to the interview to avoid the possibility of missing reported pregnancies that occurred during contraceptive use.

The dates of starting and stopping method use were recorded using both a monthly calendar and a computer-assisted personal interview (CAPI) questionnaire. For

reasons that are not apparent, there is a pronounced tendency to report method use as beginning in January of the years in the calendar[†]: The number of women who report starting a new method in January of each of the calendar years is approximately double the number who report beginning in the adjacent December or February.[‡] The pattern is less apparent for stopping use, as both December and January appear to be preferred months. Duration of use appears to be much less heaped; there is a deficit of segments with duration 10, and a surplus with durations 11 and 12.

The reason for stopping is not indicated in the calendar but can usually be determined or imputed by cross-checking other variables for the woman, either in the main respondent file or in the related pregnancy interval file (see Appendix). Once we deduced the reason method use was stopped, we could categorize it as either method-related (changed method, contraceptive failure, stopped use while still exposed to the risk of unintended pregnancy) or not method-related (planning pregnancy, no exposure to risk). Using life-table methods, we then determined the proportion of women still continuing to use each contraceptive in each month following initiation of use. Therefore, we could not determine proportions continuing use beyond four years.

In earlier rounds of the NSFG, women who were using a method in the first month of the contraceptive calendar were asked when they had begun to use that method. In all previous rounds of the survey, therefore, we were able to calculate how long women had been using their method at the time the calendar began and enter them into the life table at that duration. For the 1995 NSFG, a decision was made to drop that question, but in practice it was omitted for women younger than 25 and inadvertently retained for older women. To treat the two age-groups consistently, therefore, we dropped 4,065 intervals of use of reversible contraceptives that were begun in January 1991 or earlier because all such intervals contributed by women under 25 years of age had an unknown duration.

Thus, we analyzed only the 6,867 contraceptive-use intervals contributed by women who either began use for the first time, or who resumed use after discontinuation, between February 1, 1991, and the cutoff date. Therefore, we could not determine proportions continuing use beyond four years. The women who were dropped from the analyses of contraceptive failure and discontinuation because they were using a method in January 1991 were, on average, older than the women we included in these analyses. While excluding the exposure of the women who were dropped does not in theory result in bias (see Appendix), including it would have increased the effective sample size, thereby allowing more precise estimates of probabilities of contraceptive discontinuation and enabling us to analyze discontinuation at longer durations.

RESUMPTION OF USE

For our analysis of the next method used after a contraceptive was discontinued, the duration of prior method use is irrelevant. Therefore, we could expand our sample to include any of the 6,050 women using a method in January 1991 who stopped use during the calendar.

Also, when a woman became pregnant is relevant only for censoring exposure, and matters only for women who were pregnant at interview. We thus cut off observation for pregnant women at 10 months prior to interview (as in the earlier analyses), but

continued observation until three months before interview for women who did not report a current pregnancy. (Some women do not report early pregnancies, although they may be aware of them and may not have resumed method use because of them.)

In our analyses of contraceptive failure and discontinuation, we terminated all observations at 10 months before interview. In the analysis of resumption of use, however, the experience of women who discontinued method use during that time could be included. These additional intervals, along with 4,221 intervals from our original sample of 6,867 during the calendar period, yielded a sample of 7,357 for the resumption analysis.

WOMEN'S CHARACTERISTICS

We examined eight potential correlates of contraceptive failure, method-related contraceptive discontinuation and resumption of use after discontinuation of a reversible method—age, parity, race and ethnicity, income, previous method used, desire for a child in the future, work and study status, and marital and cohabiting status.

•*Age.* We created four categories of age at the start of use (younger than 20, 20-24, 25-29 and 30 or older). The oldest age category (30 or older) was not subdivided because of its small sample size. The youngest group includes women who were younger than 15 when they began using a method.

•*Race and ethnicity.* We used the questions about race and Hispanic origin to create a combination variable with the categories non-Hispanic white, non-Hispanic black, Hispanic, and all other.

•*Parity.* We grouped the number of children the respondent had at the time she began using a contraceptive method into the categories zero, one, and two or more.

•*Income.* We created three categories reflecting income (as a percentage of the federal poverty level) at the time of the interview (no data are available about earlier income)—less than 150%, 150-400% and more than 400%. Roughly half of the women were in the middle category.

•*Previous method.* We did not have a complete method history for the period before the calendar began, which would be necessary to identify with complete accuracy the previous method used. Women who had never used a method can be accurately identified, as all women were asked the first method they ever used and when use of that method began. Women who reported a pregnancy interval that began prior to January 1991 were asked the last method they had used in that interval. For women known to have practiced contraception prior to the period covered by the calendar, we defined the last method used prior to January 1991 as either the first method ever used (for women with no pregnancies prior to the calendar) or the last method used in the pregnancy interval that ended just before the calendar. For second and subsequent methods used in the calendar, we used the method appearing immediately prior in the calendar. We created one variable with four categories: pill, male condom, all other reversible methods and first use of a method.

•*Desire for more children.* Based on a woman's answers to questions about whether she wanted a child in the future at the time each pregnancy occurred and at the time of the

interview, we classified each contraceptive-use interval as either a spacing interval (if she wanted to have a child in the future) or a stopping interval.

• *Work and study status.* This variable is a time-varying covariate based on the extensive work history in the survey, along with the education history, which is a little less extensive. Because of lacunae in the survey, there were some periods in the five years before interview in which activity could not be determined. There were apparently insufficient variables allocated to contain starting and stopping dates of employment, as there were women who exhausted them well before the interview. Thus, we could not determine what these women were doing after that point. The work history started at age 18; if the woman left school before age 18, there was a gap in her activity history. If a woman was still in school at the interview date (even if she was past high school age and had been out of school for some time before starting again), she was not asked when she finished high school. This defect applied to all college students. We assumed that women who were still students at the post-high school level had finished high school in June of the year they turned 18. This variable has five categories: in high school, full-time study after high school, full-time work, part-time work or study, and neither studying nor working.

• *Marital and cohabiting status.* This factor is a time-varying covariate based on the marital history and the exhaustive cohabitation history, which included innumerable periods in and out of unions. Women not cohabiting were classified by their formal marital status. This variable has four categories—single (never-married), cohabiting but not married, married and previously married.

METHODS

Using the statistical software Stata, we estimated Kaplan-Meier product-limit single-decrement life-table probabilities of contraceptive failure and of discontinuation for method-related reasons. In the analysis of contraceptive failure, we censored women who stopped use for reasons other than failure at the point when they ceased use. In the analysis of method-related discontinuation, women who stopped use for reasons not related to the method were censored at the point when they ceased use. In these analyses, the resulting probabilities indicate what proportion of women would have discontinued use at each duration because of a contraceptive failure or a method-related reason had they not stopped for any other reason.

In contrast, when examining resumption of contraceptive use, we estimated Kaplan-Meyer product-limit multiple-decrement life tables.[§] At each duration following resumption of exposure to the risk of pregnancy, we estimated what proportion of women had started to use the pill, the male condom, sterilization or all other methods combined; the complement is the proportion who were not using a contraceptive method despite being exposed to the risk of pregnancy.

In all instances, we weighted observations with the sample weights from the NSFG, normalized to average 1.0. The number of unweighted observations entering each life table is displayed, along with the 95% confidence intervals. Confidence intervals estimated in Stata for the proportion of women remaining in the analysis at given durations do not reflect the increased uncertainty caused by censoring in intervals between events. This problem is particularly acute at higher durations, because the

confidence interval remains the same after the last observed event, even though fewer and fewer women actually survive to the longest durations because of censoring. We therefore employ the Peto method to produce conservative estimates of 95% confidence intervals.[11]**

In the analyses of contraceptive failure, method-related discontinuation and resumption of use following discontinuation, we estimated a Cox proportional hazards model separately for each potential correlate to assess whether risks were statistically different across the categories of each factor. The result of each model is an estimate of relative risks—the risk for a particular category relative to the risk for the reference category. For example, in the analyses of method-related discontinuation by age, we estimated risks for age categories relative to the risk at age 20-24.

It is possible that variations in risk across categories of a particular correlate are not causally related to that factor but are observed only because of the confounding effects of other factors. For example, race or ethnicity might appear to have an effect on method-related discontinuation when that factor is examined alone but might not have a significant impact once the effects of income are controlled. It is not feasible, however, to estimate separate life tables for all 23,040 possible combinations of categories for all the factors.

To assess simultaneously the effects of several factors on the risk of contraceptive failure, method-related discontinuation and resumption of use, we used Stata to estimate Cox proportional hazards models. Our goal was to find the simplest models that captured the observed variation in the propensity to experience those outcomes. We started by estimating an initial model with all factors. We next estimated a model that included only the factors with at least one category having a relative risk significantly different from 1.0 at the 5% level. Finally, we combined categories with similar relative risks to produce the simplest model. At each stage, we performed a likelihood ratio test to ensure that the restricted model fit the data as well as the prior unrestricted model.††

Observations in these analyses were unweighted, for two reasons: We were examining relative risk factors, not estimating absolute levels of risk; and we wanted to use standard model selection procedures based on likelihood ratio tests.‡‡ We employed the same procedure to estimate a final Cox model for resumption of contraceptive use.

Finally, we estimated age-specific contraceptive failure rates to produce a total lifetime contraceptive failure rate—the number of contraceptive failures that the typical woman would experience in a lifetime if she used reversible methods of contraception continuously (except for the time spent pregnant after a contraceptive failure) from exact age 15 to exact age 45. This estimate is based on the standard synthetic-cohort assumption—in this case, that the typical woman at each age experiences the average rate of contraceptive failure observed in the NSFG among women of that age.

In this analysis, we included exposure during the calendar period from contraceptive-use intervals that began in or before January 1991 and ended in that month or later. We could do so because we did not need to know the duration of use: The numerator of the age-specific contraceptive failure rate is simply the number of contraceptive failures that occurred among women in that age-group, and the denominator is the

number of years of use of a reversible method during the calendar period contributed by women in that age-group (plus the time spent pregnant by women experiencing a contraceptive failure).

If we had based this analysis on only those contraceptive-use intervals that began in or after February 1991, then the age-specific contraceptive failure rates—and hence the total lifetime contraceptive failure rate—would have been biased upward (see Appendix) because the risk of contraceptive failure falls with duration of use and because exposure at long durations of use would be disproportionately omitted (since contraceptive-use intervals that began in or before January 1991 but ended in January 1991 or later would be excluded). We used the same methodology to estimate the total lifetime method-related contraceptive discontinuation rate—the number of times the typical woman would discontinue use of a reversible method of contraception for a method-related reason if she used reversible methods of contraception continuously (except for the time spent pregnant following a contraceptive failure) from exact age 15 to exact age 45.

RESULTS

Contraceptive Failure

Table 1 displays probabilities of contraceptive failure for all reversible methods combined and for 11 separate methods: the implant, the injectable, the IUD, the pill, the diaphragm, the male condom, spermicides, the sponge, withdrawal, periodic abstinence§#167; and all other methods combined. Overall, 9% of women experience a pregnancy during 12 months of typical use of a reversible contraceptive, and 17% become pregnant during 24 months of typical use. Excluding the residual category of other methods, probabilities of becoming pregnant during the first year of typical use of a method range from a low of 2% for the implant to a high of 20% for periodic abstinence.

Table 1. Percentage of women experiencing contraceptive failure (and 95% confidence interval), by method, according to duration of use, 1995 National Survey of Family Growth

Method	N	Duration of use			
		6 months	12 months	18 months	24 months
Total	**6,867**	**5.5 (4.9-6.3)**	**9.4 (8.3-10.5)**	**13.4 (11.8-15.1)**	**16.7 (14.5-19.2)**
Implant	146	0.0 (0.0-0.0)	2.3 (0.6-8.6)	2.3 (0.5-10.5)	2.3 (0.3-16.5)
Injectable	209	1.2 (0.2-6.4)	3.2 (0.6-14.4)	9.3 (2.2-31.6)	9.3 (1.2-45.8)
IUD	59	2.3 (0.3-14.2)	3.7 (0.5-22.6)	9.5 (2.2-32.6)	17.9 (5.5-44.9)
Pill	2,130	3.0 (2.2-4.0)	6.9 (5.5-8.6)	9.5 (7.5-12.0)	12.4 (9.5-15.9)
Diaphragm	166	4.5 (1.8-10.7)	8.1 (3.4-17.9)	11.2 (4.8-24.1)	16.3 (6.9-33.9)
Male condom	2,925	5.4 (4.3-6.6)	8.7 (7.1-10.7)	13.9 (11.3-17.0)	17.6 (13.8-22.2)
Spermicide	164	10.5 (5.3-19.6)	15.3 (7.9-27.7)	22.1 (10.8-40.1)	22.1 (9.1-44.7)
Sponge	111	7.1 (2.4-19.3)	18.4 (8.3-36.0)	27.7 (8.0-62.7)	27.7 (0.03-82.6)
Withdrawal	440	12.5 (8.7-17.6)	18.8 (13.4-25.7)	24.2 (16.9-33.2)	28.5 (18.8-40.7)
Periodic abstinence	250	14.5 (9.8-21.1)	19.8 (13.4-28.4)	27.3 (18.3-38.7)	34.0 (21.7-48.9)

Other	267	32.0 (15.1-55.4)	32.0 (12.2-61.4)	32.0 (12.2-16.4)	32.0 (10.1-66.2)

Two factors make comparison of efficacy across methods problematic. First, sample sizes for most methods are small. Second, the characteristics of users of different methods, while reflecting the population actually using each method in the United States, vary greatly. For example, 63% of the weighted number of intervals of use of the diaphragm were contributed by women aged 30 or older, compared with only 16% of those of the injectable and 24% of those of the male condom.

Table 2 shows the results of Cox hazards models of contraceptive failure for all reversible methods combined, for the pill and for the male condom. Six factors have a significant impact on the risk of contraceptive failure for all methods combined. The risk of pregnancy is 25% higher among Hispanics than among non-Hispanics; it is 54% higher among low-income women and 31% lower among high-income women than among middle-income women. Moreover, women practicing contraception for the first time are 40% less likely to experience failure than are those who have previously used a contraceptive, and those who are studying full-time after high school are 36% less likely to experience contraceptive failure than are other women. Finally, the risk of pregnancy is 54% lower among those using the implant, the injectable, the pill or the IUD than among those using other reversible methods, and it is 77% higher among those who want to have a child in the future than among those who do not.

Table 2. Relative risk of contraceptive failure (and 95% confidence interval), by method and women's characteristics, from Cox proportional hazards models

Method and characteristic	Relative risk	p-value
All reversible methods combined		
Hispanic	1.25 (1.02-1.54)	.034
Low-income	1.54 (1.28-1.85)	.000
High-income	0.69 (0.55-0.86)	.001
First use of		
any method	0.60 (0.48-0.76)	.000
Full-time study		
after high school	0.64 (0.44-0.92)	.017
Implant, injectable, pill or IUD	0.46 (0.39-0.55)	.000
Desire for child		
in future	1.77 (1.46-2.15)	.000
Oral contraceptives		
Age <20	1.55 (1.06-2.27)	.024
Age >=25	0.58 (0.39-0.87)	.008
Low-income	1.75 (1.26-2.41)	.001
Pill was previous		
method	2.26 (1.60-3.19)	.000
Male condom		
Hispanic	1.86 (1.37-2.52)	.000
Age >=25	0.73 (0.56-0.95)	.021
Low-income	1.70 (1.31-2.22)	.000

Only three factors (two collapsed into only two categories) are predictive of pregnancy during use of oral contraceptives. The risk of contraceptive failure is 55% higher

among women younger than 20 and 42% lower among those aged 25 or older than it is among women aged 20-24. Low-income pill users are 75% more likely to become pregnant than are other pill users, and women whose previous method was the pill are more than twice as likely to experience failure as are those whose previous method was not the pill or those who were using the pill for the first time.

The higher risk of contraceptive failure among women whose prior method was the pill is surprising, as we would expect that resumption of a method implies successful prior experience and therefore successful current experience. However, it is possible that prior sporadic or inconsistent pill use not resulting in a contraceptive failure led to discontinuation and that resumption of sporadic use resulted in method failure.

Finally, Table 2 shows that only three factors are associated with contraceptive failure during use of the male condom. Hispanics have a risk of pregnancy 86% higher than do non-Hispanics, and the risk for low-income women is 70% higher than the risk among other women. Additionally, women aged 25 or older are 27% less likely to experience failure than are women younger than 25.

The total lifetime contraceptive failure rate is 1.8 (not shown); that is, the typical woman who uses reversible methods continuously (except for the time spent pregnant following a contraceptive failure) from age 15 to age 45 will experience 1.8 contraceptive failures. If women using sterilization are included as well, the typical woman will experience 1.3 contraceptive failures from age 15 to age 45.

DISCONTINUATION

Probabilities of discontinuing reversible contraceptive use for a method-related reason are shown in Table 3. The probability of discontinuation within six months is 31%; within 12 months, 44%; and within 24 months, 61%. Excluding the residual category of other methods, probabilities of discontinuing use within six months range from a low of 6% for the implant to a high of 51% for the sponge.

Table 3. Percentage of women discontinuing contraceptive use for method-related reasons (and 95% confidence interval), by method, according to duration of use

Method	N	Duration of use			
		6 months	12 months	18 months	24 months
Total	**6,867**	**30.6 (29.4-31.8)**	**43.6 (42.1-45.1)**	**53.9 (52.2-55.7)**	**61.3 (59.2-63.4)**
Implant	146	6.2 (3.2-11.6)	15.7 (9.9-24.0)	18.3 (11.2-28.4)	20.1 (10.9-34.1)
Pill	2,130	18.0 (16.3-19.8)	32.0 (29.6-34.5)	43.0 (40.0-45.9)	51.3 (47.7-54.8)
IUD	59	18.1 (9.9-30.7)	36.4 (24.0-50.8)	47.8 (31.7-64.4)	59.2 (41.3-75.0)
Diaphragm	166	28.4 (21.5-36.4)	42.8 (33.6-52.6)	53.4 (43.0-63.5)	59.9 (47.3-71.2)
Injectable	209	23.3 (17.2-30.8)	44.4 (34.3-55.1)	54.1 (38.8-68.7)	59.5 (39.0-77.2)
Male condom	2,925	33.9 (31.9-35.9)	47.3 (44.9-49.7)	58.2 (55.4-60.9)	65.8 (62.5-69.1)
Periodic abstinence	250	38.2 (31.9-44.9)	48.8 (41.4-56.3)	60.5 (52.3-68.2)	66.7 (56.0-76.0)
Withdrawal	440	47.4 (42.4-52.5)	57.1 (51.4-62.6)	66.3 (60.3-71.9)	73.4 (66.4-79.3)

Spermicide	164	47.0 (38.7-55.4)	58.2 (48.8-67.1)	65.1 (53.0-75.4)	71.3 (58.3-81.6)
Sponge	111	51.3 (41.1-61.3)	63.7 (51.8-74.1)	85.5 (72.0-93.1)	90.1 (69.3-97.3)
Other	267	89.8 (83.2-94.1)	92.1 (85.0-96.0)	92.1 (85.0-96.0)	92.3 (84.0-96.5)

Table 4 displays the results of the Cox hazards model analyses of method-related discontinuation. When all reversible methods are considered together, four factors are predictive of discontinuation. Women aged 30 or older are 28% less likely to stop use than are younger women. Compared with those whose previous method was the pill, women whose previous method was another contraceptive are 15% more likely to discontinue and those who are using a method for the first time are 14% less likely to do so. Women using the implant, the injectable, the pill or the IUD are only 54% as likely to discontinue as those using other reversible methods. Finally, those who want to have a child in the future are 24% more likely to discontinue than those who do not.

Table 4. Relative risk of discontinuing contraceptive use for method-related reasons (and 95% confidence interval), by method and women's characteristics, from Cox proportional hazards models

Method and characteristic	Relative risk	p-value
All reversible methods combined		
Age >=30	0.72 (0.66-0.79)	.000
Previous method other than pill	1.15 (1.06-1.24)	.000
First use of any method	0.86 (0.78-0.96)	.005
Implant, injectable, pill or IUD	0.54 (0.50-0.58)	.000
Desire for child in future	1.24 (1.14-1.35)	.000
Oral contraceptives		
Black non-Hispanic/other	1.28 (1.10-1.48)	.001
Low-income	1.39 (1.20-1.60)	.000
Male condom		
Black non-Hispanic	0.85(0.75-0.97)	.014
Age >=25	0.69 (0.61-0.78)	.000
Previous method other than pill or male condom	1.26 (1.09-1.45)	.002
First use of any method	0.77 (0.67-0.88)	.000
Never-married/previously married	1.21 (1.07-1.38)	.003

Method-related discontinuation of oral contraceptives is significantly associated with only two factors, each collapsed into only two categories. As the table shows, the risk of method-related discontinuation is 28% higher among blacks and women of other races than among whites and Hispanics, and is 39% higher among low-income women than among those with higher incomes.

Four factors are predictive of discontinuation of the male condom. Black non-Hispanic women are 15% less likely to stop using the male condom than are other women, and women aged 25 or older are 31% less likely to discontinue than are younger women. Compared with women whose prior contraceptive was the pill or the male condom, those whose previous method was another contraceptive are 26% more likely to discontinue and women who are using a contraceptive method for the first time are 23% less likely to discontinue. The risk of discontinuation is 21% higher among single

or previously married women than among married or cohabiting women.

The total lifetime method-related contraceptive discontinuation rate is 9.5; that is, the typical woman who uses reversible methods of contraception continuously (except for the time spent pregnant following a contraceptive failure) from age 15 to age 45 will discontinue use for a method-related reason 9.5 times. If women using sterilization are included as well, the typical woman will discontinue use of contraception for a method-related reason 7.2 times from age 15 to age 45.

RESUMPTION OF USE

Probabilities of starting use of the pill, sterilization, the male condom and all other methods following discontinuation of a reversible method are shown in Table 5. Within one month after discontinuing a method, 68% of women are practicing contraception—17% are relying on the pill, 5% on vasectomy or tubal sterilization, 25% on the male condom and 20% on other methods. The proportion resuming use after becoming exposed to the risk of pregnancy increases to 76% by three months, 79% by six months and 82% by 12 months.

Table 5. Percentage of women resuming use of contraceptives after discontinuation, by duration of use (in months), according to method discontinued and subsequent method used

Discontinued method and duration	All	Subsequent method			
		Pill	Sterilization	Male condom	Other
All (N 7,357)					
1	68.1 (67.5-68.7)	17.3	5.4	25.0	20.3
3	75.9 (74.8-77.0)	19.3	5.8	28.9	21.9
6	79.2 (77.9-80.4)	20.4	6.0	30.2	22.6
12	82.0 (80.5-83.4)	21.1	6.1	31.5	23.3
Pill (N=2,568)					
1	65.4 (64.3-66.5)	14.6	5.6	28.0	17.2
3	73.1 (71.1-750)	18.4	6.0	30.2	18.6
6	76.2 (73.9-783)	20.0	6.2	31.1	19.0
12	79.2 (76.6-816)	21.2	6.3	32.1	19.6
Male condom (N=3,046)					
1	67.9 (66.9-688)	21.2	4.6	24.0	18.1
3	76.6 (74.8-	22.4	4.9	30.2	19.1

	782)				
6	79.8 (77.8-817)	23.2	5.1	32.1	19.5
12	82.9 (80.5-850)	23.7	5.1	34.1	20.0
Withdrawal (N=443)					
1	72.4 (70.2-746)	14.8	2.5	28.5	26.6
3	79.2 (74.1-835)	15.3	2.6	32.0	29.3
6	84.7 (78.7-893)	15.8	3.0	33.5	32.3
12	86.7 (79.1-919)	16.4	3.1	33.9	33.3
Other (N=1,300)					
1	72.1 (70.8-73.4)	14.3	8.1	20.3	29.4
3	78.9 (76.2-81.3)	15.3	8.4	22.4	32.7
6	81.9 (79.1-84.5)	15.8	8.6	23.3	34.2
12	84.0 (80.6-86.8)	16.5	8.7	24.1	34.7

There is not much variation among women according to most characteristics (not shown). Proportions starting use within three months of becoming exposed range from 74% among women aged 30 or older to 78% among women aged 25-29, from 70% among blacks to 78% among whites, and from 74% among low-income women to 78% among high-income women. A detailed examination of differences by previous method shows that at three months, the proportion resuming method use ranges from 73% of women who discontinue pill use to 79% among those who stop relying on withdrawal. Those who discontinue pill use are more likely to switch to the male condom than to resume using the pill (30% vs. 18%). In contrast, those who discontinue use of the male condom are more likely to resume use of this method than to switch to the pill (30% vs. 22%). Not surprisingly, switching to sterilization from a reversible method increases with age (not shown). This pattern is more common among whites than among blacks or Hispanics, and is more frequent among women who discontinue a contraceptive other than the pill, the male condom or withdrawal than among women who stop using those methods.

Results of a Cox proportional-hazards model (Table 6) show that whites are 12% more likely to resume use than are nonwhites. Compared with women aged 20-29, women younger than 20 are 7% more likely to resume use and those aged 30 or older are 14% less likely. Women with two or more children are 17% more likely to resume use than are primiparous or nulliparous women. The rate of resumption of use is 7% lower among low-income women and 8% higher among high-income women than among

middle-income women.

Table 6. Relative risk of resuming contraceptive use after discontinuation (and 95% confidence interval), by women's characteristics, from Cox proportional hazards models

Characteristic	Relative risk	p-value
White	1.12 (1.08-1.16)	.000
Age <20	1.07 (1.03-1.12)	.001
Age >=30	0.86 (0.83-0.90)	.000
Parity >=2	1.17 (1.12-1.22)	.000
Low-income	0.93 (0.90-0.97)	.001
High-income	1.08 (1.04-1.12)	.000
Previous method was pill	0.94 (0.91-0.97)	.000
Full-time study after high school	1.15 (1.10-1.21)	.000
Not working/studying	0.94 (0.90-0.98)	.007
Desire for child in future	0.95 (0.91-0.98)	.005
Previous use ended in failure	1.31 (1.27-1.36)	.000

Those whose prior method was the pill are 6% less likely to resume use than are those whose prior contraceptive was another method. Compared with women who are working full-time or working and studying part-time or are in high school, those who are studying full-time following high school are 15% more likely to resume use, and those who are neither studying nor working are 6% less likely to do so. The likelihood of resuming use is 5% lower for women who want to have a child in the future than for those who do not. Finally, women whose last interval of method use ended in a contraceptive failure are 31% more likely to resume use than are those who discontinued use for any other reason.

DISCUSSION

Estimates of the percentage of women experiencing a pregnancy during the first year of typical use (Table 7) were previously developed by the first author and were adopted by the U.S. Food and Drug Administration (FDA).[12] Compared with these estimates, the rates presented in Table 1 are much higher for the implant, the injectable and the IUD, and are slightly higher for the pill. In contrast, they are much lower for the diaphragm, the male condom, spermicides and the sponge,[*†] somewhat lower for periodic abstinence and about the same for withdrawal.

Table 7. Percentage of U.S. women experiencing an unintended pregnancy during the first year of typical use and the first year of perfect use of contraceptives, and the percentage who have discontinued use by the end of the first year, by method

Method	% experiencing failure during		% discontinuing*
	Typical use†	Perfect use‡	
Chance§	85	85	na
Spermicides**	26	6	60
Periodic abstinence	25	u	37
Calendar	u	9	u
Ovulation method	u	3	u
Symptothermal††	u	2	u
Postovulation	u	1	u

Cervical cap‡‡			
Parous women	40	26	58
Nulliparous women	20	9	44
Sponge			
Parous women	40	20	58
Nulliparous women	20	9	44
Diaphragm‡‡	20	6	44
Withdrawal	19	4	u
Condom§§			
Female	21	5	44
Male	14	3	39
Pill	5	u	29
Progestin only	u	0.5	u
Combined	u	0.1	u
IUD			
Progesterone T	2.0	1.5	19
Copper T 380A	0.8	0.6	22
LNg 20	0.1	0.1	19
Injectable	0.3	0.3	30
Implant	0.05	0.05	12
Tubal sterilization	0.5	0.5	0
Vasectomy	0.15	0.10	0

*Among couples attempting to avoid pregnancy, the percentage who discontinue use within one year. †Among typical couples who initiate use of a method (not necessarily for the first time), the percentage who experience an accidental pregnancy during the first year if they do not stop use for any other reason. ‡Among couples who initiate use of a method (not necessarily for the first time) and who use it perfectly (both consistently and correctly), the percentage who experience an accidental pregnancy during the first year if they do not stop use for any other reason. §The percentages becoming pregnant are based on data from populations in which contraception is not practiced and from women who cease using contraceptives to become pregnant. In such populations, about 89% become pregnant within one year. This estimate was reduced slightly to represent the percentage who would become pregnant within one year among women now relying on reversible methods of contraception if they abandoned contraceptive use altogether. **Foams, creams, gels, vaginal suppositories and vaginal film. ††Cervical mucus (ovulation) method supplemented by calendar in the preovulatory phase and by basal body temperature in the postovulatory phase. ‡‡With spermicidal cream or jelly. §§Without spermicides. *Notes:* na=not applicable. u=unavailable. *Source:* See reference 8.

These differences may result, in large part, from differences in the source of the data and in the numbers of women involved. The estimates in Table 7 for the implant, the injectable, the IUD and the sponge are based on large prospective clinical trials; the estimates for these methods shown in Table 1 are based on much smaller numbers (ranging from 59 for the IUD to 209 for the injectable) from retrospective reports. For spermicides, periodic abstinence, the diaphragm, the male condom and the pill, the estimates in Table 7 are derived from the experience of married women in the 1976 and 1982 rounds of the NSFG and from that of all women participating in the 1988 NSFG.[13]

However, the estimates from the prior NSFGs (in Table 7) and those from the 1995 NSFG (in Table 1) differ in two important ways. First, the results from the prior NSFGs

were standardized to reflect the estimated probabilities of pregnancy that would be observed if users of each method had the same characteristics (the same age distribution, the same proportion seeking to prevent further childbearing instead of delaying the next wanted pregnancy, the same parity distribution and the same proportion living in poverty); the data from the 1995 NSFG, in contrast, are not standardized in this way. Second, the results from the 1988 NSFG were adjusted for estimated underreporting of abortion. For spermicides, periodic abstinence, the diaphragm, the male condom and the pill, estimates from the 1988 NSFG that were neither standardized nor adjusted for abortion underreporting[14] are similar to those shown in Table 1.

Compared with previous estimates of method-related discontinuation during the first year of use developed by the first author and adopted by the FDA (Table 7),[15] the estimates based on the 1995 NSFG (Table 3) are about the same for the pill, the diaphragm and spermicides. However, the current estimates are four percentage points higher for the implant; eight percentage points higher for the male condom; and 12-14 percentage points higher for the injectable, the sponge, periodic abstinence and the IUD.[*,‡] As with failure rates, the two sets of discontinuation rates are not comparable, because the estimates adopted by the FDA for the implant, the injectable and the IUD are based on results from large prospective clinical trials, whereas those presented in Table 3 are based on small numbers of retrospectively reported intervals of use. Another difficulty is that methods were not classified by brand in the NSFG's monthly calendar of contraceptive use. A change from one brand or type of pill or male condom to another could not, therefore, be detected. In contrast, in a clinical trial of a particular brand of oral contraceptive, a switch from that brand to another brand would be considered a discontinuation for a method-related reason.

The one-year discontinuation rate for the injectable that was adopted by the FDA and is shown in Table 7 was calculated from the results of two World Health Organization (WHO) trials of the 150-mg dose injected every 90 days.[16] It is considerably lower than the rates of discontinuation reported in four U.S. studies (50-77%),[17] all of which were conducted after the drug had been approved by the FDA. The results from these six studies are not strictly comparable, because discontinuation for reasons such as desiring to become pregnant and no longer having intercourse was included in the four U.S. studies. Nevertheless, the proportions continuing use would still be far lower than the estimates used by the FDA if discontinuation for reasons unrelated to use of the injectable were excluded.

Note that discontinuation among users of the injectable has been measured differently from discontinuation among users of other methods in clinical trials. As in the NSFG, a woman in a clinical trial is usually considered to be a user of a method as long as she considers herself to be using that method. However, in clinical studies of the injectable, a woman is considered to have discontinued use if she does not return for her next shot within 14 weeks (15 weeks in some studies), even though contraceptive protection probably extends well beyond that period, and even if she returns thereafter and receives another injection. This convention of classifying such women as discontinuing but not pregnant at 14 (or 15) weeks leads to an overestimate of the discontinuation rate[18] and to an underestimate of the pregnancy rate if women miss an injection and become pregnant after 14 weeks but still consider themselves to be using the

injectable.

In contrast to the 1995 NSFG estimates, the first-year discontinuation rates shown in Table 7 for spermicides, periodic abstinence, the diaphragm, the male condom and the pill were computed in two steps. In the first step, the proportions of married women in the 1982 NSFG who discontinued use were calculated under the assumption that the only forms of discontinuation were method change and complete termination of contraceptive use while still at risk of an unintended pregnancy.[19,*,§] These discontinuation rates were then standardized to reflect the estimated probabilities of continuation that would be observed if users of each method had the same characteristics (the same distribution by age, race and education). In the second step, we multiplied the complement of the discontinuation rates (which do not take pregnancy into consideration) obtained in the first step by the complement of the first-year typical-use failure rate in the second column of Table 7 to obtain the probability of continuing use among those seeking to avoid pregnancy.

CONCLUSION

The risk of failure during typical use of reversible contraceptives in the United States is not low—overall, 9% of women become pregnant within one year of starting use. The typical woman who uses reversible methods of contraception continuously from her 15th to her 45th birthday will experience 1.8 contraceptive failures. Contraceptive failure rates computed from the 1995 NSFG are similar to those computed from the 1988 NSFG[20] for the five methods that can be compared: pill (7% in the 1995 NSFG vs. 5% in the 1988 NSFG), male condom (9% vs. 7%), diaphragm (8% vs. 10%), periodic abstinence (20% vs. 21%), and spermicides (15% vs. 13%). These high pregnancy rates do not reflect the inherent efficacy of methods when used correctly and consistently (see Table 7),[21] but instead reflect imperfect use (because most reversible methods are difficult to use correctly).

Discontinuation of use of a reversible contraceptive for a method-related reason is very common—31% of women stop within six months of starting use, and 44% do so within 12 months. The typical woman who uses reversible methods of contraception continuously from her 15th to her 45th birthday will discontinue contraceptive use for a method-related reason nearly 10 times. Such high rates of discontinuation almost surely reflect dissatisfaction with current methods. Fortunately, the vast majority of women resume use of contraceptives shortly after becoming exposed to the risk of pregnancy.

Multivariate analyses identified several subgroups consistently at risk of adverse outcomes. Low-income women have a much higher risk of contraceptive failure than other women for all reversible methods combined, for oral contraceptives and for the male condom, and a lower likelihood of resuming contraceptive use after discontinuing a reversible method. Hispanics have a higher risk of contraceptive failure for all reversible methods of contraception combined and for the male condom. Black non-Hispanic women have a higher risk than other women of discontinuing use of oral contraceptives and of the male condom for a method-related reason. Women who want a child in the future have higher risks of contraceptive failure and discontinuation for a method-related reason. Of special interest for public policy are the increased risk of contraceptive failure among the poor and the decreased likelihood of resuming use

after discontinuation of a reversible method among the poor and among women of color.

Our analyses suffer from the inherent limitations of self-reported data. It is likely both that sensitive behaviors and events—such as induced abortion—are not completely reported in the NSFG and that other information—such as precisely which methods were used in each month since January 1991—simply cannot be accurately recalled. Moreover, the concept of use is an elastic one that depends entirely on whether a woman considers herself to be a user of a particular method at a specific point in time. Finally, women were not asked in the NSFG why they stopped using a method; instead, the reason must be inferred from other information they gave. The degree to which the picture we paint more or less accurately reflects reality is, therefore, unknowable.

APPENDIX

Contraceptive Overreporting

The 12-month probability of pregnancy during use of the IUD is 3.7% (see Table 1); using the estimated standard error of this estimate, we find that the chance of observing a risk that high is only 6.3% if the true probability is 0.8%, the estimated probability of pregnancy during typical use of the Copper-T IUD based on results from large U.S. clinical trials.[22] Likewise, the 12-month probability of pregnancy during use of Norplant is 2.3%; the chance of observing a risk that high is only 1.3% if the true probability is 0.5%, the estimated probability of pregnancy during typical use of Norplant based on results from large U.S. clinical trials.[23] The joint chance of observing risks that high for both methods is only 0.08% if the true probabilities are 0.8% and 0.5%, respectively. These results are suggestive of overreporting of acknowledged pregnancies as contraceptive failures in the NSFG.

DISCONTINUATION AND RESUMPTION

As a first step, we assumed that use of a method began when the code for that method appeared as one of the methods in a month in the focal period and ended when we found a subsequent month in which the code did not appear. Such a classification scheme would result in multiple spells of use for women who used more than one method in a month. To avoid this result, we generally classified multiple method use in each month by the following hierarchy based on efficacy: male or female sterilization, the implant, the injectable, the IUD, oral contraceptives, the male condom and a residual group of all other methods.[†][*] The reason for stopping was not indicated in the calendar but could usually be determined or imputed by cross-checking other variables for the woman, either in the main respondent file or in the related pregnancy interval file:

• If the woman was using a method during the month in which she became pregnant, the NSFG interviewer asked whether she had stopped practicing contraception before she became pregnant. If the woman had not stopped use, we deduced that the pregnancy resulted from contraceptive failure. The NSFG intervewer also asked which method or methods she was using when the pregnancy occurred, but we did not always find these methods recorded in the calendar. In some cases, the method reported was used along with another method, and we classified these cases according to our

efficacy hierarchy. There were also some cases in which both vasectomy and a reversible method were being used, in which case we classified the method for that segment as sterilization (although it is possible that the woman had more than one partner). In case of ambiguity, we relied on the method calendar, as we needed it to calculate dates and had fewer problems if we used a consistent source for other data.

• There are two variables for date of conception in the pregnancy interval file. One, CONCEPT, is the date computed by the CAPI program based on the date of pregnancy termination and the gestational length in weeks or months (with probes for unknown values). The other variable, DATECON, ostensibly based on the same questions, with all missing values imputed, is a recode by the National Center for Health Statistics (NCHS).

There is no documentation of the formula used to calculate CONCEPT, which differs from DATECON in about 30% of the cases. Most of the differences are of only one month in either direction, and in all of these cases DATECON appears more (or at least equally) reasonable. CONCEPT has a few clearly wrong values in addition to the unknown values. (One is a date that would fall in an earlier pregnancy interval; two others imply gestational lengths of more than 10 months.) For this reason, we preferred to use DATECON. Unfortunately, however, we had to rely on CONCEPT to answer questions about whether method use was stopped.

In every case, we used DATECON to determine length of use. We relied on CONCEPT only to determine if there was an answer to the questions about stopping use. Where CONCEPT differed from DATECON, we assumed that the answer to the questions should be based on DATECON. For instance, if a woman stopped using contraception in May, and CONCEPT had a value equivalent to May, the woman was asked if she had stopped use before she became pregnant. If she said "no," we assumed there was a contraceptive failure in the month of DATECON, even if DATECON was April or June rather than May. We further assumed that method use stopped in the month of DATECON, adding or subtracting a month from the duration of use if necessary to make the duration conform to DATECON. If there was more than a month's difference, we did not make this adjustment. There are very few such cases, and even fewer in which a method was used in one or both months (CONCEPT or DATECON). In these few cases, we assumed there was a failure if method use continued for at least one month after DATECON; otherwise, we assumed the outcome was unknown.

• If a woman reported method use continuing after the beginning of the pregnancy, she was not asked whether she had stopped using the method. Most of these cases were probably true contraceptive failures, but some, especially those in which use continued throughout the pregnancy, appear to represent either noncontraceptive use (e.g., condom use for prevention of sexually transmitted infections), or perhaps a misunderstanding of the meaning of "stopped use." If the pregnancy lasted longer than five months and the woman practiced contraception throughout its duration, we assumed that the conception resulted from contraceptive failure if it was either unwanted or mistimed.

• If a woman had stopped practicing contraception before she became pregnant, the NSFG interviewer asked a series of questions about whether the pregnancy was planned. We used the answers to determine whether the last method the woman used

prior to the pregnancy was stopped because the woman planned to get pregnant. This determination also required matching data between the two files, with the attendant complications.

• For pregnancy intervals that began before 1991 but ended during the calendar period, women were not asked the detailed set of questions regarding method use at the time of conception, which we used to determine contraceptive failure. We based the assessment of failure on whether method use was stopped before the pregnancy began; if it was not, we assumed the method used at the time of conception was the method found in the calendar on the calculated conception date.

• The contraceptive use calendar for the 1995 NSFG has more than 16 separate variables for each month of the observation period, allowing the listing of complex combinations of methods. Some respondents appear to alternate methods, rotating from one to another within a single month in a repeating pattern. For example, one woman reported using sponge and rhythm, condom and rhythm, and foam and rhythm separately in each month. There is no way to determine the order in which these methods were used. However, if a woman used exactly two methods, she was asked whether the methods were used simultaneously or sequentially. If she used three or more methods, she was asked the various ways in which they were combined. If there was only one combination, and it included all methods used in the month, we assumed that use was simultaneous; otherwise, we assumed the methods were used sequentially. We have used the following rules for dealing with these combinations:

1. If two methods were used sequentially in one month, and one was used in the previous month, while the other was used in the following month, we treated the case as a method change in the month in which both were found.

2. If multiple methods, none of which ranked higher than the male condom in effectiveness, were used sequentially, we included them in the residual category "other methods."

3. Sequential use of multiple methods, at least one of which ranked higher than the male condom in effectiveness, seems implausible (with the possible exception of vasectomy used with one partner and another method used with another partner). In the analyses, we included these cases in the residual category "other methods."

4. If more than one method was used simultaneously, at least one of which was ranked more effective than male condom, we used the code of the most effective method.

5. If two or more methods, the most effective of which was the male condom, were used simultaneously, we included them with male condoms.

6. If two or more methods were used simultaneously, all of which were less effective than the male condom, we included them with the residual category "other methods."

• Examination of the dates of union and dates when the woman was not having intercourse, as well as the dates of menopause and noncontraceptive sterilization, revealed if a woman was no longer exposed to risk when she stopped use. We assumed that if use ended in one month and a woman reported not having intercourse in either that month or the following month, then she was not at risk when she discontinued use of her method.

• The appearance of different methods of contraception in two consecutive months indicated that the woman had changed methods.

• We classified other discontinuation with no immediate change to another method, in a period when the woman reported she was having intercourse and was not sterile, as "stopped, other." This category includes stopping use in the month a pregnancy occurred, if the pregnancy was not planned and was not a contraceptive failure.

Some data were missing for reasons that are unclear. According to the Round 5 user's guide, a pair of errors in the skip patterns caused about 5% of the pregnancy intervals to have missing data for a series of questions including wantedness of the pregnancy, and also for such questions as whether method use was stopped before conception. (The answer to this latter question is important for our purposes, as there is no other way to distinguish a contraceptive failure from a very short period of nonuse preceding the pregnancy.) The more damaging of these errors, according to the user's guide, is that women who did not explicitly answer yes when asked if they had ever had voluntary intercourse were not asked questions about contraception and timing. However, as more than 95% of the women interviewed were not even asked whether they had ever had voluntary sex (either because they had never had sex, or because their first act of intercourse was voluntary) and therefore could not have given an affirmative answer, this explanation cannot be correct.

We assumed that a woman became potentially exposed to the risk of resuming contraceptive use in three situations:

1. She had a contraceptive failure, in which case she became potentially exposed when the ensuing pregnancy ended.

2. She stopped practicing contraception because she wanted to become pregnant, in which case she became potentially exposed after that pregnancy ended.

3. She discontinued use for some other reason, in which case she became potentially exposed immediately.

If, in the month she became potentially exposed to risk, she started using a method, we classified her as actually exposed to risk and as resuming use. If, on the other hand, she did not resume contraceptive use, we checked to see whether she reported not having intercourse in that month or whether she was trying to get pregnant. If she reported that she was not having intercourse or was trying to become pregnant, we classified her as not being at risk of pregnancy and as being potentially exposed to the risk of resuming use in the next month, and the algorithm was applied again. We then calculated the life-table probability of beginning use of another method (including another period of use of the same method).

POSSIBLE BIAS DUE TO INTERVAL SELECTION

• Lack of bias is dependent on being in a steady state, a condition unlikely to be met as methods wax and wane in popularity. To test the assumption that including only contraceptive-use intervals that began in or after February 1991 does not result in bias, we examined only those intervals contributed by women aged 25 or older at interview. Among the 4,045 intervals that began in February 1991 or later, the 36-month

probabilities of contraceptive failure and method-related discontinuation were 20% and 71%, respectively. Including not only those 4,045 intervals but also the 1,586 intervals that began before February 1991 and ended in February 1991 or after, the 36-month probabilities of contraceptive failure and method-related discontinuation were 18% and 64%, respectively.

The difference between the two estimates is only partly due to differences in the characteristics of the women who were already practicing contraception in 1991, as opposed to those who began using a method later. Many women misreported their starting dates of method use to be in January of each of the calendar years. If we consider all use that began in January 1991 or later, the 36-month probabilities of contraceptive failure and method-related discontinuation are 18% and 68%, respectively. These lie between the estimates derived from all use and those derived from use beginning in February 1991 or later.

Moreover, the differences in results based on intervals starting in or after January 1991 and results based on intervals starting in or after February 1991 are of similar magnitude to the differences in results based on intervals starting in or after January 1991 and results based on all intervals. Therefore any bias caused by selecting only intervals that began in or after February 1991 is probably dwarfed by bias due to reporting error.

When Cox regression models of contraceptive failure and method-related discontinuation with the same factors in the top panels of Tables 2 and 4 were run on all contraceptive-use intervals and on intervals that began in January 1991 or after, the qualitative conclusions are identical, and the quantitative results are similar. The difference in estimated coefficients is at most 1.1 times the size of the standard error of the coefficient in the model based on all intervals and is generally much smaller; the difference averages 40% of the standard error in the contraceptive failure model and 66% of the standard error in the model of method-related discontinuation.

• The total lifetime contraceptive failure rate when exposure and contraceptive failures from all contraceptive-use intervals that began in or before January 1991 but ended in that month or later are included is 1.8. In contrast, if only those intervals that began in February 1991 or thereafter are included, the total lifetime contraceptive failure rate would be 2.7.

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*Of all pregnancies with known outcomes preceded by method use that began and ended in our observation period, 16% ended in spontaneous abortion; reported pregnancies resulting from contraceptive failure were no more likely than planned pregnancies to end in spontaneous abortion (15% each). The denominator of the 16% rate is about 9% too small because it is missing 41% of induced abortions, and induced abortions comprise 23% of all pregnancies (see reference 2). If this adjustment is made, then spontaneous abortions reported in the NSFG account for about 15% of the total number of pregnancies estimated to have occurred. The true rate of spontaneous abortion among clinically recognized pregnancies is 12-14% (see reference 6), so it is likely that some induced abortions are reported as spontaneous abortions. If true spontaneous abortions are actually underreported, then reported spontaneous abortions must include induced abortions.

†The questionnaire does not appear to encourage this sort of reporting, nor did the CAPI probes suggest or provide such dates if the respondent was uncertain about the starting and ending dates. It is possible that the sheer length of the interview discouraged probing or caused fatigue-induced memory lapses. The heaping cannot be caused by imputation, as the calendar variables from which the dates were calculated were not

imputed.

‡Examination of intervals of pill and of condom use showed no differential in heaping by method. A similar tendency, but much less pronounced (typically 25-30% higher than adjacent months) is apparent in the data from the 1988 NSFG, where method-use records were constructed from dates rather than a calendar. Ironically, one of the claimed advantages of a calendar is that its use reduces heaping of dates.

§One can estimate such models in Stata by treating women who resumed use of any method other than the one being analyzed as exposed to risk forever rather than by censoring them.

**If N_i women are observed at duration i, then at least $N=N_i/S_i$ women must have initiated use, where S_i is the life-table probability of surviving to duration i. If exactly N women did initiate use, then binomial theory yields the standard error of S_i as $\text{sqrt}[S_i(1-S_i)/N]$. The standard error of $Q_i=1-S_i$ is therefore $(1-Q_i)\text{sqrt}(Q_i/N_i)$. This estimate will be conservative if, because of censoring, more than $N=N_i/S_i$ women initiated use. To produce 95% confidence intervals for Q_i, we first used the delta method to find the standard error of $\text{logit}(Q_i)$ and then constructed 95% confidence intervals for $\text{logit}(Q_i)$; the antilogits of the upper and lower bounds of the confidence interval for $\text{logit}(Q_i)$ are the upper and lower bounds of the confidence interval for Q_i.

†Performing a test after looking at the results is invalid. We used the tests informally simply to achieve a parsimonious description of the data.

‡The argument for using weights is that they will correct for compositional effects. If all factors that govern the weights are included in the model, there will be no compositional bias. In the NSFG, weights partially reflect the oversampling of blacks and Hispanics. We included race and ethnicity in all models and dropped this variable in the final step only if it did not have a significant effect. The disadvantages of using weights are that estimation is less efficient and that standard model selection strategies based on likelihood ratio tests cannot be employed. The estimates in our final models when weights were used were similar to those when they were not used.

§§Of the 250 intervals of use of periodic abstinence, only 33 were intervals of natural family planning, so reliable separate estimates for that method could not be computed.

*†About half (49%) of the weighted number of intervals for the sponge in Table 1 are contributed by nulliparous women. The first-year probability of pregnancy in Table 1 is similar to the estimate in Table 7 for nulliparous women (20%), but is far lower than the estimate for parous women (40%).

*‡Of the three IUDs listed in Table 7, the LNg IUD is not yet available in the United States and the Progesterone-T is not commonly used. Therefore, we discuss here only results for the Copper-T IUD.

*§To obtain the estimate for the sponge, which was not approved for use in the United States until 1983, we substituted the probability of discontinuation (excluding pregnancy) for the diaphragm in the first step.

†*We did not use the standard NCHS hierarchy, because its ranking of methods does not reflect current understanding of relative contraceptive efficacy (see reference 8). The NCHS orders methods, from most to least effective method during typical use, as follows: female sterilization, male sterilization, the implant, the injectable, oral contraceptives, emergency contraceptive pills, the IUD, the diaphragm, the male condom, the female condom, spermicidal foam, the cervical cap, the sponge, the spermicidal suppository, spermicidal jelly or cream, periodic abstinence, withdrawal and other methods. Our hierarchy recognizes that emergency contraceptive pills are not an ongoing method of contraception, that the IUD is far more effective than the pill or the injectable, that the male condom is more effective than the diaphragm and that there is no evidence that one type of spermicide is more effective than another.