Data from the
NATIONAL SURVEY OF FAMILY GROWTH

Series 23
Number 5

Contraceptive Efficacy Among Married Women Aged 15-44 Years

United States

Statistics are presented on the effectiveness of contraceptives used by married women aged 15-44 years. The percent of women who failed to prevent an unwanted pregnancy or to delay a wanted pregnancy until its desired time is shown for various demographic and socioeconomic groups.

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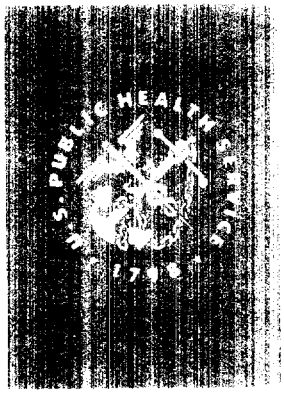

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FOREWORD

The National Survey of Family Growth collects information on the fertility, family planning practices, and reproductive health of women in the United States. The information is based on standardized home interviews with large, nationally representative samples of women in the reproductive years.

To supplement its own analyses of the Survey's rich data, the National Center for Health Statistics called upon various specialists outside the Center to prepare several analytical reports in the series of *Vital and Health Statistics*.

This report was planned by Ms. Barbara Vaughan, Dr. James Trussell, Dr. Jane Menken, and Dr. Elise Jones of the Office of Population Research, Princeton University, within a general framework requested by the National Center for Health Statistics. These authors conducted the analysis and prepared a report to the Center on their findings. Table A, all estimates of standard errors, and appendixes I and II were prepared by Center staff, under the supervision of William Grady, who also adapted the report for publication in *Vital and Health Statistics*.

The report presents a detailed analysis and a complete methodological discussion of measures of contraceptive effectiveness derived by life-table techniques, selected highlights of which have been published previously. Although the data from which these measures were computed refer to contraceptive experience in the early 1970's, they are unique and of continuing current importance for any authoritative discussions of contraceptive efficacy. These data are the first to include monthly information for a 3-year period on both contraceptive use and exposure to sexual intercourse, making possible the most refined life-table measures of contraceptive efficacy so far available for a nationally representative sample of American women. They replace other measures, still frequently cited, which are based on outdated methods (e.g., the Pearl index) and upon noncomparable studies from different cultures, many of which were conducted well before the 1970's. The rates in this report undoubtedly provide an important baseline against which findings from many future studies of contraceptive efficacy will be compared.

The authors are indebted to Dr. Norman Ryder of the Office of Population Research, Princeton University, for his helpful criticisms of earlier versions of this report.

William F. Pratt, Chief
Family Growth Survey Branch
Division of Vital Statistics

CONTENTS

LIST OF TEXT FIGURES

LIST OF TEXT TABLES

SYMBOLS

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CONTRACEPTIVE EFFICACY AMONG MARRIED WOMEN AGED 15–44 YEARS

Barbara Vaughan; James Trussell, Ph.D.; Jane Menken, Ph.D.;
Elise F. Jones, Ph.D., Office of Population Research, Princeton University,
and William Grady, M.A., Division of Vital Statistics

INTRODUCTION

This report contains an analysis of the continuity and effectiveness of contraceptive practice among married women aged 15-44 years in the United States during the 3-year period July 1, 1970 through July 1, 1973. The analysis is based on data from cycle I of the National Survey of Family Growth, conducted by the National Center for Health Statistics. The National Survey of Family Growth was designed to provide information about fertility, family planning intentions and activity, and other aspects of maternal and child health that are closely related to childbearing. Data were collected through personal interviews with 9,797 women aged 15-44 years who either had ever been married or had offspring living in the household. Interviews were conducted between July 1973 and February 1974, and centered on September 1973. Respondents were selected from a multistage, area probability, cross-sectional sample of households in the conterminous United States. The statistics reported here do not pertain to all contraceptors, but to women who were both married and using contraceptives for some time during the 3-year study period. Appendix I contains information about the sample design, data collection, and estimating procedures. Appendix II contains definitions of certain terms used in this report, and appendix III describes in detail the procedures used in selecting cases for this study.

SUMMARY OF PRINCIPAL FINDINGS

The contraceptive failure rates presented here are the first to be produced using a new technique to determine rates for a nationally representative sample of women. With this technique, improved estimates of the percent of women who experienced a contraceptive failure during 1 year of continuous use are obtainable. The failure rates for specific methods of contraception are of fundamental value in evaluating each method and in providing guidance to clinical patients in the selection of a method. Comparisons of failure rates by social and demographic characteristics such as age, parity, race, and education provide insights into the causes of group differences in both unwanted and completed fertility.

Within one year after the initiation of contraceptive use, about 4 percent of a sample of married women aged 15-44 years in the United States who wanted no additional children at any time in the future became pregnant. Among women who sought to delay a wanted pregnancy, the contraceptive failure rate was about 7 percent. Because the failure rate of preventers is significantly lower than that of delayers, and because the motivation for using contraceptives is so different, failure rates were calculated separately for the two groups of women.

Among women attempting to prevent an unwanted pregnancy, the first-year failure rates by individual contraceptive method ranged from

a low of no failures for women employing sterilization, to a high of about 13 percent for users of foam, cream, and jelly. Between these extremes, the contraceptive failure rates were about 2 percent for oral contraceptive (the pill), about 3 percent for the intrauterine contraceptive device (IUD), about 7 percent for the condom, and about 10 percent for the diaphragm and for the rhythm method. Among delayers, the first-year contraceptive failure rates were lowest for the pill (about 2 percent) and highest for the rhythm method (about 29 percent). Failure rates for the other devices were as follows: about 6 percent for the IUD; about 14 percent for the condom; about 16 percent for the diaphragm; and about 17 percent for foams, creams, and jellies.

Among the respondents who were attempting to prevent any additional births, first-year failure rates were found to decrease with increasing age at last live birth, educational attainment, and parity. Women 15-19 years of age at the time of the last live birth had a failure rate of about 7 percent; for those 35-39 years of age the rate was about 1 percent. For women with less than 12 years of education the first-year failure rate was about 4 percent, and for those with more than 12 years the rate was about 3 percent. The failure rates associated with parity (number of children ever born) ranged from a high of about 5 percent for women with no children to a low of about 2 percent for women with 5 children. The only major exception to the pattern of declining failure rates with increasing parity occurred among women with six or more children: they experienced a contraceptive failure rate of about 4 percent during the first year of use.

There was no systematic relationship between age at last live birth or parity and first-year contraceptive failure rates among sample women who were attempting to delay the birth of a wanted child. However, education was found to be related to failure: about 9 percent of women with less than 12 years of education and about 7 percent of those with more than 12 years experienced a contraceptive failure.

There was little difference in the proportions of black and white women who failed to prevent an unwanted pregnancy during the first year of contraceptive use. However, the failure rate of women attempting to delay a wanted pregnancy was 3 percentage points higher for white women than for black women, who had a failure rate of about 4 percent.

Among white women in the sample, Catholic women who sought to prevent an unwanted pregnancy were slightly more successful than all other women; about 3 percent compared with 4 percent, respectively, had first-year failures. However, among white women who sought to delay a wanted pregnancy, Catholic women were slightly less successful; about 9 percent failed, compared to about 7 percent of other women.

Second-year failure rates were found to be generally lower than first-year rates. About 2 percent of the women attempting to prevent an unwanted pregnancy and 5 percent of the women attempting to delay a wanted pregnancy experienced a contraceptive failure during the second year of use. These figures are about 2 percentage points below the corresponding first-year rates.

When extended use-failure rates (a measure which combines effectiveness of method use with continuation of use) were analyzed, it was found that black women were more likely than white women to fail to prevent an unwanted pregnancy. The higher extended use-failure rates occur primarily because black women, although more likely than white women to use the most effective contraceptive methods, are more likely to discontinue use of a method without substituting another. Although the difference in continuation between black and white women is not large, even a small difference greatly increases the probability of a pregnancy for the group that started using a method.

Low failure rates are found consistently throughout this study. Considerably higher rates were reported by Ryder[1] in the only previous study representative of all currently married women in the United States. Although the differences are largely methodological (he used extended use effectiveness), they also reflect a genuine improvement in effectiveness over time and a switch to more effective methods. Overall, the low use-effectiveness failure rates mask the not insignificant proportion of women who, for one reason or another, abandoned use of contra-

ceptives altogether. In this study, about 3 percent and about 10 percent of those whose intentions were to prevent and delay, respectively, terminated use of a contraceptive method within 1 year without switching to another. For these women there is a high probability of unintended pregnancy.

Another consistent finding reported here is that within relative age and contraceptive intention categories, there is little variation in failure rates by religion, race, marriage cohort, or education. There is some variation, but not nearly the range reported by Ryder.[1] There seems to have been a convergence in efficacy among subdivisions of the population which exhibited sizable differentials in earlier studies (based on information from before 1970). The convergence among education, religious, and racial groups may be a function of the vast increase in the quantity and quality of contraceptive information disseminated, and of the increased activity in family planning programs over the last decade. This convergence in failure rates also reflects the coitus-independent property of the newer, most effective methods of contraception. No coitus-related action need be taken when using sterilization, the pill, or the IUD. In contrast to the use of the condom, foam, diaphragm, rhythm, or withdrawal, the effective use of these three methods does not require high motivation. Both the effectiveness of sterilization, the pill, and the IUD and the fact that 70 percent of all the months of contraceptive use included in this analysis were contributed by women using these three methods provide sufficient proof of a contraceptive revolution.

MEASURES OF CONTRACEPTIVE EFFECTIVENESS

In previous studies designed to be representative of the entire ever-married U.S. population, data sufficient to estimate contraceptive use and failures on a month-by-month basis were not recorded. Therefore, for computing effectiveness rates, a measure known as "extended use effectiveness" was employed.[2,3] For this measure, the period of exposure to the risk of conception is assumed to include the entire interval between pregnancies (minus months of separation from the spouse) if contraceptives were used at any time during that interval. Further, an unintended pregnancy that occurred during the interval is assumed to be a contraceptive failure, even if the method of contraception was abandoned before the pregnancy occurred.

The extended use-effectiveness measure is readily calculable when periods of contraceptive use cannot be separated from periods of nonuse. When such a separation can be made, the use of this measure is a matter of judgment. Some investigators feel that the true measure of the effectiveness of a contraceptive method should include the method's attractiveness or loyalty of use, and would therefore choose to calculate extended-use effectiveness.

An alternative procedure possible when months of contraceptive use can be separated from months of nonuse is the calculation of two measures. One measure is the effectiveness of a contraceptive method when it is used; the second is the continuation rate—the proportion of women who are still using a method after various durations of time. Because the 1973 National Survey of Family Growth included a 3-year, month-by-month retrospective record of contraceptive use and nonuse, both continuation and effectiveness measures can be calculated. However, it is important to note that these measures are calculated on the assumption that among women included in the subsequent analysis, reporting is correct. Misstatements of periods of use and the timing of pregnancy will, of course, be reflected in the estimated failure rates.

The preferred methodology in estimating contraceptive use effectiveness or continuation of use involves constructing a life table. A detailed description of the procedure is given in appendix IV, but a brief description is warranted here. A life table for measuring continuation rates can be regarded as a table listing, for each duration since the initiation of use of a contraceptive method, the proportion of women who are still using that contraceptive. Such a table is a "multiple decrement" life table since there are many ways to exit from it. Women may become unintentionally pregnant or may stop using contraceptives to become pregnant or for medical or

other reasons. Each reason for stopping competes with every other reason, and the continuation rate measures the net effect of all reasons acting simultaneously. When measuring contraceptive effectiveness, the goal is to eliminate the effects of all reasons except becoming pregnant unintentionally. It is possible to construct an associated "single decrement" life table which shows, when all reasons for stopping use other than unintentional pregnancy have been eliminated, and for various durations since the initiation of contraceptive use, the proportion of women who have not experienced a contraceptive failure. For a given duration, say 12 months, the proportion of women who have stopped using a method for all reasons combined cannot be smaller than the proportion of women who have experienced a contraceptive failure.

In clinical trials, it is usually possible to observe each woman from the initiation of contraceptive use. However, in a cross-sectional study such as the National Survey of Family Growth, the proportion of women who initiate use (either for the first time or after a period of nonuse) within the period covered by the month-by-month chart of contraceptive use (in this case, 3 years) is small compared with the total number of users. In addition, no continuation or failure rates for more than 3 years could be calculated if only the data for women who initiated contraceptive use during the observation period were considered. Increasing the period covered by the month-by-month chart would solve the problem, but it is clear that a retrospective account of contraceptive utilization becomes less accurate as the period of time covered increases. The designers of the National Survey of Family Growth therefore chose the 3-year period as a compromise between the goals of collecting as much information as possible and minimizing recall error.

The construction of a multiple increment life table provides a way to utilize the full range of experience recorded for individual women within the 3-year period. It is assumed that a woman who, at the start of the 3-year period is in, say, her 6th month of use, is representative of all women who enter their 6th month. Therefore, her experience from the 6th month on is included in the life table. Her experience before the 6th month is not included, since the experience of women who started use at the same time but terminated for any reason before the 6th month cannot be observed or retrieved.

If there are strong trends in continuation or effectiveness rates over time, the multiple increment life table based on period rates gives a biased estimate of the failure rates at longer durations for any cohort of women initiating a segment of contraceptive use during the period in question. Since the focus here is 12-month failure rates, this consideration is unlikely to be important.

SOURCE AND LIMITATIONS OF THE DATA

Data Source

The data collected in the 1973 National Survey of Family Growth (NSFG) and available for a life-table analysis of contraceptive use included: dates of the respondent's current marriage and all previous marriages and marriage dissolutions; information about fecundity, current reproductive intention, number of pregnancies and live births, dates of all conceptions and pregnancy terminations, and the 3-year chart of monthly contraceptive status. The latter contains one code for each calendar month between July 1, 1970 and the date of the interview. Possible codes are pregnancy, contraceptive method used (a separate code for each of 18 possible methods), no intercourse, and no contraceptive method used. Coding priority was in the above order for months in which more than one code might be appropriate. If two methods were used simultaneously, priority was given to the method assumed to be more effective. If methods were changed during the month, priority was given to the method used in the previous month.

Information pertaining to each of the respondent's pregnancy intervals that began or ended in or covered the study period including the interval following the most recent pregnancy (the open interval) was also collected. It included data on reproductive intentions, the respondent's feelings at the time of conception

about the timing of the pregnancy (too soon, too late, or right time),[a] and, if contraception was used during the interval, dates use started and ended and whether use was stopped before conception occurred. Appendix V gives a summary of the interview question sequence and wording for questions essential to the definition of key variables.

Several possible sources of ambiguity arise in these data. First, since the 3-year chart contains only one code for each month, the circumstances of transition from one code to another cannot be adequately represented. For instance, a month in which contraceptives were used followed by a month in which a pregnancy occurred could represent contraceptive use that (1) ended in the month prior to conception, (2) ended in the month of conception, or (3) continued for several more months, until the woman realized she was pregnant. The pregnancy interval data, which contain dates of starting and stopping contraceptive use and the date of conception, are inadequate in other respects. Only the total numbers of months in which no intercourse occurred, and not the dates of no exposure, are shown. Information about sterilization is included only if a respondent volunteered such information.

A second source of ambiguity results from the process of imputing values for data missing because an answer was not given, not ascertained, or in some cases unknown. Missing data were imputed separately for the 3-year chart and the pregnancy interval questions. When imputation was based on independent information for the same respondent, the resulting data for that respondent were consistent. However, most imputations were made using known information from other respondents who were matched by age, race, and so forth, either by randomly selecting known values for respondents with the same matching criteria or by sorting the respondents on the matching criteria and using known values from the adjacent record. These procedures sometimes resulted in the imputation of information that was not consistent with information known about the respondent.

[a]These data were used to determine whether or not the intention in using contraceptives was to delay another wanted pregnancy or to prevent any further (unwanted) pregnancies. This dichotomous intention variable proved to be very powerful and is discussed more fully in a later section.

Description of Sample

To calculate the use effectiveness of contraceptives, consideration was limited to those pregnancy intervals in which contraceptive failure was possible, during the observation period (July 1, 1970-July 1, 1973), that is, in which a woman was sexually active and using contraceptives. Although direct information on sexual activity was not obtained, it was assumed for the study that married women were engaged in regular sexual activity and that unmarried women (single, widowed, divorced, or separated) were not; thus women who were unmarried throughout the observation period were excluded from the study, and some intervals of contraceptive use for the remaining women were excluded because the women were unmarried at the beginning of the interval. Women who were sterile (or who had sterile husbands) throughout the observation period because of an accident, illness, or therapeutic operation were also excluded under the assumption that they did not practice contraception. Finally, all other intervals in which no use of contraceptives was reported were excluded from consideration.

After the exclusions, the sample included women who had one or more intervals of entirely marital contraceptive use which began in the observation period, or which began before but continued into the observation period. It represented about 23 million women in the U.S. population in 1973, as estimated by NSFG; some of the characteristics of this population are shown in table A under the headings "applicable population." These women make up the population for which contraceptive failure (as operationally defined with the data available) was possible during the observation period, and the population to which the results of this study are intended to apply. It is not, however, the population whose experience was actually sampled for the calculations of failure rates presented here, because additional exclusions of respondents and intervals had to be made when data

necessary to the calculations were missing or unreliable. The details of all exclusions are found in appendix III. Many data deficiency exclusions were necessary because of inconsistencies between information on the 3-year month-by-month chart of contraceptive status and the pregnancy interval data. The largest single exclusion was of pregnancy intervals for which the intention of contraception (to prevent an unwanted pregnancy or delay a wanted pregnancy) could not be determined. Because intention is strongly associated with failure rates, results are presented separately for the two categories, and intervals with unknown intention were excluded.

The number of contraceptive use intervals excluded because of data deficiencies was large; the population whose experience is actually represented in this study consists of about 10.0 million women, less than one-half the population to which the results are intended to apply. However, since the criteria used for exclusions are unrelated to the characteristics of the sample of women, the exclusions ensure data accuracy without compromising representativeness. Some characteristics of the study population and the population it is intended to represent are shown in table A. Differences between the estimated proportions in each category in the applicable and study populations are small and reach statistical significance in only three categories: compared to the applicable population, the study population has proportionally more women with less than 12 years of education, more women from the South, and fewer women from the Northeast. These differences were significant for white women considered separately, but there were no significant differences for black women considered separately. Even the statistically significant differences were generally

Table A. Number of ever-married women 15-44 years of age who had at least one interval of entirely marital contraceptive use between July 1, 1970 and July 1, 1973 (applicable population) and the number of women from that population whose information was sufficient to be included in this study (study population) by race, and percent distribution by religion, education, geographic region, and place of residence: United States, 1973

Religion, education, geographic region, and residence	All races		White		Black	
	Applicable population	Study population	Applicable population	Study population	Applicable population	Study population
	Number in thousands					
All women	23,299	9,991	21,314	8,814	1,748	1,075
	Percent distribution					
Total	100.0	100.0	100.0	100.0	100.0	100.0
Religion						
Catholic	27.1	24.8	28.3	26.3	10.4	9.8
Other and none	72.9	75.2	71.7	73.7	89.6	90.2
Education						
Less than 12 years	24.2	27.3	23.1	25.9	36.3	38.2
12 years	48.7	47.4	49.4	48.4	43.6	42.0
More than 12 years	27.0	25.3	27.4	25.7	20.0	19.8
Geographic region						
Northeast	20.0	12.3	19.8	11.4	23.3	21.0
North Central	26.1	27.3	26.9	28.6	19.0	18.8
South	33.0	38.1	31.6	35.9	50.9	55.4
West	20.9	22.3	21.8	24.1	6.8	4.8
Residence						
Metropolitan	71.0	69.2	69.9	67.0	81.6	85.1
Nonmetropolitan	29.0	30.8	30.1	33.0	18.4	14.9

not large, and it is unlikely that they biased the results, especially after the introduction of the statistical controls discussed later. Within the limits of sampling variability, also discussed later, the results may be taken to apply to the population of women who had at least one interval of entirely marital contraceptive use which began between July 1, 1970 and July 1, 1973 or which began before July 1, 1970 and continued after that date.

Identifying the Outcome of Each Contraceptive Use Interval

After the identification, among the sample women, of 6,302 eligible pregnancy intervals containing at least one valid contraceptive use interval (a total of 7,747 use intervals), the outcome of each contraceptive use interval had to be determined. For the purpose of calculating life-table failure rates, three categories of outcome were considered: close of observation, contraceptive failure, and stopping the use of contraceptives for other reasons.

The close of observation occurred on July 1, 1973 except when the interview took place before September 1973. In the latter case, observation ceased at the end of the 3d month prior to the interview to exclude the possibility of pregnancies unrecognized before the interview (see appendix IV).

Contraceptive failure, the type of termination of contraceptive use that is the focus of the study, occurred if the date of stopping the use of contraceptives came after the month in which a pregnancy began or if the date of stopping was in the same month in which the pregnancy began and the respondent said she had not stopped contraceptive use at the time she became pregnant. A set of circumstances that could have been considered as contraceptive failure occurred if the date of stopping the use of contraceptives was in the same month in which a pregnancy began and the respondent reported that she had stopped the use of contraceptives before she became pregnant, but not because she wanted to become pregnant.[b] In the calculation of failure rates, this set of circumstances was included with "other reasons for stopping" and was not considered a contraceptive failure.

Aside from contraceptive failure, contraceptive use could be stopped for a number of reasons that are extraneous to the purpose of this study. The respondent could stop contraceptive use in order to become pregnant. For closed pregnancy intervals this event was defined as occurring when contraceptive use was followed by pregnancy, with or without an intervening interval of nonuse, and the dates of stopping contraceptive use and the start of pregnancy given in the pregnancy interval data agreed with the information in the 3-year chart of monthly contraceptive status. The latter was necessary to ensure that the conditions of termination of contraceptive use given in the pregnancy interval data related to the contraceptive use interval under consideration rather than a subsequent use interval that was ineligible. If the information did not match, termination of contraceptive use was classified as "stopped, other." Stopping contraceptive use in order to become pregnant could also apply to the method most recently used in the open interval if the respondent was trying to conceive at the time of interview.

A change of contraceptive method also frequently occurs. A termination of contraceptive use was assigned to this classification if the contraceptive use interval was immediately followed by an interval of use of a different method or by a period of no exposure to the risk of conception and then the use of a different method. A change of method to sterilization, however, would only have been detected if sterilization were mentioned in the 3-year chart as a contraceptive method following the use of another method; that is, a change to sterilization would be classified as "stopped, other," if sterilization were mentioned only in response to questions on fecundity and not those on contraceptive use.

Marital dissolution (by separation, divorce, or husband's death) is another reason for stopping contraceptive use. Cases in which a period of no exposure to the risk of conception intervened between the stopping of contraceptive use

[b] To consider this set of circumstances as contraceptive failure assumes implicitly that the stopping of contraceptive use and the conception occurred in the same menstrual month as well as in the same calendar month.

and the marital dissolution were included in this category.

No exposure to the risk of conception in the months just prior to the end of a pregnancy interval would appear to have been a logical possibility only in the case of the open interval. However, due to the priorities of coding, the 3-year chart could show no exposure followed immediately by pregnancy if the pregnancy occurred in the month exposure was resumed, whether or not there had been use of contraceptives in that month. Hence some closed pregnancy intervals contained contraceptive use intervals that were counted as terminating in no exposure.

Finally, there were other circumstances grouped in the classification "stopped, other." Some of these were situations in which contraceptive use was stopped before conception, but not in order to conceive. The situation referred to previously, in which contraceptive use had been stopped in order to conceive but the method in use at that point could not be positively identified, was also included in this category.

The last step in the data preparation was the determination of the amount of exposure to the risk of contraceptive failure per calendar month of use (each representing an ordinal month in the experience of any given woman) within the 3-year observation period. More precisely, since we are calculating probabilities (q_x's) of failure and not central failure rates (m_x's), the adjusted number of women entering a given month of use must be estimated. During a contraceptive use interval, each calendar month preceded and followed by contraceptive use constituted 1 month of exposure. For the first month of use for any pregnancy interval starting within the 3-year period, only half the women were considered to have contributed a whole month of exposure on the assumption that the initiation of use had occurred, on the average, halfway through the calendar month. Since the close of observation always occurred at the end of a calendar month, all women who were not pregnant at the close of the study contributed a whole final month of exposure. As indicated previously, observation was considered to end at least 2 months before the interview. There being one opportunity for termination during each calendar month, women who experienced contraceptive failures and terminations for any other reason were considered to have contributed a full final month of exposure. The number of months during which the respondent reported that she was not having intercourse was subtracted from the length of the contraceptive use interval. Exposure was considered to begin no sooner than the second month following a pregnancy to allow for postpartum amenorrhea.

CONTRACEPTIVE FAILURE IN THE FIRST YEAR OF USE

Contraceptive Intention: Prevent Versus Delay

A variable that has proved to have powerful explanatory value is the motivation of a woman for using contraceptives.[1,2,4] Specifically, it has been found useful to classify women into two groups: those seeking to prevent any further (unwanted) births, and those seeking to delay the next wanted birth. The procedure by which contraceptive use intervals were defined as either prevent or delay intervals is described in detail in appendix VI. As can be seen from table 1, the prevent-delay classification identifies groups of women for whom contraceptive failure rates are quite different. Because the failure rate for preventers is significantly lower than that for delayers, and because the motivation for using contraceptives is so different for the two groups of women, all subsequent results are presented separately for each group.

The 1-year failure rates for preventers (for all methods except sterilization) and delayers (5.1 percent and 7.3 percent, respectively) are far below those (about 14 percent and 26 percent, respectively) reported by Ryder.[1] The discrepancy is due to two factors. First, as previously mentioned, the measures are quite different. Ryder employed "extended use effectiveness," and extended-use failure rates are higher than use failure rates. Second, because the entire past experience of respondents was used by Ryder in calculating failure rates, experiences in different time periods are mixed. Since there has been a remarkable improvement in contraceptive effectiveness over time (as

Ryder himself showed by comparing first-year failure rates for different marriage cohorts), the average failure rate is higher than the rate computed from data for only the most recent time period.

Age, Education, and Parity

The age of the respondent[c] might be expected to have an influence on the likelihood of contraceptive failure. First, fecundity is known to decline with age and, other things being equal, lower fecundity implies that a smaller proportion of women will experience a failure. Moreover, advancing age probably strengthens a woman's motivation to terminate childbearing but does not necessarily affect a woman's motivation to delay childbearing. Thus age might be expected to have a greater effect on failure rates for preventers than delayers. As seen in table 2 and figure 1, among women attempting to prevent an unwanted pregnancy, older women had consistently lower failure rates. On the other hand, there is no systematic relationship between age and the failure to delay pregnancy.

The educational attainment of a woman has been found nearly universally to be associated with the likelihood of contraceptive failure. Table 2 and figure 2 show that high educational attainment was associated with low contraceptive failure rates, although the differences among educational attainment groups is not statistically significant. Education may indicate contraceptive sophistication, or it may represent the opportunity cost of an unintended pregnancy.

Women with a large number of children were expected to have high failure rates because high parity may be due, in part, to previous contraceptive failure. In fact, it is shown in the first column of table 2 and in figure 3 that among preventers high parity is associated, although not significantly, with low failure rates, except at the very highest parity. There was no association

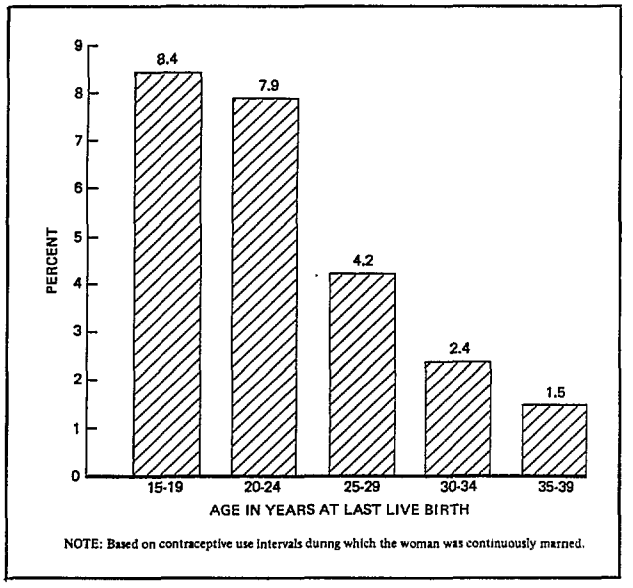


Figure 1. Percent of married women 15-44 years of age attempting to prevent an unwanted pregnancy who experienced a contraceptive failure during the first year of use (for users of all contraceptive methods except sterilization), by age at last live birth: United States, 1970-73

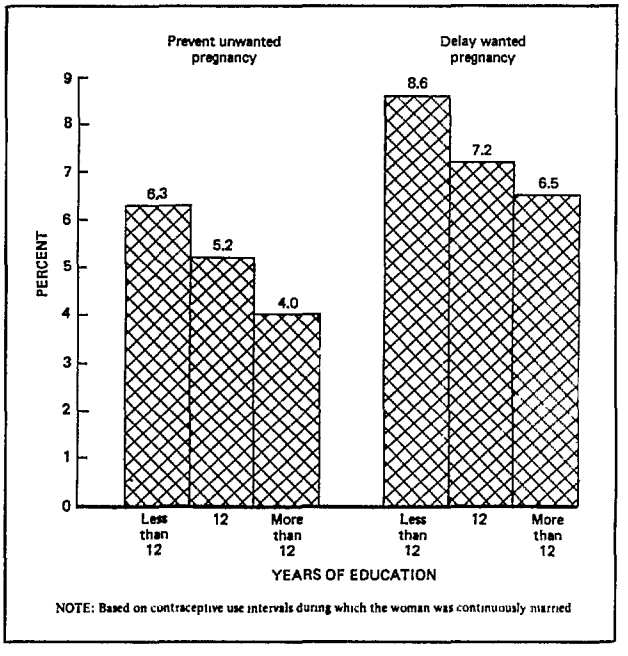


Figure 2. Percent of married women 15-44 years of age who experienced a contraceptive failure during the first year of use (for users of all contraceptive methods except sterilization), by contraceptive intention and education: United States, 1970-73

[c]Since the unit of analysis in this study is the contraceptive use interval, the age of the respondent is given by age at her last live birth, which is the beginning of the birth interval from which the use interval was drawn. For women with no live births, age at last live birth is equal to age at marriage, the beginning of the first birth interval.

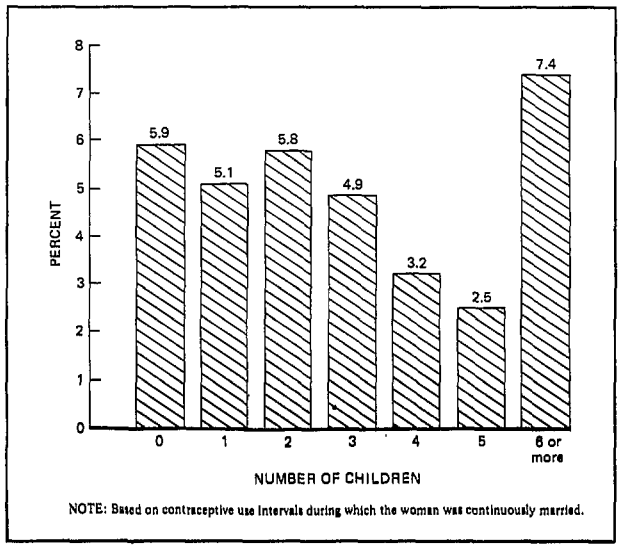


Figure 3. Percent of married women 15-44 years of age attempting to prevent an unwanted pregnancy who experienced a contraceptive failure during the first year of use (for users of all contraceptive methods except sterilization), by parity: United States, 1970-73

between parity and contraceptive failure rates for women attempting to delay pregnancy.

Subsequent analyses involving race, religion, geographic region, marriage cohort, and method should be cross-tabulated by these three control variables—age, education, and parity—in addition to intention.

Relative Age

Ryder found that age, education, and parity had no systematic association with contraceptive failure rates when the effects of these variables were examined within categories of "relative age." He noted that a woman who had her third pregnancy at age 23 was in some sense younger (younger at a comparable stage in the family life cycle) than a woman who had her first pregnancy at 23. He therefore defined a variable called "relative age" which was determined jointly by the order of pregnancy interval and the age of the woman at the start of the interval.

Ryder used a three-step procedure for coding relative age. First, the sample women were ordered according to age at first marriage (the start of the first pregnancy interval) and divided into four age groups (low, low middle, high middle, and high). The upper age limits of the three youngest age groups were then used to define the upper age limits of these groups for higher order pregnancy intervals: 2 years were added to the limits for the second pregnancy interval, 4 years were added to the limits for the third pregnancy interval, and so on. Finally, a woman was assigned an appropriate relative age group for each of her pregnancy intervals according to her age at the beginning of the interval and the defined age limits. However, as a consequence of this arbitrary addition of 2 years to define age limits and of the truncating of some of the birth cohorts, the relative age categories were unevenly represented within each pregnancy order; the magnitude of the observed differentials between relative age categories is partly a function of this uneven representation. If the lowest relative age represented the same fraction of women for each order, the proportions failing for relatively young women would have risen with birth order from order two to order five.

In response to this problem it was decided, for this report, to define the relative age categories in terms of the age quartiles of the *universe* of women arriving at the beginning of intervals of each order, and to include all intervals in this universe, regardless of whether contraceptives had been used in the interval. It was also decided that birth intervals rather than pregnancy intervals should be used. There were two reasons for this decision. The primary reason is practical. Pregnancy interval data may be unreliable because of the propensity of women to underreport pregnancies ending in spontaneous abortion. The second reason is that relative age may influence fertility decisions primarily through the joint effect of the number of children (births, not pregnancies) and the woman's age.

To mitigate the truncation effect of a cross-sectional sample, it was necessary to use life-table techniques to determine the proportion of women arriving at the beginning of birth intervals of each order at each age. Because the sample *is* truncated, however, the numbers actually falling into each category tend again to be uneven and weighted toward the young ages. Since the universe is defined to comprise all intervals, however, there is a compensating bias among the intervals eligible for the analysis of

contraceptive failure, because noncontracepting women, whose intervals are by definition excluded from the analysis of contraceptive failure, are likely to arrive at the beginning of each interval at a younger age than contraceptors.

Because of the difficulty of specifying the date of the beginning of exposure to the risk of conception, Ryder considered only intervals following a pregnancy, that is, intervals of order 2 and higher. In this report intervals of use were included in the analysis if use of the method began after marriage (see appendix III for exceptions). Thus the relative ages of women in the first birth interval were coded with reference to the date of marriage and the quartile age limits used were those of the second birth interval (that between the first and second births), minus 1 year.

The upper age limit of each of the first three quartiles for birth orders 1-6 are shown in table B. The first, second, and third quartile age limits are the ages at which the cumulative probabilities of having a birth of a given order are 25 percent, 50 percent, and 75 percent, respectively, of the overall probability of ever having a birth of that order (by exact age 45). The calculations were also made by 5-year birth cohorts of women, but among women who were old enough to have had sufficient exposure to the possibility of births of any given order no significant time trends were discernible.

In summary, we have modified the definition of relative age proposed by Ryder. The present definition provides a classification by the age of a woman at the beginning of a birth interval which would be comparable for intervals of every order. As can be seen from table IV in appendix VII, there is no systematic variation by parity, education, or age within the relative age groups. The inference is drawn that any independent effect of these variables is subsumed in the relative age classification. This consideration reaffirms and strengthens the analytical importance of the relative age concept.

Method of Contraception

Failure rates vary widely according to the contraceptive method used (table 3 and figure 4). The most successful contraceptive method observed in this study was sterilization, with no reported failures. Sterilization was followed by the oral contraceptive pill and the IUD which were both more effective than any of the remaining, coitus-related, methods of contraception (although among preventers the difference in failure rates between the diaphragm and either the pill or IUD did not attain statistical

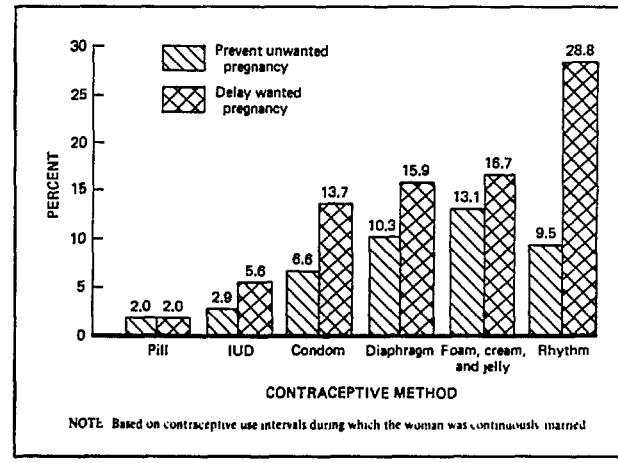


Figure 4. Percent of married women 15-44 years of age who experienced a contraceptive failure during the first year of use, by contraceptive intention and contraceptive method: United States, 1970-73

Table B. Quartile upper age limit for ever-married women 15-44 years of age, by birth order and quartile: United States, 1973

Quartile	Birth order						
	0	1	2	3	4	5	6 or or higher
	Age in years						
First quartile	17.21	18.21	20.73	22.92	24.60	26.20	28.18
Second quartile	19.39	20.39	23.31	25.86	27.87	29.72	30.52
Third quartile	22.41	23.41	26.46	29.11	31.27	33.40	33.83

significance).[d] The pill was used with equal success by both preventers and delayers; 2 percent of pill users in each intention category experienced a contraceptive failure during the first year of use. IUD users attempting to delay a wanted pregnancy were somewhat less successful users than those attempting to prevent an unwanted pregnancy but the difference is not significant. Among condom users, preventers were much more successful than delayers were in their use of the method, and exhibited less than half as many first-year failures. Preventers using the rhythm method were also more successful than delayers. Their 1-year failure rate was less than one-third that of rhythm method delayers.

Although differences in failure rates among women in different relative age categories were not significant for any contraceptive method, the rates for the condom consistently decreased as relative age increased. The same pattern, with a few inconsistencies was found for the other coitus-related methods (foam, diaphragm, rhythm) and for the pill among delayers. Among preventers, the failure rates for the pill were not related to relative age. The IUD is the major exception to the general pattern and is discussed in a later section.

Because there is a great demand for a single failure rate to be assigned to each contraceptive method so that methods can be easily compared, a standardized failure rate for each method is presented in table C. Since some cells in table 3 contain data derived from a very small number of women, it was not possible to standardize by both relative age and intention. Hence the data are standardized by intention only. The procedure for standardizing is a matter of choice; one may weight the failure rates by the distribution of months of exposure to the risk of conception or by the distribution of the number of intervals entering the 12-month life table. Fortunately, either procedure yields the same result; the proportions of *either* intervals *or* months are almost evenly split between prevent and delay. Hence the standardized rate is the simple arithmetic average of the two.

[d]The standard error of the diaphragm failure rate for preventers is extremely large (5.6 percent) due to the small number of women who reported using that method.

Table C. Percent, standardized by contraceptive intention, of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, by contraceptive method: United States, 1970-73

Contraceptive method	Contraceptive failure
	Percent
Pill	2.0
IUD	4.2
Condom	10.1
Foam, cream, and jelly	14.9
Other	14.5
Diaphragm	13.1
Rhythm	19.1
Other[2]	10.8

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.
[2]Excludes sterilization.

The standardized failure rate is the percent of women who would fail in the first year of contraceptive use among a group of women with equal proportions of delayers and preventors. In actual populations of users, the proportions who are preventers and delayers vary among contraceptive methods, so the "raw," or unstandardized failure rates, would differ from the standardized rates shown. These rates are higher for methods in which delayers predominate, and lower for methods in which preventers predominate. In practical situations in which the intention of contraceptive use is known, the intention-specific rate for preventers or delayers should be used; if nothing is known about intention, the standardized rate is appropriate.

Race

A common finding of recent studies of contraceptive utilization is that black women are less likely than white women to use contraceptives, but black contraceptors are more likely than white contraceptors to use effective methods. A report published by the National Center for Health Statistics which analyzed the current body of data was consistent with this assertion.[5] As can be seen from table 4 and figure 5, black women were more successful than white women were in delaying a wanted pregnancy. This pattern is consistent within all rela-

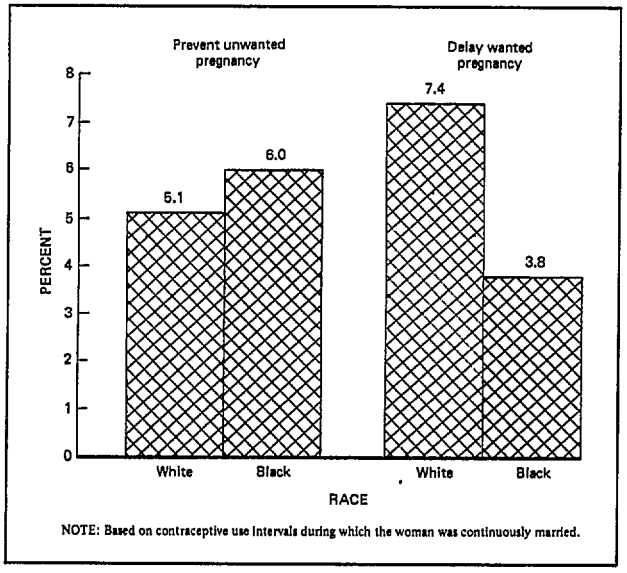


Figure 5. Percent of married women 15-44 years of age who experienced a contraceptive failure during the first year of use (for users of all contraceptive methods except sterilization), by contraceptive intention and race: United States, 1970-73

tive age groups, although the differences are not significant. Among women who were attempting to prevent an unwanted pregnancy, there was no consistent pattern by relative age group, but for all age groups combined, white women in the sample used in this study had a 12 percent lower failure rate in the first year than black women had. These data (table 4) also support Ryder's observation that black women, unlike white women, are apparently no more successful when their intention is to prevent an unwanted pregnancy than when delaying a wanted pregnancy. This pattern varies by relative age group, but when all relative age groups are combined the failure rate for black preventers is higher (but not significantly) than that for black delayers. White women, on the other hand, were clearly more successful when their intention was to prevent rather than to delay a pregnancy.

Since the intervals of contraceptive use which entered the life tables are a subsample of all contraceptive intervals, it is interesting to look at the distribution of contraceptive methods used by race among this subset of intervals. Since sterilization, the pill, and the IUD have been shown to be the most effective contraceptive methods, they are grouped together for this analysis. The failure rate by race is a function of both the distribution of contraceptive use intervals by method, and of months of exposure per contraceptive use interval which are included in the life table. Thus, for each method (or group of methods) there is a choice of presenting the distribution either of intervals or of months of exposure to the risks of conception which occurred during contraceptive use intervals included in the analysis. Neither alone determines the rate, so the choice is a matter of preference. For this analysis, months of exposure was chosen. Fortunately, the two distributions are remarkably similar so that either choice gives the same result.

As can be seen from table D, within the

Table D. Percent of months of exposure to the risk of conception[1] during the first year of contraceptive use for women whose intention was to prevent an unwanted pregnancy, during which the pill, IUD, or sterilization were used, and during which the IUD was used, by relative age and race: United States, 1970-73

Contraceptive method and race	Relative age				
	Total	Low	Low middle	High middle	High
	Percent				
Pill, IUD, or sterilization					
White	68.6	79.3	71.9	70.4	62.7
Black	76.2	83.7	83.3	77.2	67.9
IUD					
White	9.7	8.1	10.6	12.0	7.4
Black	14.0	7.5	10.4	21.1	13.4

[1]Includes only those months which occurred during contraceptive use intervals included in the analysis.

sample of women used in this study, black preventers were more likely than white preventers were to use the most effective contraceptive methods at all relative ages. In particular, in the higher relative age groups, they were more likely than white women were to use the IUD.

Hence, the higher failure rates for black women who sought to prevent an unwanted pregnancy might be due to their less effective use of the more effective contraceptive methods, especially the IUD. This inference is supported by table 5, which presents a breakdown of failure rates by method and race. (An insufficient number of cases in many cells precludes further breakdowns by relative age.) Among women who were attempting to delay a wanted pregnancy, black women were somewhat, but not significantly, more successful users of every method except the pill. Among black and white preventers, pill effectiveness was roughly equal; but the IUD failure rate for black women in the sample was considerably higher than that of sample white women, a finding that was unexpected. While sample size was too small for an adequate test of this relationship, the large difference exhibited by women in the sample points to the need for a further examination of IUD use on the basis of additional data. In conclusion, there does not appear to be an unambiguous racial difference in effectiveness of usage.

Religion

Previous research found that the probability of a contraceptive failure varies by religion.[1] In this report, failure rates were compared for two categories of religion, Catholic and "other or no religion." These categories were chosen because they were expected to exhibit the greatest difference in failure rates between any two religious groups, and because data limitations preclude any further breakdown.

In recent years, Catholic women have increasingly abandoned the rhythm method for more effective methods of contraception. The change from rhythm is especially pronounced after the last wanted child has been born. With this change in contraceptive use by Catholic women has come a remarkable improvement in their contraceptive efficacy; few of the previously observed differences by religion remain (see table 6 and figure 6).

Among white women, the difference in failure rates of Catholic women and women of other religions is not significant either for those trying to prevent an unwanted pregnancy or for those trying to delay a wanted one. Further, among preventers, Catholic women were slightly more successful contraceptive users at every relative age but one. If sterilization is excluded from the analysis, the religious differential among preventers increases, demonstrating that white Catholic women are less likely to use sterilization and are even more successful users of the remaining methods.

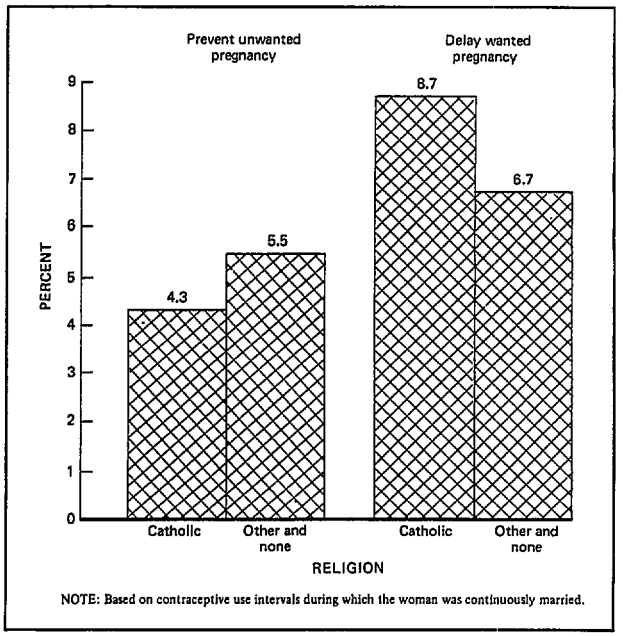


Figure 6. Percent of married white women 15-44 years of age who experienced a contraceptive failure during the first year of use (for users of all contraceptive methods except sterilization), by contraceptive intention and religion: United States, 1970-73

Marriage Cohort

Ryder[1] found that the more recent the marriage cohort, the more effective was contraceptive use when examined within contraceptive intention and relative age categories. He interpreted these findings as resulting from an upward trend in efficacy over time because the experience of the most recent cohorts was

limited to the most recent time periods in which contraceptive efficacy was high; much of the experience of the older cohorts occurred during periods of low efficacy. A possible alternative explanation, however, is that the differences in the failure rates of different cohorts are due to cohort effects: The most recent cohorts have lower failure rates because their members were more likely to use more effective contraceptive methods or to use the methods more effectively, independent of the time period observed. Since the current data are limited to one time period (1970-73), it should be possible to determine which of these two explanations is more likely. Given that the effects of differences in age among the members of different cohorts are subsumed under relative age groups, if cohort differences are due to time period effects, then within one time period there should be no cohort differences in failure rates. Conversely, if the rate differences are due to cohort effects, then within one time period the older cohorts should have higher failure rates.

Table 7 shows that if there is any systematic association of marriage cohort with failure rates among preventers, it is not that suggested by the hypothesis that efficacy has been increasing for the most recent cohorts. Although the differences are not significant, earlier cohorts were generally more successful preventers. No systematic differences among delayers are seen. An important point to note, however, before concluding that only period rather than cohort changes in efficacy have occurred, is that any differentials by marriage cohort measured in a specified time period reflect both true cohort differences and any confounding life cycle differences not captured by the relative age categorization. Since these two effects work in opposite directions (by hypothesis, the older the cohort, the higher the failure rate; the longer the marital duration, the lower the failure rate), results such as those found in table 7 might be obtained even if a cohort trend toward higher efficacy exists. However, such a trend seems likely to be small. Therefore, although we cannot separate with certainty a time period from a cohort marital-duration effect, table 7 strongly suggests that improvement in efficacy over time was the major contributor to the large cohort cumulated life-time differentials observed by Ryder.[e]

Place of Residence

Contraceptive failure is related to the geographic region in which a woman lives. As seen in table 8, the proportion of sample women who failed to prevent an unwanted pregnancy was more than twice as great for women who lived in the North Central and West Regions as for those who lived in the South. The influence of geographic location on failure rates is probably not independent of the age, education, and parity of women, but a paucity of cases prevents further breakdown. There does not appear to be any association between failure rates and residence in metropolitan or nonmetropolitan areas (see table 9).

FAILURE RATES AT HIGHER DURATIONS

Because of the cross-sectional nature of the 3-year chart of monthly contraceptive status, the first-year failure rates selectively represent the experience of women who began a continuous segment of contraceptive use (although not necessarily for the first time) no earlier than 11 months prior to July 1, 1970. The vast majority[f] started using contraceptives during the 3-year interval covered by this study. In order to have started using a method during that period, such women must have (1) changed methods, (2) terminated a pregnancy, or (3) (re)married. On balance, their termination rates reflect the experience of less successful users. This point is perhaps made clearer by the fact that women who had been successful contraceptors for at

[e] A corollary would be that Ryder's pronounced upward trend in effectiveness of use is underestimated, since *all* segments of contraceptive use, including the most recent and therefore most successful, were employed when calculating the failure rates for each, especially the oldest, cohort.

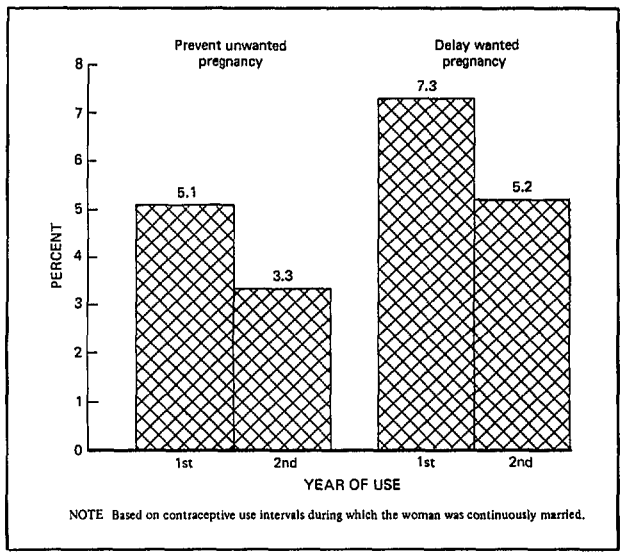
[f] 2,148 of 2,503 delay-use intervals and 2,293 of 2,691 prevent-use intervals, respectively, started during the 3-year interval.

least a year before July 1, 1970 and who successfully avoided pregnancy during the 3-year period without changing methods would not appear in the 12-month life table at all. Because the life tables are multiple increment, their experience would, however, be counted at higher durations of use. It is interesting to explore the experience of such long duration users.

First- and second-year failure rates are given in table 10. Second-year failure rates are somewhat lower than first-year rates (see figure 7).[g] There are two possible explanations for lower rates in the second year. First, the probability of failure may vary over women; hence, only (on the average) more successful users are represented in the second-year failure rate. Second, failure rates may decline over time for individual women. We cannot distinguish empirically between these two causes; regardless of cause, on the average the second-year failure rates reflect the experience of more successful contraceptive users. Table 11 shows the first- and second-year failure rates for the pill, the only method for which there is a sufficient number of months of exposure to warrant separation.

The same logic applies to failure rates at even higher durations of use, but further examination of these data are precluded by the relatively small number of months of exposure over the durations from 3 to 5 years.

[g]Significance cannot be determined since standard errors of second-year failure rates are not available.



NOTE Based on contraceptive use intervals during which the woman was continuously married.

Figure 7. Percent of married women 15-44 years of age who experienced a contraceptive failure during the first and second years of use (for users of all contraceptive methods except sterilization), by contraceptive intention: United States, 1970-73

EXTENDED USE EFFECTIVENESS

A consistent finding in the analysis of contraceptive use failure rates is the remarkable overall uniformity and small proportion of women who experienced a contraceptive failure. Within relative age and intention categories there is little variation in failure rates by religion, race, marriage cohort, or education. This study does show some variation, but not the large range noted by Ryder[1]. There seems to have been a convergence in efficacy among subdivisions of the population among which one might have strong a priori reasons for suspecting differentials. However, the convergence may simply be due to a different method of measuring failure rates. To test this possibility, Ryder's definition of *extended* use effectiveness was employed to compute the proportions of women who failed to prevent or delay pregnancy in the first year of a segment of contraceptive use. Recall that if contraceptives were used in any pregnancy interval, an unintended pregnancy was counted as a failure even if no contraceptives were being used when the pregnancy occurred. Ryder included all intervals in the pregnancy history in his study; here only those which began or ended between July 1, 1970 and July 1, 1973 were considered. Except for the definition of exposure to the risk of a failure, the methodology used to compute extended use-failure rates is identical to that for use-failure rates described previously and in appendix IV. Thus differences in use-failure rates compared to extended use-failure rates are due to differences in the measurement of exposure to the risk of conception. Table 12 shows extended use-failure rates for women in the sample used in this study. When measured in this way:

1. The differentials by religion are small and are confined, as in table 6, to those

whose intention was to delay their next wanted pregnancy.

2. For delayers, black women had much higher failure rates than white women had, in contrast to the rates shown in table 4; for preventers the differentials were larger than in table 4.
3. The association between contraceptive failure and the educational attainment of women is maintained, with those of higher educational attainments having lower failure rates, but the spread is larger than that shown in table 2.

It may be concluded that extended use effectiveness is a measure of a type of contraceptive failure in which both method nonuse and failure during use are contributing factors. Differentials in extended use effectiveness are due primarily to intergroup differences in the nonuse of contraceptives. However, convergence is indeed occurring even when efficacy is measured in this way.

CONTINUATION RATES

Although the use-failure rates presented in the preceding sections are low, at least in comparison to extended use-failure rates previously available, the discontinuation rates are not. Because measures of discontinuation of contraceptive use for reasons directly associated with a method of contraception were desired, continuation rates were calculated in three ways, each eliminating some reasons for stopping use. Table 13 shows continuation rates in which the only reasons for stopping are "stopped, other" and "change of method," where unintentional pregnancy is not included. Table 14 gives continuation rates in which *all* method-related terminations (including unintentional pregnancy) are included. The first set of rates measures the extent to which women discontinue use of a contraceptive method because of dissatisfaction with that method; the second set of rates adds contraceptive failure to the reasons for discontinuation.

A final measure of continuation of contraceptive use that is of great interest is the proportion of women who would continue to use contraceptives if the only cause of discontinuation were "stopped, other." Women who stop using contraceptives altogether are exposed to a substantially higher risk of unintended pregnancy than those who change methods. Thus the continuation rates measured in this way, presented in table 15, indicate the attractiveness of a contraceptive method in the vital sense that discontinuation implies abandonment of contraceptives altogether. This measure is identified closely with Ryder's concept of extended use effectiveness; the relationship is explored in detail in the final section of this report.

Three reasons for stopping contraceptive use were excluded in calculating the rates in tables 13-15—stopped to get pregnant, stopped because marriage was dissolved,[h] and stopped because exposure to the risk of conception was ended. One additional reason—unintended pregnancy—was eliminated in table 13, and an additional category, change of method, was eliminated in table 15. The methodology underlying each calculation is identical to that underlying the calculation of failure rates given in appendix IV. For this reason the product of the proportion of women continuing to use contraceptives, derived from table 13, and the proportion of women not experiencing a contraceptive failure (1.0 minus the proportion experiencing a failure, derived from table 3) equals the proportion of women continuing contraceptive use shown in table 14. Similarly, the product of the proportion of women not experiencing a contraceptive failure and the appropriate proportion continuing contraceptive use, derived from table 15, yields the proportion continuing contraceptive use if the only causes of contraceptive failure are pregnancy and "stopped, other." The proofs of these assertions are given in appendix IV. As expected, women in the sample were less likely to continue using any contraceptive if their intention was to delay the next wanted pregnancy rather than to prevent an unwanted one. If the condition "stopped to get pregnant" were added as a cause of discontinuation of contraceptive use,

[h]This category does not imply that women stopped using contraception after their marriage was dissolved but simply indicates that they were excluded from the analysis.

the proportions of women continuing to use contraceptives among those who wished to delay pregnancy would be much lower. A comparison of the 12-month continuation rates in table 14 with the 12-month failure rates in table 3 shows that when all reasons for stopping contraceptive use are combined, the risk of an unintended pregnancy is small relative to the total method-related risk.

THE RELATIONSHIP BETWEEN EXTENDED USE EFFECTIVENESS, USE EFFECTIVENESS, AND CONTINUATION RATES

Earlier in this report, the differences between extended use effectiveness and use effectiveness were discussed. It was argued that extended use failure rates could be misleading since it is not possible to distinguish failures that occur during the use of a contraceptive method from those which occur after a method is abandoned. Later, use and extended use-failure rates were presented, and several measures of continuation of contraceptive use were shown. It is useful to examine the relationships between these measures.

It is convenient to frame the discussion in terms of 1-year rates, but the argument applies to rates for any duration of time. Since the rates involved are life-table rates, they represent the experience that cohorts of women would have had if they were subject to the monthly failure rates produced by the life table. Women who did not experience a contraceptive failure in the extended use sense can be divided into two categories: (1) those who did not fail to prevent pregnancy and used contraceptives for an entire year, and (2) those who discontinued contraceptive use during the year, did not change to another method, and yet did not become pregnant. In probability terms

$$P_e = P_c + P_d \qquad (1)$$

where

P_e is the probability of not becoming pregnant as measured by extended use effectiveness,

P_c is the probability of not becoming pregnant and continuing to use contraceptives, and

P_d is the probability of discontinuing contraceptive use and not becoming pregnant.

The term P_c can be viewed as the product of two terms: the probability P_u, of not failing (not becoming pregnant) as measured by use effectiveness rates, and the probability C of continuing contraceptive use if the only cause of discontinuation is "stopped, other" (abandonment of all contraception). The probabilities P_e and C are derived from the rates shown in tables 12 and 15, respectively; the rates from which the P_u probabilities are derived are scattered throughout many other tables in this report. From equation 1 we see that extended use-failure rates cannot be recreated from knowledge of use effectiveness rates and continuation rates alone. One must also know the term P_d, which is a function not only of the overall proportion of women $(1 - C)$ who stop using contraceptives, but also of the particular pattern of discontinuation over the 12-month period. For example, given a value of C, if all women who discontinue contraceptive use did so at the end of the first month of use, the proportion of discontinuers who became pregnant would be much higher than if all women who discontinue did so at the end of the 11th month of use. The term P_d is also a function of the fecundability of women who discontinue contraceptive use. However, as a first approximation we treat fecundability as biologically constant for all women at every duration of exposure to the risk of conception. Then P_d is merely a function of the pattern of discontinuation and a natural constant (fecundability).[i]

Thus, P_d can be separated into two factors: P_n, the probability of a woman not becoming pregnant given that contraceptives use is abandoned and $(1-C)$, the probability that the use of

[i] In principle the probabilities of a woman becoming pregnant for each month after the cessation of contraceptive use can be computed by the same life-table procedures employed to measure use effectiveness. However, the small numbers of women involved make the calculated monthly pregnancy rates extremely unstable.

contraceptives is discontinued. Note that P_n is still a function of the pattern of discontinuation. The purpose of this factorization is to identify a discontinuation level factor C and a discontinuation pattern factor P_n. The factor P_n can be identified only approximately with the pattern of discontinuation since it is not true that fecundability is the same for all women and every duration. Nevertheless, even this approximate measure is instructive.

It was mentioned earlier that while contraceptive use effectiveness rates showed little variation by race, the extended use effectiveness rates suggest that black women in the sample were less effective contraceptors. We can now examine the components of this discrepancy. In table E, the terms P_e, P_c, P_d, P_u, P_n, and C are presented as an illustration of the decomposition of extended use effectiveness. It can be inferred that sample black women did not have lower extended use effectiveness rates than white women had solely because they had lower continuation rates. Among sample women whose intention was to prevent an unwanted pregnancy, if black women had had the same continuation rate as white women, their extended use effectiveness rate would have been 94.5 percent, rather than 92.1 percent, but would still have been below the rate for white women (95.2 percent). When this measure is used, approximately three-quarters of the racial difference is due to the larger proportion of sample black women who abandoned contraceptive use altogether.[j] The remainder of the difference can be attributed to the relatively earlier discontinuation among black women than among white women who discontinued. This conclusion is supported by the detailed life-table continuation rates computed as those for table 15 but not shown; for example, 73 percent of those discontinuing contraceptive use among sample black women but only 51 percent of those discontinuing among white women had done so by the end of the sixth month.

[j]Of course, there is an index number problem. If white women were assigned the continuation rate of black women, their extended use effectiveness rate would fall to 0.932; hence, only two-thirds of the difference is explained by differences in continuation rates.

Table E. Estimates of components of extended use effectiveness rates[1] for married women[2] 15-44 years of age, by contraceptive intention and race: United States, 1970-73

Contraceptive intention and race	Components of extended use effectiveness rates						
	P_e	P_c	P_u	C	P_d	P_n	$(1 - C)$
Prevent unwanted pregnancy[3]							
White	0.952	0.934	0.963	0.970	0.018	0.600	0.030
Black	0.921	0.876	0.958	0.914	0.045	0.523	0.086
Delay wanted pregnancy							
White	0.877	0.836	0.926	0.903	0.041	0.423	0.097
Black	0.859	0.843	0.962	0.876	0.016	0.129	0.124

[1]$P_e = P_c + P_d$.
$P_c = P_u \cdot C$.
$P_d = P_n(1 - C)$.
P_e = Proportion of women not becoming pregnant in 1 year measured by extended use effectiveness (1 – extended use failure rate/100).
P_c = Proportion of women not becoming pregnant and using contraceptives for 1 year.
P_d = Proportion of women who abandoned contraceptive use and did not become pregnant within 1 year.
P_n = The conditional probability of not becoming pregnant given that contraceptives were abandoned in the particular pattern observed over the course of the first year since use began.
C = One-year continuation rate, when the only cause of failure is "stopped, other."
P_u = Proportion of women not becoming pregnant in 1 year as measured by use effectiveness (1 – use failure rate/100).
[2]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.
[3]Includes sterilization.

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LIST OF DETAILED TABLES

Table 1. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by contraceptive method and intention: United States, 1970-73

Contraceptive intention	All methods	All methods except sterilization
	Percent	
Prevent unwanted pregnancy	3.7	5.1
Delay wanted pregnancy	. . .	7.3
	Standard error	
Prevent unwanted pregnancy	0.45	0.61
Delay wanted pregnancy	. . .	0.76

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 2. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by contraceptive method and intention, age at last live birth,[2] education, and parity: United States, 1970-73

Age at last live birth, education, and parity	Prevent unwanted pregnancy		Delay wanted pregnancy
	All methods	All methods except sterilization	All methods except sterilization
Age at last live birth	Percent		
15-19 years	7.0	8.4	9.9
20-24 years	6.1	7.9	5.6
25-29 years	2.9	4.2	8.4
30-34 years	1.6	2.4	7.3
35-39 years	1.1	1.5	*
Education			
Less than 12 years	4.2	6.3	8.6
12 years	3.8	5.2	7.2
More than 12 years	2.9	4.0	6.5
Parity			
No live births	5.0	5.9	7.5
One live birth	4.4	5.1	5.8
Two live births	4.6	5.8	9.6
Three live births	3.1	4.9	4.1
Four live births	2.1	3.2	19.8
Five live births	1.6	2.5	*
Six live births or more	4.4	7.4	*
Age at last live birth	Standard error		
15-19 years	2.31	2.92	1.84
20-24 years	1.06	1.30	0.93
25-29 years	0.62	0.90	1.85
30-34 years	0.68	1.01	5.10
35-39 years	1.15	1.60	---
Education			
Less than 12 years	0.84	1.26	2.43
12 years	0.79	1.10	0.97
More than 12 years	0.90	1.24	1.33
Parity			
No live births	3.38	3.97	1.28
One live birth	2.03	2.36	1.32
Two live births	0.81	1.05	2.26
Three live births	0.85	1.30	2.17
Four live births	0.81	1.20	9.87
Five live births	1.44	2.27	---
Six live births or more	2.26	3.51	---

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

[2]Since the unit of analysis in this study is the contraceptive use interval, the age of the respondent is given by her age at last live birth, which is the beginning of the birth interval from which the use interval was drawn. For women with no live births, age at last live birth is equal to age at marriage, the beginning of the first birth interval.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 3. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by relative age, contraceptive intention and contraceptive method: United States, 1970-73

Contraceptive intention and contraceptive method	Relative age				
	Total	Low	Low middle	High middle	High
Prevent unwanted pregnancy	Percent				
All methods[2]	3.7	8.5	4.5	3.5	2.1
Pill	2.0	2.8	1.8	2.9	1.2
IUD	2.9	-	2.3	2.1	5.0
Condom	6.6	23.4	9.8	7.1	2.2
Foam, cream, and jelly	13.1	46.2	15.6	8.0	5.4
Other[3]	8.5	*	13.2	8.2	4.8
Diaphragm	10.3	*	*	11.1	4.2
Rhythm	9.5	*	*	14.2	5.4
Other[3]	6.5	*	5.6	0.9	4.3
Delay wanted pregnancy					
All methods	7.3	11.0	8.1	6.2	6.7
Pill	2.0	5.7	2.2	1.5	0.8
IUD	5.6	6.9	3.2	4.6	7.6
Condom	13.7	48.3	22.0	10.7	9.1
Foam, cream, and jelly	16.7	*	34.5	7.6	11.1
Other	20.4	*	21.1	25.9	16.0
Diaphragm	15.9	*	*	27.0	4.3
Rhythm	28.8	*	*	39.2	23.6
Other	15.1	*	20.7	6.5	19.1
Prevent unwanted pregnancy	Standard error				
All methods[2]	0.45	1.64	1.01	0.88	0.51
Pill	0.67	2.27	1.24	1.43	0.88
IUD	1.42	-	2.30	2.20	3.43
Condom	1.92	---	6.10	3.32	1.55
Foam, cream, and jelly	3.68	21.08	5.17	4.99	4.28
Other[3]	---	---	---	---	---
Diaphragm	5.58	---	---	12.86	4.33
Rhythm	4.09	---	---	8.71	3.78
Other[3]	---	---	---	---	---
Delay wanted pregnancy					
All methods	0.76	3.40	1.71	0.99	1.35
Pill	0.50	3.59	1.00	0.57	0.64
IUD	2.21	7.42	2.89	3.36	3.73
Condom	2.73	20.40	8.33	4.56	4.45
Foam, cream, and jelly	3.42	---	9.56	3.75	6.01
Other	3.26	---	7.84	5.39	5.30
Diaphragm	5.30	---	---	---	---
Rhythm	5.39	---	---	---	---
Other	5.54	---	---	---	12.25

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.
[2]Includes sterilization.
[3]Excludes sterilization.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 4. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by relative age, contraceptive intention, contraceptive method, and race: United States, 1970-73

Contraceptive intention, contraceptive method, and race	Relative age				
	Total	Low	Low middle	High middle	High
	Percent				
PREVENT UNWANTED PREGNANCY					
All methods					
White	3.7	9.6	4.5	3.6	1.8
Black	4.2	2.8	4.7	1.7	6.9
All methods except sterilization					
White	5.1	15.6	6.2	4.8	2.6
Black	6.0	4.3	6.1	2.1	10.5
DELAY WANTED PREGNANCY					
All methods except sterilization					
White	7.4	12.6	8.3	6.2	6.8
Black	3.8	1.2	5.0	4.4	3.7
	Standard error				
PREVENT UNWANTED PREGNANCY					
All methods					
White	0.49	1.95	1.07	0.93	0.50
Black	1.44	1.30	1.61	0.85	3.96
All methods except sterilization					
White	0.67	3.30	1.40	1.21	0.71
Black	2.02	1.93	1.96	1.08	5.58
DELAY WANTED PREGNANCY					
All methods except sterilization					
White	0.76	3.87	1.81	0.95	1.36
Black	1.72	0.92	4.63	3.29	1.96

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 5. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by contraceptive method, contraceptive intention, and race: United States, 1970-73

Contraceptive intention and race	Sterilization	Pill	IUD	Condom	Other
Prevent unwanted pregnancy			Percent		
White	-	2.1	2.4	6.7	10.2
Black	-	1.9	8.1	4.4	12.2
Delay wanted pregnancy					
White	. . .	2.0	5.1	14.1	19.4
Black	. . .	2.6	3.2	8.2	7.8
Prevent unwanted pregnancy			Standard error		
White	-	5.65	1.43	2.00	2.18
Black	-	0.92	7.43	2.92	4.90
Delay wanted pregnancy					
White	. . .	0.52	2.30	2.78	2.31
Black	. . .	1.98	2.12	7.46	6.71

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 6. Percent of married white women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by relative age, contraceptive intention, contraceptive method, and religion: United States, 1970-73

Contraceptive intention, contraceptive method, and religion	Relative age				
	Total	Low	Low middle	High middle	High
	Percent				
PREVENT UNWANTED PREGNANCY					
All methods					
Catholic	3.3	4.7	4.3	3.9	1.7
Other and none	3.8	11.2	4.6	3.5	1.9
All methods except sterilization					
Catholic	4.3	7.1	5.7	4.8	2.3
Other and none	5.5	18.1	6.4	4.8	2.7
DELAY WANTED PREGNANCY					
All methods except sterilization					
Catholic	8.7	13.9	10.9	6.1	9.3
Other and none	6.7	11.6	7.3	6.2	5.1
	Standard error				
PREVENT UNWANTED PREGNANCY					
All methods					
Catholic	0.88	4.82	2.23	1.42	0.97
Other and none	0.62	2.55	1.58	1.12	0.62
All methods except sterilization					
Catholic	1.14	7.08	3.01	1.73	1.34
Other and none	0.90	4.42	2.15	1.54	0.89
DELAY WANTED PREGNANCY					
All methods except sterilization					
Catholic	1.39	12.17	3.14	2.07	2.28
Other and none	0.96	3.51	2.02	1.29	1.56

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 7. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by relative age, contraceptive intention, contraceptive method, and year of marriage: United States, 1970-73

Contraceptive intention, contraceptive method, and year of marriage	Relative age				
	Total	Low	Low middle	High middle	High
PREVENT UNWANTED PREGNANCY					
All methods			Percent		
1970-73	5.4	4.1	0.5	5.7	10.6
1965-69	7.0	12.8	10.1	6.1	2.0
1960-64	3.4	11.2	2.2	3.4	2.4
1955-59	1.9	-	-	1.8	3.1
All methods except sterilization					
1970-73	6.8	6.5	0.7	6.4	12.6
1965-69	8.8	20.0	12.8	7.2	2.5
1960-64	4.7	15.7	3.1	4.8	3.3
1955-59	3.0	-	-	2.9	4.7
DELAY WANTED PREGNANCY					
All methods except sterilization					
1970-73	6.9	1.5	8.2	7.5	6.3
1965-69	7.2	19.8	6.9	4.5	7.1
1960-64	8.8	*	11.3	7.5	7.7
PREVENT UNWANTED PREGNANCY					
All methods			Standard error		
1970-73	2.98	15.00	---	---	12.04
1965-69	1.42	3.61	2.78	2.25	1.35
1960-64	0.71	4.71	1.22	1.47	1.14
1955-59	0.69	-	-	1.28	1.27
All methods except sterilization					
1970-73	3.75	17.61	---	---	14.71
1965-69	1.77	6.26	3.57	2.54	1.74
1960-64	0.99	6.64	1.71	2.08	1.52
1955-59	1.07	-	-	1.99	1.86
DELAY WANTED PREGNANCY					
All methods except sterilization					
1970-73	1.04	1.46	---	1.38	2.50
1965-69	1.03	6.53	2.22	1.43	1.84
1960-64	2.90	---	6.81	4.86	3.52

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 8. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by contraceptive intention and method and geographic region: United States, 1970-73

Geographic region	Prevent unwanted pregnancy		Delay wanted pregnancy
	All methods	All methods except sterilization	All methods except sterilization
	Percent		
Northeast	2.7	3.5	9.1
North Central	4.5	6.6	7.4
South	2.2	2.9	6.2
West	5.7	9.4	6.9
	Standard error		
Northeast	0.69	0.83	2.15
North Central	0.75	1.05	1.50
South	0.45	0.57	1.07
West	1.88	3.46	1.89

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 9. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the standard error of the percent, by relative age, contraceptive intention, contraceptive method, and place of residence: United States, 1970-73

Contraceptive intention, contraceptive method, and residence	Relative age				
	Total	Low	Low middle	High middle	High
	Percent				
PREVENT UNWANTED PREGNANCY					
All methods					
Metropolitan	3.7	8.8	4.8	3.6	2.0
Nonmetropolitan	3.7	8.1	4.0	3.2	2.5
All methods except sterilization					
Metropolitan	5.3	14.4	6.7	4.9	2.9
Nonmetropolitan	4.8	12.7	5.2	4.1	3.3
DELAY WANTED PREGNANCY					
All methods except sterilization					
Metropolitan	7.8	11.8	8.2	6.7	7.8
Nonmetropolitan	6.0	9.2	8.0	5.1	3.8
	Standard error				
PREVENT UNWANTED PREGNANCY					
All methods					
Metropolitan	0.52	2.05	0.98	1.04	0.54
Nonmetropolitan	0.82	2.77	2.57	1.50	1.28
All methods except sterilization					
Metropolitan	0.74	3.24	1.37	1.38	0.78
Nonmetropolitan	1.06	4.87	3.17	1.97	1.60
DELAY WANTED PREGNANCY					
All methods except sterilization					
Metropolitan	0.94	4.62	2.26	1.15	1.70
Nonmetropolitan	1.24	4.79	2.78	2.01	1.88

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 10. Percent and standard error of the percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, and the percent who experienced a failure during the second year of use, by relative age, contraceptive intention, and contraceptive method: United States, 1970-73

Contraceptive intention and contraceptive method	Relative age				
	Total	Low	Low middle	High middle	High
	Percent				
FIRST YEAR					
Prevent unwanted pregnancy					
All methods	3.7	8.5	4.5	3.5	2.1
All methods except sterilization	5.1	13.7	6.2	4.7	3.0
Delay wanted pregnancy					
All methods except sterilization	7.3	11.0	8.1	6.2	6.7
SECOND YEAR					
Prevent unwanted pregnancy					
All methods	2.4	3.7	2.2	1.6	2.7
All methods except sterilization	3.3	6.3	3.1	2.2	3.7
Delay wanted pregnancy					
All methods except sterilization	5.2	6.9	6.1	3.8	6.2
	Standard error				
FIRST YEAR					
Prevent unwanted pregnancy					
All methods	0.45	1.64	1.01	0.88	0.51
All methods except sterilization	0.61	2.71	1.33	1.16	0.71
Delay wanted pregnancy					
All methods except sterilization	0.76	3.40	1.71	0.99	1.35

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 11. Percent and standard error of the percent of married women[1] 15-44 years of age using the oral contraceptive pill who experienced a contraceptive failure during the first year of use, and the percent who experienced a failure during the second year of use, by relative age and contraceptive intention: United States, 1970-73

Contraceptive intention	Relative age				
	Total	Low	Low middle	High middle	High
First year	Percent				
Prevent unwanted pregnancy	2.0	2.8	1.8	2.9	1.2
Delay wanted pregnancy	2.0	5.7	2.2	1.5	0.8
Second year					
Prevent unwanted pregnancy	1.1	0.7	0.3	2.2	0.8
Delay wanted pregnancy	1.8	5.0	0.1	2.4	1.1
First year	Standard error				
Prevent unwanted pregnancy	0.67	2.27	1.24	1.43	0.88
Delay wanted pregnancy	0.50	3.59	1.00	0.57	0.64

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

NOTE: In this report percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

Table 12. Percent of married women[1] 15-44 years of age who became unintentionally pregnant within 1 year after beginning use of a contraceptive method, regardless of whether use was stopped at any time during that period, by relative age, contraceptive intention, race, religion,[2] education, and contraceptive method: United States, 1970-73

Contraceptive intention, race, religion, education, and contraceptive method	Relative age				
	Total	Low	Low middle	High middle	High
	Percent				
PREVENT UNWANTED PREGNANCY[3]					
All preventers	5.0	9.4	7.0	5.0	2.6
Race					
White	4.8	10.4	6.9	4.8	2.2
Black	7.9	4.9	9.1	8.5	8.4
Religion					
Catholic	4.8	4.7	8.6	4.4	2.3
Other and none	4.9	11.9	6.2	5.0	2.1
Education					
Less than 12 years	6.0	13.9	6.2	3.7	1.8
12 years	5.0	0.9	7.4	5.5	3.2
More than 12 years	3.9	*	8.0	4.9	2.3
Contraceptive method					
Pill	3.8	3.2	5.7	4.5	1.7
IUD	5.6	-	5.5	5.3	7.4
Condom	7.3	24.8	13.0	7.3	2.2
Foam, cream, and jelly	16.7	50.0	18.3	15.4	5.3
All other methods	9.5	*	15.2	8.4	5.9
DELAY WANTED PREGNANCY					
All delayers	12.4	20.1	12.0	12.2	10.5
Race					
White	12.3	20.5	12.1	12.0	10.5
Black	14.1	19.2	10.0	14.1	14.3
Religion					
Catholic	14.7	26.4	15.0	13.5	14.1
Other and none	11.1	18.4	11.0	11.2	8.1
DELAY WANTED PREGNANCY					
Education					
Less than 12 years	16.7	23.0	14.6	6.8	18.0
12 years	12.1	14.2	11.8	12.3	11.7
More than 12 years	10.5	*	7.7	12.8	8.9
Contraceptive method					
Pill	7.0	17.5	4.8	7.6	3.0
IUD	10.0	*	5.9	11.7	11.8
Condom	20.0	49.2	29.4	18.4	13.8
Foam, cream, and jelly	22.5	*	40.6	13.3	16.1
All other methods except sterilization	24.5	*	27.2	28.4	21.0

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.
[2]Results for religion are based on the contraceptive use intervals of white women only.
[3]Includes sterilization.

Table 13. Percent of married women[1] 15-44 years of age who continued to use the same contraceptive method, if only method-related reasons[2] for stopping (excluding unintended pregnancy) are allowed, by contraceptive intention, months since use began, contraceptive method, race, education, and religion[3]: United States, 1970-73

Contraceptive method, race, education, and religion	Delay wanted pregnancy			Prevent unwanted pregnancy		
	Months since use began					
	12	24	60	12	24	60
	Percent					
All women[4]	70.9	57.6	34.1	77.2	68.5	51.2
Contraceptive method						
Pill	75.8	59.4	30.6	72.7	59.1	33.0
IUD	76.2	67.4	51.8	77.9	70.2	54.6
Condom	66.5	55.6	42.7	64.2	57.1	46.3
Foam, cream, and jelly	56.5	48.1	28.8	57.9	49.3	27.6
All other methods except sterilization	64.0	54.6	40.9	70.8	58.7	46.7
Race[4]						
White	70.4	57.3	33.8	77.4	68.8	51.0
Black	74.5	64.7	35.9	73.3	62.6	50.1
Education[4]						
Less than 12 years	71.1	57.4	43.1	78.0	70.2	54.3
12 years	72.6	58.2	35.8	77.6	69.5	52.4
More than 12 years	68.4	56.8	26.6	75.7	65.0	45.4
Religion[4]						
Catholic	68.6	55.1	31.5	78.9	69.4	51.9
Other and none	71.3	58.3	34.9	76.7	68.5	50.6

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

[2]Method-related reasons for stopping contraceptive use are unintended pregnancy, stopped to change methods, and "stopped, other," which is the abandonment of contraceptives altogether. Unintended pregnancy is not included as a reason.

[3]Results for religion are based on the contraceptive use intervals of white women only.

[4]Includes sterilization for preventers.

Table 14. Percent of married women[1] 15-44 years of age who continued to use the same contraceptive method, if only method-related reasons[2] for stopping are allowed, by contraceptive intention, months since use began, contraceptive method, race, education, and religion[3]: United States, 1970-73

Contraceptive method, race, education, and religion	Delay wanted pregnancy			Prevent unwanted pregnancy		
	Months since use began					
	12	24	60	12	24	60
	Percent					
All women[4]	65.8	50.6	26.6	74.4	64.4	44.8
Contraceptive method						
Pill	74.3	57.1	29.2	71.2	57.2	31.5
IUD	71.9	60.2	45.3	75.6	67.5	48.7
Condom	57.4	44.5	28.8	60.0	51.4	37.1
Foam, cream, and jelly	47.1	32.5	15.1	50.3	39.6	16.7
All other methods except sterilization	51.0	38.4	13.7	64.7	49.6	31.9
Race[4]						
White	65.2	50.2	26.6	74.5	64.6	44.5
Black	71.6	58.2	26.7	70.2	59.0	45.6
Education[4]						
Less than 12 years	65.0	48.5	36.0	74.7	65.0	46.5
12 years	67.3	50.9	27.1	74.7	65.8	47.2
More than 12 years	63.9	51.1	21.0	73.5	61.3	38.5
Religion[4]						
Catholic	62.6	46.6	23.1	76.3	65.6	44.6
Other and none	66.5	52.0	28.3	73.8	64.2	44.5

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

[2]Method-related reasons for stopping contraceptive use are unintended pregnancy, stopped to change methods, and "stopped, other," which is the abandonment of contraceptives altogether.

[3]Results for religion are based on the contraceptive use intervals of white women only.

[4]Includes sterilization for preventers.

Table 15. Percent of married women[1] 15-44 years of age who continued to use the same contraceptive method, if abandonment of contraceptives altogether[2] is the only reason for stopping that is allowed, by contraceptive intention, months since use began, contraceptive method, race, education, and religion[3]: United States, 1970-73

Contraceptive method, race, education, and religion	Delay wanted pregnancy			Prevent unwanted pregnancy		
	Months since use began					
	12	24	60	12	24	60
	Percent					
All women[4]	90.3	81.3	61.3	96.6	94.9	91.0
Contraceptive method						
Pill	89.7	80.2	57.3	94.5	90.5	82.9
IUD	93.7	89.0	78.7	95.1	94.0	92.4
Condom	91.5	84.4	73.0	96.6	95.3	92.7
Foam, cream, and jelly	91.0	78.5	58.0	92.5	90.3	80.7
All other methods except sterilization	88.6	79.4	59.5	97.9	97.6	94.3
Race[4]						
White	90.3	81.3	61.7	97.0	95.7	92.2
Black	87.6	80.7	52.9	91.4	85.3	76.1
Education[4]						
Less than 12 years	86.0	75.9	58.6	94.4	92.1	86.2
12 years	90.9	80.9	63.1	97.5	96.1	91.7
More than 12 years	91.3	84.7	57.3	97.0	95.5	95.0
Religion[4]						
Catholic	89.6	78.5	53.9	97.0	95.3	91.7
Other and none	90.6	82.7	65.5	96.9	95.9	90.6

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

[2]Women whose reason for stopping contraceptive use was classified as "stopped, other" were considered to have abandoned contraceptives altogether.

[3]Results for religion are based on the contraceptive use intervals of white women only.

[4]Includes sterilization for preventers.

APPENDIXES

CONTENTS

APPENDIX FIGURE

LIST OF APPENDIX TABLES

APPENDIX I

TECHNICAL NOTES

Background

This report is one of a series of statistical reports based on information collected from a nationwide sample of women through the National Survey of Family Growth conducted by the National Center for Health Statistics.

The National Survey of Family Growth (NSFG) utilizes a questionnaire to obtain demographic and socioeconomic information and information on fertility, family planning, and health factors related to childbearing. As data relating to various subjects within these broad topics are tabulated and analyzed, separate reports are issued. This report is based on data collected in the first cycle of the survey.

The population covered by the sample for NSFG is women 15-44 years of age living in households in the conterminous United States at the time of interview who were ever married or had children of their own living with them. The sample did not include women living in institutions or group quarters. Personal interviews were conducted by the staff of the National Opinion Research Center (NORC), Chicago, beginning in July 1973 and ending in February 1974.

Statistical Design

The sampling plan for the survey was a multistage probability design. Black households and households of all other races were selected at different probabilities so that the sample was composed of about 40 percent black women and 60 percent women of all other races. The sample was designed so that tabulations could be provided for each of the four geographic regions of the United States.

The first stage of the sample design consisted of drawing a sample of primary sampling units (PSU's). A PSU consisted of a county, a small group of contiguous counties, or a standard metropolitan statistical area (SMSA) as defined by the U.S. Bureau of the Census in March 1971. The second and third stages of sampling were used to select several segments (clusters of about 100 dwelling units) within each PSU. A systematic sample of dwelling units was then selected from each segment. Each sample dwelling unit was visited by an interviewer, who listed all household members. If a woman under 45 years of age, ever married, or with offspring in the household, was listed in the household, an extended interview was conducted. If more than one woman in the household met the eligibility criteria, one of the women was randomly selected for an extended interview.

Since the design of NSFG was a complex multistage probability sample, the derivation of estimates involved three basic operations:

Inflation by the reciprocal of the probability of selection.—The probability of selection is the product of the probabilities of selection from each step of selection in the design (PSU, segment, listing unit, household, and sample persons within household).

Nonresponse adjustment.—The estimates were inflated by a multiplication of two factors. The first has the number of sample households in a given PSU and stratum as its numerator and the number of households screened in the PSU and stratum as its denominator. The second factor has as its numerator the number of screened households having an eligible woman of a specific age and race class and PSU group, and as its denominator, the number of women actually interviewed in the same age and race class and PSU. Screener response for the total survey was 89.8 percent and interview response was 90.2

percent for the total sample, yielding an overall response rate of approximately 81.0 percent.

Poststratification by marital status-age-race.—The estimates are ratio adjusted within each of 12 age-race cells to an independent estimate of the population for ever-married women. These independent estimates were derived from the U.S. Bureau of the Census Current Population Surveys of 1971-73. The numbers of single women with offspring living with them were inflated by the two steps just described.

All figures are individually rounded; aggregate figures are rounded to the nearest thousand. The sums of aggregates and percents may not add up to the total due to rounding.

The effect of the ratio-estimating process is to make the sample more closely representative of the population of women under age 45 years, living in households in the conterminous United States, and ever married or with offspring living with them. The final poststratification reduces the sample variance of the estimates for most statistics.

Descriptive material on the sampling design and estimation procedures may be found in another report.[6]

Measurement Process

Field operations for the survey were conducted by NORC as agent for NCHS. The responsibilities of NORC included pretesting the interview schedule, selecting the sample, interviewing respondents, and carrying out quality control checks. The questionnaire was pretested in November 1972 and subsequent smaller field trials were held in March 1973. Interviewers were trained for 1 week prior to fieldwork and had their first few schedules reviewed thoroughly. During the first part of the fieldwork, each interview schedule was reviewed for the completeness of certain key items, and more intensive review and followup were performed if errors were discovered. Review and followup were reduced to a sample of each interviewer's work in the later part of the fieldwork. A 10 percent sample of all households with telephones was recontacted to verify the interview and the accuracy of a few items. All these operations were monitored by NCHS.

Parts of the interview schedule applicable to this report are reproduced in appendix V. The full questionnaire is reproduced in another report.[7] The complete schedules are available on request. Two different forms were used, one for interviewing currently married women and the other for interviewing widowed, divorced, separated, or single women with offspring living with them. The two forms differ mainly in the wording of items referring to the husband; there are a few questions in each schedule that do not appear in the other.

Data Reduction

Coding and keying were done by NORC and the U.S. Bureau of the Census. Each coder's work was systematically sampled for verification. Keying at the Bureau of the Census was performed on key-to-disk equipment programed to reject invalid entries. Each keyer's work was systematically sampled for verification. The data were edited by the Bureau of the Census and NCHS to minimize internal inconsistencies. After editing, value entries were imputed to cases with missing data on an item-by-item basis. No item with more than 15 percent missing data was included in the imputation. The imputed value entry for a case was selected from a randomly chosen case with similar characteristics such as race, age, and marital status, using a procedure known as "hot deck" imputation.

Reliability of Estimates

Since the statistics presented in this report are based on a sample, they may differ somewhat from the figures that would have been obtained if a complete census had been taken using the same questionnaires, instructions, interviewing personnel, and field procedures. This chance difference between sample results and a complete count is referred to as sampling error and is measured by a statistic called the standard error of the estimate. Approximate standard errors for 1-year contraceptive use failure rates reported in this study are shown in the lower panel of the detailed tables containing the rates.

NOTE: A list of references follows the text.

These standard errors were computed using a procedure known as balanced half-sample replication. Details of this procedure can be found in another publication.[6] Standard errors for 2-year use failure rates, continuation rates, and extended use effectiveness rates were not calculated because of time and cost considerations.

The chances are about 68 out of 100 that an estimate from the sample differs from a value that could be obtained by a complete census by less than the standard error. The chances are about 95 out of 100 that the difference between the sample estimate and a complete count would be less than twice the standard error. In this report, percents that have a standard error that is 25 percent or more of the estimate itself are considered "unreliable." The reader is advised to use caution in interpreting results involving unreliable estimates.

In this report, sample statistics are compared among subgroups using the normal deviate test. The level of confidence used with this test is a matter of preference and in this case the 0.10 level was chosen. Thus a statistically significant difference among comparable percents from two or more subgroups is one sufficiently greater than zero that a difference of that size or larger would be expected in less than 10 percent of repeated samples of the same size and type if there were no true difference in the populations sampled. If the observed difference or a larger one could be expected in more than 10 percent of repeated samples, one cannot be sufficiently confident to conclude that there is a true difference in the populations. When an observed difference is sufficiently greater than zero to be statistically significant, the true difference in the population is estimated to lie between the observed difference plus or minus 1.68 standard errors of that difference in 90 out of 100 samples.

When two or more sample statistics are compared and they have only small, statistically nonsignificant differences among them, they may be referred to as the "same" or "similar." However, when a substantial difference observed is found to be not statistically significant, one should not conclude that no difference exists, but simply that such a difference cannot be established with 90 percent confidence from this sample. Observed differences that are described in terms such as "greater," "less," "larger," "smaller," and so forth, have been tested and found statistically significant. Lack of comment in the text about any two statistics does not mean that the difference was tested and found to be not significant.

The standard error of a difference between two comparative statistics, say, the proportion of those with characteristic M among black women compared with white women, is approximately the square root of the sum of the squares of the standard errors of the statistics considered separately.

A formula for the standard error of a difference, $d = P_1 - P_2$, is

$$\sigma_d = \sqrt{(P_1 V_{P_1})^2 + (P_2 V_{P_2})^2}$$

where P_1 is the proportion for one group, P_2 the proportion for the comparative group, and V_{P_1} and V_{P_2} are the relative errors of P_1 and P_2, respectively. This formula will represent the actual standard error quite accurately for the difference between separate and uncorrelated characteristics, although it is only a rough approximation in most other cases.

Nonsampling Error

In addition to sampling error, the survey results are subject to several sources of potential nonsampling error, including interview nonresponse, nonresponse to individual questions within the interview, inconsistency of responses to individual questions, respondent error or misreporting, and errors of recording, coding, or keying by survey personnel. It is impossible to measure accurately the extent of nonsampling errors. Although some useful approximate measures can be made of some types of nonsampling error, the survey must rely on several quality control procedures and other methods incorporated into the survey design to minimize nonsampling error.

Interview Nonresponse

Interview nonresponse, or the failure to obtain whole interviews, arises from several

NOTE: A list of references follows the text.

sources—incomplete listing of households for the sampling frame, inability to screen all sample households for eligible respondents, and inability to complete a full interview. Completeness of listing cannot be tested directly because it requires an independent, accurate accounting of the households that should have been listed. In NSFG, listing accuracy was tested at the time of screening by use of the "half open interval" check for missed households; that is, at designated sample households, the interviewer was required to check for dwelling units between the sample household just screened and the next listed dwelling unit. This procedure resulted in the addition of 781 missed units or an additional 2.4 percent to the original sample of dwelling units to be screened.

Of the original sample of 32,818 dwelling units to be screened, 3,820 were found to be vacant, not dwelling units, or group quarters. Of the remaining dwelling units, 9.7 percent were not successfully screened. This included 2.3 percent refusals to have the household members listed; 1.6 percent of households with members with language problems, illness, or otherwise unavailable in the field period; 4.6 percent where no one could be found at home; and 1.1 percent for other reasons such as refused access to the unit.

Of the 26,177 households for which screening was completed, 10,879 were found to contain an eligible respondent. However, interviews were not completed in 9.8 percent of these cases because of refusals by the eligible respondents (5.0 percent); language, illness, and related problems (2.0 percent); and no contact after repeated calls (2.7 percent).

The nonresponse adjustment for interview nonresponse imputes to nonresponding dwelling units and women the characteristics of similar respondent dwelling units and women.

Item Nonresponse

Nonresponse to individual questions (item nonresponse) was less than 2 percent for about half (51 percent) of the items. Item nonresponse occurred when the respondent refused to answer the question, when the respondent did not know the answer to the question, when the question was erroneously not asked or the answer not recorded by the interviewer, and when the answer was uncodable. For 37 percent of the items, nonresponse was between 2.0 percent and 10.0 percent. For 12 percent of the items, nonresponse was greater than 10 percent for persons eligible to answer the items. Half of the high nonresponse items were concentrated in two areas—detailed income questions and questions about the reasons for switching from one contraceptive method to another. The remaining high nonresponse items were generally those asked of small numbers of persons.

The amount of missing data or imputed values for various items are shown with their definitions in appendix II. Some illustrative items and their nonresponse rates are: parity (no missing data), intention to have another child (0.7 percent), whether no contraceptive method was used or contraception was stopped in order to become pregnant (1.9 percent), and highest grade of school attended (0.1 percent).

For most items an adjustment for missing data was made by one of four imputation procedures. In order of frequency employed they were: (1) "hot deck" imputation, (2) imputation from a sorted file, (3) editing from other data within the same case, and (4) allocation based on technical judgments.

"Hot deck" imputation refers to a procedure in which the file is first randomized. Next a matrix is created for values of items (e.g., race, age, and marital status) judged to be correlated with the item to be imputed (e.g., number of times married). A reasonable "cold deck" value (e.g., 2 = married twice) is assigned to each cell of the matrix in case the first file record with the given characteristics has missing data. The randomized file is processed, and each record is identified as belonging to one cell of the matrix (e.g., white, aged 25-29 years, currently married). The item to be imputed is checked: If it is blank—not applicable (e.g., not married before), it is ignored; if it has a missing data code, the code in the matrix is placed in the record. If it has an acceptable code, that code replaces the code already in the matrix, and it remains in the matrix until another record with the same characteristics and a known code is encountered. This ensures that the probability of a code being assigned to a record with missing data is the

same as the probability of that code occurring among records with the same characteristics but with known data.

For imputation from a sorted file, the records are first sorted by selected characteristics (e.g., marital status, race, and age) so that the first group of records would be currently married black women aged 15-19 years, the second group would be currently married black women aged 20-24 years, and so forth. An initial value is assigned for the item to be imputed—that is, 4 (tubal ligation) for type of sterility, and for any item dependent on the item to be imputed—for example, 9 (not ascertained) to whether the operation was for contraceptive reasons. The ordered file is processed, and each record is checked. If the item to be imputed is blank—not applicable, it is ignored; if it has a known code, the code replaces the existing set of values; if the item has a missing data code, it and its dependent items would be changed to the preset values above. This procedure ensures that the imputed code is reasonable for the ordering characteristics and that the probability of assignment is the same as that in the population in general. There is some bias, however, as the boundaries between groups are crossed.

When sampling error affects the precision of survey estimates, nonsampling error introduces bias. Imputation procedures reduce this bias to the extent that the assumptions about the relations between respondent and nonrespondent characteristics are true. The amount of remaining bias, if any, cannot be measured. Therefore, stringent quality control procedures were introduced at every stage of the survey, including the check on completeness of the household listing mentioned earlier, the extensive training and practice of interviewers, field observations of interviewers, field editing of questionnaires, short verification interviews with a subsample of respondents and missed households, verification of coding and editing, an independent recoding of a sample of questionnaires by NCHS, keypunch verification, and an extensive computer "cleaning" to check for nonpermissible codes, missing data, and response inconsistencies. One source of bias that can be evaluated through special studies but cannot be controlled is respondent error, whether deliberate or unwitting. In this survey as in others, the data are subject to problems of accurate recall and the stability of respondents' views from one time to the next.

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APPENDIX II

DEFINITION OF TERMS

Pregnancy interval.—A pregnancy interval is the period between marriage and the date of a woman's first pregnancy termination (regardless of its outcome), or between the dates of two successive pregnancy terminations (if she has had more than one), or between the date of her most recent pregnancy termination (or marriage if she had no pregnancies) and the interview. The latter interval is called the "open" interval, because it has not been "closed" by a pregnancy; the others are "closed" intervals. Closed intervals are numbered from the earliest to the most recent; the period between marriage and the first pregnancy is the first interval, the period between the first and second pregnancies is the second interval, and so on. The first interval is only defined, however, when marriage precedes the first pregnancy termination. The dates of pregnancies needed to define pregnancy intervals were obtained from each respondent as part of her complete reproductive history. For the sample as a whole, less than 10 percent of the dates of pregnancy termination which determine the first pregnancy interval are imputed because of missing data. For all pregnancy intervals, the proportion based on imputed dates decreases with increasing pregnancy interval order.

Birth interval.—A birth interval is the period between marriage and the date of a woman's first live birth, or between the dates of two successive live births (if she has had more than one), or between the date of her most recent live birth (or marriage if she has had no live births) and the interview. The latter interval is called the "open" interval, because it has not been "closed" by a birth; the other intervals are "closed" intervals. Closed intervals are numbered from the earliest to the most recent, in the same manner as pregnancy intervals. Also, the first interval is only defined when marriage precedes the first live birth. The dates of births needed to define birth intervals are obtained from each respondent as part of the complete history of her pregnancies. For the sample as a whole, less than 10 percent of the dates of birth which determine the first birth interval are imputed because of missing data. For all birth intervals, the proportion based on imputed dates decreases with increasing birth interval order.

Contraceptive use interval.—A contraceptive use interval is the period between the date a woman began the use of a contraceptive method and the date she stopped using it (regardless of the reason for stopping) or the interview date. In addition, for the purposes of this study, only intervals that began during a marriage were considered. The dates of starting and stopping the use of a method, needed to define contraceptive use intervals, were obtained from each respondent as part of the history of her contraceptive use between July 1, 1970 and July 1, 1973. Less than 2 percent of contraceptive use intervals are based on imputed data.

Contraceptive intention.—Contraceptive intention is the motive of the woman in using contraceptives. Women were classified into three groups: "preventers," those who used contraceptives to avoid any further (unwanted) births; "delayers," those who used contraceptives to delay a wanted birth; and "indeterminant," those whose reasons for using contraceptives were unclear. Women classified as "indeterminant," 10 percent of the respondents, were omitted from the analysis. Contraceptive intention is based on imputed data for less than 5 percent of all respondents.

Contraceptive failure.—Contraceptive failure is defined as having occurred if the woman becomes pregnant while using contraceptives.

Use failure rate.—A first-year use failure rate is the percent of women who would experience a contraceptive failure during the first year of continuous contraceptive use. A second-year use failure rate is the percent of women who would experience a contraceptive failure during the second year of continuous contraceptive use. Both rates, as used in this study, are life-table rates and thus represent the percent of a cohort of women that would have experienced a contraceptive failure during the specified period if the women had been subjected to the monthly failure rates produced by the life table. The monthly failure rates are based on the actual experiences of the women in this study.

Use effectiveness rate.—First- and second-year use effectiveness rates are the percents of women who would *not* experience a contraceptive failure during the first and second years of continuous contraceptive use, respectively. These rates are equal to 100 minus the corresponding use failure rate.

Extended use failure rate.—A 1-year extended use failure rate is the percent of women who would experience an unintended pregnancy within the first year after beginning the use of a contraceptive method, regardless of whether use was stopped before the pregnancy actually occurred.

Extended use effectiveness rate.—A 1-year extended use effectiveness rate is the percent of women who would *not* experience an unintended pregnancy within the first year after beginning the use of a contraceptive method, regardless of whether use was stopped during that year. This rate is equal to 100 minus the 1-year extended use failure rate.

Continuation rate.—Twelve-, twenty-four-, and sixty-month continuation rates are the percents of women who would continue to use the same contraceptive method for 12, 24, and 60 months, respectively, after beginning its use.

Age at last live birth.—Age at last live birth is the age, in years, of a woman at her last birthday before her most recent live birth.

Relative age.—Relative age is a classification of the age of a mother at the time she gave birth to a child of a given order, in relation to the ages of all other mothers at the time they gave birth to a child of the same order. For example, a woman who had her first child at a very young age, compared with other women, would be classified as having a "low" relative age for that birth order. Relative age, in this study, is determined for each birth interval of the women in the sample and is used to classify contraceptive use intervals falling within each birth interval.

Parity.—Parity is the fact or condition of having borne children and is specified in terms of the number of live births a woman has had. A woman with no live births is referred to in obstetrical and demographic terminology as "nulliparous" or "zero parity," a woman with one live birth is referred to as "primaparous" or "parity one," and so on. A woman's parity was determined for this study from the questions, "Have you given birth to a baby at any time?" and, if yes, "Altogether, how many babies have you given birth to, including any who died very young?" The accuracy of this information is further verified by obtaining detailed data about each pregnancy and additional information on pregnancies that ended in live issue. A complete pregnancy history was a primary focus of the survey, and information on the number of live births and the number of pregnancies was obtained for 100 percent of the respondents.

Marriage cohort.—A group of women who were first married in a specified calendar period constitutes a marriage cohort. Because the information for classifying women in marriage cohorts comes from a sample at one point in time, it may be a biased sample of all women who married in a specific period. Women who were married in a specific period but who were outside the ages included in the sample, 15-44 years, are not represented in the marriage cohorts constructed from these data. This bias is negligible for recent cohorts but significant for earlier cohorts; in early cohorts, many women who were of relatively advanced age at the time of marriage were past age 45 at the time of interview and are not represented in the sample. The effect of this omission is the overrepresentation of early-marrying women in the early cohorts constructed from the sample data. For that reason, marriage cohorts earlier than 1955 are not considered here.

Race.—Women were classified as white,

black, or "other races" according to the interviewer's observations at the time of interview. The agreement between this classification and the respondent's own reports of ethnic origin, also obtained in the interview, was very high; for instance, of those classified as "black" by interviewer observation, 96 percent reported their ethnic origin as at least partly "black, African, or Negro"; of those who reported their ethnic origin as "black, African, or Negro," 100 percent were classified as "black" by interviewer observation. Race was imputed for 10 respondents.

Education.—Education was classified according to the highest grade or year of regular school or college that was completed. The determination of the highest year of regular school or college completed by the respondent was based on responses to a series of questions concerning (1) the last grade or year of school attended, (2) whether or not that grade was completed, (3) whether any other schooling of a vocational or generally nonacademic type was obtained, and (4) whether or not such other schooling was included in the years of regular school or college reported in (1). Information on education was reported almost completely: Only about 1 percent of the data was imputed.

Religion.—Women were classified by religion in response to the question: "Are you Protestant, Roman Catholic, Jewish, or something else?" Because the numbers responding "Jewish" or "something else" were too few for separate analysis, and because those groups resemble Protestants in their contraceptive practice, they were combined with Protestants for this report in a category "Other and none." Data on religious denominations were reported for all but 26 respondents, or more than 99 percent. Religion was imputed for the 26 respondents.

Geographic region.—For the purpose of classifying the population by geographic area, the U.S. Bureau of the Census has grouped the 50 States and the District of Columbia into four regions, as follows:

Region	*States included*
Northeast	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania
North Central	Michigan, Ohio, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, Nebraska
South	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Texas, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma
West	Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Alaska, Oregon, California, Hawaii

Alaska and Hawaii are not included in the NSFG sample design.

Place of residence.—The population residing in standard metropolitan statistical areas (SMSA's) constitutes the metropolitan population. Except in New England, an SMSA is a county or group of contiguous counties that contains at least one city of 50,000 inhabitants or more, or "twin cities" with a combined population of at least 50,000. In addition to the county or counties containing such a city or cities, contiguous counties are included in an SMSA if, according to certain criteria, they are essentially metropolitan in character and are socially and economically integrated with the central county. In New England, SMSA's consist of towns and cities rather than counties. The metropolitan population for this study is based on SMSA's as defined in the 1970 U.S. census and does not include any subsequent additions or changes. A more detailed discussion has been published.[8] Place of residence was reported for all respondents.

NOTE: A list of references follows the text.

APPENDIX III

SELECTION OF SAMPLE

For the calculation of "true" use effectiveness during the 3-year period prior to the survey, all intervals of contraceptive use (including sterilization) occurring during a continuous marriage were considered. Certainly, many women who are not married have intercourse and use contraceptives, but their exposure to pregnancy may be intermittent; therefore, their experience was not considered.

The first step in the preparation of the data for the calculations was the selection of eligible intervals of contraceptive use. This process involved three steps: the elimination of ineligible respondents, the elimination of ineligible pregnancy intervals, and the elimination of ineligible intervals of contraceptive use (use intervals). All numbers of women, pregnancy intervals, and use intervals reported in this section are the raw unweighted totals. In all other sections failure rates are based on the *weighted* observations. The weight assigned to each respondent is a reflection of the type of multistage sampling scheme employed by the National Center for Health Statistics (NCHS) to ensure that adequate numbers of particular subgroups of the population, for example, black women, were interviewed.

All information for a respondent was omitted if:

1. The respondent had not been married at any time during the observation period (1,635 women), either because the respondent was single on July 1, 1973 (742 women) or was widowed, separated or divorced during the entire study period, July 1, 1970 to July 1, 1973.
2. The respondent or her current husband had become noncontraceptively sterile before July 1, 1970 (324 women).
3. The number of pregnancy intervals ending between July 1, 1970 and July 1, 1973 recorded in the pregnancy interval data disagreed with the information given on the 3-year chart of monthly contraceptive status (75 women).

For the remaining 7,763 women, each of their 10,865 pregnancy intervals falling at least partly in the observation period was examined and the pregnancy interval was disqualified if:

1. No method of contraception was used in the pregnancy interval (2,474 intervals).
2. More than four methods of contraception were reported for a closed pregnancy interval. (The pregnancy interval data allowed for the reporting of only four contraceptive methods in any given interval, precluding the possibility of matching the information in the 3-year chart) (1 interval).
3. Inconsistent or incomplete information about the intention of sterilization was recorded, or the date given for a contraceptive sterilization operation preceded the date of termination of the last previous contraceptive method by more than 2 months (9 intervals).
4. There were discrepancies between the pregnancy interval data and the information on the 3-year chart of more than 1 month in the date of the start (83 intervals) or the end (20 intervals) of a pregnancy interval. In cases in which the pregnancy interval data showed a pregnancy lasting more than 10 months, both the preceding and the following

intervals (31 intervals) were invalidated. In most such cases, it appeared that the date of conception given in the pregnancy interval data was off by 1 year and the 3-year chart had been adjusted to show a pregnancy during the first part of the time given. However, this adjustment often conflicted with other evidence in the record; thus it was not possible to determine the start and end of gestation.

5. During a pregnancy interval overlapping the start of the 3-year period, the number of months of nonexposure to the risk of conception reported in the pregnancy interval data disagreed with information in the 3-year chart, and the woman was married and using a contraceptive method on July 1, 1970 (275 intervals). In the absence of a month-by-month record for the period prior to July 1, 1970, it could not be determined whether the period of nonexposure interrupted the period of contraceptive use.
6. During a pregnancy interval overlapping the start of the 3-year period, the woman was already pregnant on July 1, 1970, so that no valid contraceptive use could occur in the pregnancy interval (853 intervals).
7. Different pregnancies were recorded in 2 successive months so that there could, according to the coding priorities, be no record of intervening contraceptive use (38 intervals).

Finally, within each of the remaining 7,081 pregnancy intervals, intervals of contraceptive use were discarded if:

1. The respondent was not married at the time contraceptive use began (595 intervals). For the pill and the IUD, use was allowed to begin as many as 2 months before marriage. There was no restriction as to how long before marriage sterilization could have occurred, but exposure to the risk of conception was considered to begin in the month of marriage.
2. For contraceptive use intervals followed in the same month by pregnancy, it was not known whether or not contraceptive use was stopped before the pregnancy began (67 intervals). Since this variable was imputed, there should have been no missing data, but in some cases the correct sequence of questions had apparently not been asked.
3. For contraceptive use intervals followed by pregnancy, there was a discrepancy between the pregnancy interval data and information on the 3-year chart as to whether contraceptive use was stopped before the pregnancy began (34 intervals).
4. The contraceptive method reported as being used at the start of observation (July 1, 1970) on the 3-year chart was not the same method as the one reported for that date in the pregnancy interval data (68 intervals).
5. The contraceptive method was not acceptable (essentially noncontraceptive sterilizations that were entered on the 3-year chart) (15 intervals).

An additional 588 contraceptive use intervals were, in effect, discarded because reproductive intention could not be determined. The 588 contraceptive use intervals of indeterminate intention were not included in any tabulation. Since to be classified as having indeterminate intentions in a closed interval implies a marital disruption, and hence excludes the possibility of observing a contraceptive failure, and because all open intervals so classified are contributed by women who are post-married, sterile, or for whom pregnancy is medically inadvisable, a classification of indeterminate does not represent a category of intention between prevent and delay.

It is difficult to speculate with any degree of certainty about the effect of the large number of data exclusions. We suspect that, on balance, respondents excluded are the relatively less successful contraceptors and that, as a consequence, the failure rates presented here may be somewhat low. Also, if the 101 contraceptive use in-

tervals excluded for reasons 2 and 3 included a large number of contraceptive failures, their exclusion biases further downwards the rates presented here. However, it is not possible to test this hypothesis, since the vast majority of exclusions were made because of inaccuracies in the data that could not be resolved.

APPENDIX IV

THE CALCULATION OF GROSS RATES OF CONTINUATION FOR CONTRACEPTIVE METHODS: SINGLE AND MULTIPLE INCREMENT LIFE TABLES

James Trussell and Jane Menken

A decade ago, Robert Potter, realizing the biases involved in using the Pearl index as a measure of contraceptive effectiveness, proposed analyzing contraceptive continuation by life-table procedures.[9] Many such life tables have now been prepared by various researchers,[1,10-19] and the recent development of FORTRAN programs for (mini-) computers drastically eased the manipulation of great quantities of data and facilitated computation.[16] Moreover, the Population Council, in collaboration with Potter, has issued a series of recommended programs for evaluating continuation rates.[17,18] The purpose here is to point out a logical error in the accepted method for constructing the single decrement life table associated with the multiple decrement life table, generated by competing reasons for stopping contraceptive use, and to propose an alternative derivation of these gross rates.[k] Moreover, a different procedure is recommended for handling women who are lost to followup or are censored by the initiation of the analysis. The first two sections of this appendix contain a review of the procedure for constructing a single and multiple decrement life table and may be omitted by those familiar with the standard notation and methodology.

NOTE: A list of references follows the text.

[k]This treatment is a simplified version of Chiang's[19] mathematical exposition of competing risks. It differs in that the assumptions are modified somewhat to take into account specifics of the contraceptive use situation. Because much of this mathematical literature on competing risks is inaccessible to most demographers, the method is derived simply in detail in this appendix.

Preliminary Manipulation of the Data

The procedure developed by Potter[20] for analyzing the continuation of IUD use in Taiwan is quite general and can be readily adapted for analyses of other methods and for use in situations other than clinical trials. Each woman, after insertion of the IUD, is observed at regular intervals and is recorded at each observation as being in a certain status (continuing use, expulsion, pregnant, etc.) in an ordinal month of use. For example, a woman may be recorded as being a continuing user in the 6th month or as having expelled her IUD in the 12th month. Such an accounting procedure is used in medical clinics; the patient file contains this information. Next, at the time of the analysis, women are classified by their terminal status. Normally the first segment of use of a contraceptive is the segment of interest; this segment can be terminated by pregnancy, other discontinuation, loss to followup (LFU),[l] or by the initiation of the analysis itself (the woman is still using contraceptives at the time of the analysis). It is very important to note that if a woman is lost to followup, she is coded in the terminal status LFU in the month of her last contact with the clinic, not

[l]Of course, there were no cases lost to followup in the NSFG data. This terminal category is included here for completeness.

the month in which she was sought but not found. Similarly, pregnancy should be coded in the month in which it occurs, not in the month in which it is confirmed. However, since pregnancy cannot be detected in the month in which it occurs, problems arise; these are discussed in the last section of this appendix. Next, the length of observation from initiation to terminal status is measured. Since the length of observation is measured in ordinal months, a procedure for computing the number of women retaining the IUD at the start of the monthly interval is necessary.

As an illustration, the case in which observation is measured in intervals of 1 month was chosen. Other intervals, such as 3 or 6 months, are permissible, and the methodology is unaltered. The notation used by Potter is very convenient:

N_x = number of women retaining the IUD at the start of the monthly interval $(x, x + 1)$, i.e., the $(x + 1)$th ordinal month;

D_{xj} = number of terminations during month $(x, x + 1)$ due to cause j;

$T_x = \sum_j D_{xj}$ = total observed terminations during month $(x, x + 1)$;

F_x = number of women lost to followup during month $(x, x + 1)$;

C_x = number of continuing users last observed during month $(x, x + 1)$.

The terminology "in month x" refers to experience in the ordinal month $x + 1$. Note that this treatment is identical with common usage of the concept of age; children aged 4 are in their 5th year of life.

Since the only known quantities are the number of insertions (N_0), the number of terminations observed in month x, (T_x), the number of continuing users last observed in month x, (C_x), and the number of women lost to followup in month x, (F_x), N_{x+1} must be obtained recursively:

$$N_{x+1} = N_x - T_x - F_x - C_x \qquad x \geqslant 0. \quad (1)$$

By such a procedure, a preliminary table, which shows N_x, C_x, T_x, and F_x, is obtained. One more modification is needed before a life table can be computed. The value N_x is not, properly, the number of women who are exposed to the risk of terminating use. Women coded as both F_x and C_x are included as exposed to risk for a full month. However, since they have been observed for, on the average, only half a month, Potter removed one-half month for each of these women to obtain the adjusted number of women entering month x:

$$N_x^* = N_x - \tfrac{1}{2}(F_x + C_x). \quad (2)$$

This procedure is in keeping with the standard assumption that cases lost to followup are unselected relative to the subsample effectively observed during that month. Women whose experience is censored due to the initiation of the analysis and women who are lost to followup are treated in the same way, because there is no chance of observing a termination; the observation of both types of women is artificially ended by an event that is not a proper cause of method termination. It is suggested later that the two types of termination should be treated differently.

Construction of a Multiple Decrement Life Table

The construction of a single decrement table can proceed in the usual manner once the initial data manipulation has taken place. Let the conditional probability of failing during the xth month (the interval x to $x + 1$) be q_x; then q_x is estimated in the Potter procedure by

$$\hat{q}_x = \frac{T_x}{N_x^*} \quad (3)$$

and the estimated probability of retaining the device for exactly x months is given by

$$\hat{P}_x = \prod_{t=0}^{x-1} (1 - \hat{q}_t). \quad (4)$$

The discontinuation rates by individual cause in a multiple decrement life table, called "net rates" by Tietze, are similarly constructed. If we let q_{xj} be the conditional probability of

failing during the xth month due to cause j, then q_{xj} is estimated by

$$q_x = \frac{D_{xj}}{N_x^*} \tag{5}$$

where D_{xj} is the number of discontinuations due to cause j in month x. The cumulative rate by duration x of discontinuation due to cause j (Q_{xj}) is

$$Q_{xj} = \sum_{t=0}^{x-1} P_t q_{tj}, \tag{6}$$

which can be estimated from the $\hat{P}_x$ and $\hat{q}_{xj}$.

Further, it is clear that the sum of cumulative discontinuation rates by cause equals the cumulative discontinuation rate for all causes; hence, the cumulative discontinuation rates are additive.[m]

Construction of the Associated Single Decrement Life Table

The cumulative discontinuation rates due to cause j in a multiple decrement life table are functions of the other competing discontinuation rates. As Potter[9] explained:

> "... a problem arises when net cumulative rates are used in comparing the relative frequency of a particular type of termination, such as expulsion, in two different samples or in subgroups within a sample. For example, suppose that the monthly rates of expulsion—that is, the probabilities of expelling during the first month after insertion, the second, and so on—are lower in sample B than in sample A for those retaining the device up to the beginning of that month. Now, if the levels of competing risks are also lower in B than in A, so that fewer women in B are lost to pregnancy and removal and therefore more women are exposed on the average longer to the risk of expulsion than is the case in A, then it is possible for sample B to show a higher net cumulative rate of expulsion despite its lower monthly rates of expulsion."

Therefore, it is enlightening to construct a life table in which all competing risks other than the one(s) of interest have been eliminated. Preston et al.,[21] in their work on cause of death, called such a life table the *associated single decrement life table*. Tietze labeled the rates calculated from the associated life table "gross rates." Suppose that we are interested in cause j; then all the other causes we seek to eliminate can be denoted $\bar{j}$. Further, associated life-table risks are indicated by an asterisk over the rates. Then it is clear that the cumulative rates in the associated tables must satisfy one constraint:

$$P_x = P_{xj}^* P_{x\bar{j}}^*. \tag{7}$$

In words, at duration x the product of the probability of continuing contraceptive use if cause j is the only cause of discontinuation and the probability of continuing use if only cause j is eliminated must equal the observed probability of continuing use if all causes are considered together. At duration x the cumulative net failure rates are additive and the cumulative gross continuation rates are multiplicative over all causes.

We denote by q_{xj}^* the gross rate of discontinuing in month x from cause j when all other causes are eliminated. Potter's procedure for estimating the q_{xj}^* is a direct extension of the method for estimating the net rates given by equation 5. It consists of subtracting from N_x^* one-half the number of women who discontinued contraceptive use for all causes other than the one under consideration on the grounds that, on the average, they would have been exposed to the risk of discontinuation of use for the cause of interest for about half a month. This procedure, however, only approximates the constraint (equation 7), as seen from the example discussed later and demonstrated in tables I-III. However, an exact computation of risks that satisfies equation 7 can be easily developed.

[m] $\sum_j Q_{xj} = \sum_j \sum_{t=0}^{x-1} P_t q_{tj} = \sum_{t=0}^{x-1} P_t \sum_j q_{tj} = \sum_{t=0}^{x-1} P_t q_t = Q_x$.
All true rates can be replaced by their estimators to obtain $\sum_j \hat{Q}_{xj} = \hat{Q}_x$.

Table I. Example of a simple multiple decrement life table with two decrements

Month of use	Adjusted number of women still using a contraceptive at the beginning of month x	Number of women who discontinue contraceptive use for reasons 1 and 2 between months x and $x+1$		Observed proportion discontinuing use for reasons 1 and 2 between months x and $x+1$	
x	N_x^*	D_{x1}	D_{x2}	$\hat{q}_{x1}$	$\hat{q}_{x2}$
0	1,000	100	200	0.1000	0.2000
1	700	100	100	0.1429	0.1429
2	500				

Table II. Estimates of gross rates of discontinuation of contraceptive use (probability of discontinuation of use between months x and $x+1$) for reasons 1 and 2, by method of computation

Month of use	Method of computation			
	Formula 9		Potter procedure	
	Probabilities of discontinuing use for reasons 1 and 2 between months x and $x+1$		Probabilities of discontinuing use for reasons 1 and 2 between months x and $x+1$	
x	$\hat{q}^*_{x1}$	$\hat{q}^*_{x2}$	$\hat{q}^*_{x1}$	$\hat{q}^*_{x2}$
0	0.1118	0.2118	0.1111	0.2105
1	0.1548	0.1548	0.1538	0.1538

Table III. Estimates of gross rates of survival from reasons for discontinuation 1 and 2 (probability of not discontinuing use due to reasons 1 and 2) to the end of the second month of use, by method of computation

Method of computation			
Formulas 9 and 11		Potter procedure and formula 11	
Probabilities of not discontinuing use for reasons 1 and 2 by the end of month 2		Probabilities of not discontinuing use for reasons 1 and 2 by the end of month 2	
$\hat{p}^*_{21}$	$\hat{p}^*_{22}$	$\hat{p}^*_{21}$	$\hat{p}^*_{22}$
0.7506	0.6661	0.7521	0.6680

Let us consider two possible causes of discontinuation of contraceptive use. We need never consider more than two at one time, since we can combine all causes into the cause(s) of interest and the cause(s) we wish to eliminate. In the population (the multiple decrement life-table population) the net rates are q_{x1} and q_{x2} and the gross rates are q^*_{x1} and q^*_{x2}. Then we can express the q_{xi} in terms of the q^*_{xi} as follows

$$q_{x1} = p^*_{x2}\, q^*_{x1} + \tfrac{1}{2} q^*_{x2}\, q^*_{x1} = q^*_{x1}\,(p^*_{x2} + \tfrac{1}{2} q^*_{x2}) \tag{8}$$

$$q_{x2} = p^*_{x1}\, q^*_{x2} + \tfrac{1}{2} q^*_{x1}\, q^*_{x2} = q^*_{x2}\,(p^*_{x1} + \tfrac{1}{2} q^*_{x1})$$

where

$$p^*_{xi} = 1 - q^*_{xi}$$

and the simplifying assumption is made that if both causes of discontinuation occur in the same month x it is equally likely that cause 1 precedes cause 2 and vice versa. In words, the expected proportion of women who discontinue use because of cause 1 is equal to the probability of discontinuing use because of cause 1 if it alone operated times the expected proportion of those who would be at risk if cause 2 alone operated (those who would continue and half those who would discontinue). The statement for cause 2 is symmetric.

Solving for q^*_{x1}, we obtain

$$q^*_{x1} = \frac{2 + q_{x1} - q_{x2} \pm \sqrt{(2 + q_{x1} - q_{x2})^2 - 8 q_{x1}}}{2} \tag{9}$$

Formula 9 is obviously symmetric for q^*_{x2}. Further, it can be shown (see the notes that follow) that the expressions under the radical for both q^*_{x1} and q^*_{x2} are equal. Since equation 9 yields two values of q^*_{x1}, how do we know which one to choose? First, it is clear that q^*_{x1} must be bounded by the constraint

$$q_{x1} \leqslant q^*_{x1} \leqslant \frac{q_{x1}}{1 - q_{x2}} \tag{10}$$

since the women who discontinue use for cause 2 do so somewhere between the very beginning (upper bound) and the very end (lower bound) of month x. Second, it is shown in the notes that follow that only one root will lie within the bounds set by equation 10 provided that

$$q_{x1} + q_{x2} < 1,$$

that is, provided that the q_x in the single decrement life table is less than 1 for any given month. This condition must always be satisfied; moreover, the root computed by subtracting the expression under the radical in equation 9 is always chosen. Estimates of the q^*_{xi} are obtained by replacing the q_{xi}'s in equation 9 by their estimates, the $\hat{q}_{xi}$'s.

Now that the framework of analysis has been fully explored, let us turn to the example given in table I. From the first three columns of table I, the values of $\hat{q}_{xi}$ given in columns 4 and 5 are first computed. The values of $\hat{q}^*_{xi}$ can be computed according to equation 9. These estimates, along with the estimates of the q^*'s obtained from the Potter procedure, are shown in table II. Finally, the $\hat{P}^*_{2i}$ can be constructed by a procedure analogous to equation 4:

$$\hat{P}^*_{2i} = \hat{p}^*_{0i} \cdot \hat{p}^*_{1i}. \tag{11}$$

These estimates are presented in table III.

Using equation 7, the product of $\hat{P}^*_{21}$ by $\hat{P}^*_{22}$ in table III should be 0.5, the proportion of women continuing use to month 2 in the multiple decrement life table; the $\hat{P}^*_{2i}$ computed according to equations 9 and 11 satisfy this constraint, but those computed according to the Potter formula do not. In this example, the product from the Potter procedure is 0.502 and the bias is quite small. However, as the number of types of termination or the number of months of followup increases, the biases can become large.

Differences Between Contraceptive Life Tables

The fact that pregnancy cannot be detected at the time it occurs poses a serious problem in the treatment of women whose experience is censored by either the end of observation or loss

to followup. To a first approximation, expulsions and removals of IUD's for pain and/or bleeding occur uniformly over a cycle, and they can be observed when they occur. Hence, we can be sure that the C_x women who were observed to be continuing IUD users of contraceptives of duration x months at the time of the study had not in fact expelled the IUD or had it removed. We cannot be sure without further followup, that they were not pregnant at that time. Therefore, unless all women classified as C_x can be located approximately 2 months following the close of the study and be found to be not pregnant, their full observed period of exposure cannot be utilized in the construction of any life table. Instead, only the segment for which a pregnancy could possibly be observed can be used. We suggest that an arbitrary 2 months be subtracted for all C_x women. By this procedure, all C_x women are either coded or recoded as C_{x-2}. By the same logic *no observed termination should be recorded during the last 2 months of the study*. Women who conceive during this period should be coded as continuing users in the 3d month prior to the close of the study. This procedure with regard to continuing users is equivalent to Tietze and Lewit's recommendation[18] of establishing the cutoff date for a study at least 2 months before the calendar month of analysis.[n] Also, records of women who are followed for less than 2 months must be discarded entirely. Unless such a procedure is followed, some pregnancies will be missed and all rates (single decrement, gross, and net) will be biased downward.

Women who are lost to followup constitute a different problem entirely. There are three choices of treatment of these cases:

1. Code these women as last observed at month x. This is the treatment proposed by Potter and by Tietze and Lewit. By a logic identical to that above, however, we do not know that these women were not already pregnant at month x. Hence the net pregnancy rates in month x or $x-1$ will be biased downward, and the other net termination rates will be slightly biased downward, since some pregnant women would be erroneously included in their denominator.
2. Code these women as last observed at month $x-2$, that is, treat them the same as women censored by the end of the study at month x. In this case, the net pregnancy rates are unbiased, but all other failure rates are biased upward since months of exposure are taken from their denominator.
3. Treat loss to followup as a competing risk. This treatment is proposed by Chiang, but it has the obvious disadvantage that this risk includes pregnancy, since some women who are lost to followup are pregnant.

This discussion emphasizes that there is no unambiguously correct way to handle women who are lost to followup. However, if our primary concern is the estimation of pregnancy risks, alternatives (1) and (3) are obviously unsatisfactory. We are left with alternative (2); clearly, even though the multiple decrement pregnancy rates will be correct, the gross pregnancy rates will be affected if loss to followup accounts for a significant proportion of all terminal codes.

Given these decisions, women who are *last observed* at month x (either censored or lost to followup at x) can be assumed not to be pregnant at month $x-2$. Because it is certain that they did not terminate contraceptive use for any other reason, it can be assumed that they are observed for the full month $x-2$.[o] Therefore, equation 2 must be modified to be identical with equation 1.

$$N^*_{x+1} = N_{x+1} = N_x - T_x - F_x - C_x \qquad x \geqslant 0 \tag{12}$$

[n] They do not, however, consider any of the problems discussed below which arise from their treatment of women lost to followup.

[o] Equivalently, if all women can be located 2 months after the close of the study, each can be given a full month of exposure in month x.

with the understanding that women censored or lost to followup at month x are coded as C_{x-2} and F_{x-2}, respectively.

Construction of a Multiple Increment Life Table

The preceding discussion holds for situations in which it is possible to follow women from the time of initiation of contraceptive use to the termination of use or the beginning of the analysis. In many cases such prospective studies are not possible. Instead one observes for some time period a cross-section of women who have been using contraceptives for various durations. The methodology developed above would enable one to analyze only the experiences of women who initiated contraceptive use during the period under observation. If this period is short, then, on the average, the subsample of women initiating use would be small in relation to all users. Furthermore, any life table constructed must terminate at a duration that does not exceed the period of observation.

The construction of a multiple increment life table allows all period use to be considered.[22] First each woman is coded both by terminal status (T_x, F_x, or C_x) and by the month of use in which she entered into observation E_y where $y \leqslant x$.[P]

The experience of a woman who enters observation at month y is counted in the life table only at months $\geqslant y$. Her (successful) experience before month y is not counted, since women who started to use contraceptives at the same time but failed before month y are not observed and their experience is not counted. The assumption underlying the construction of a multiple increment life table is that women who enter observation at month y are representative of all women who are still using contraceptives at month y. The only change in methodology occurs in the recursive formulation of N_x^*:

$$N_0^* = \tfrac{1}{2}E_0 \qquad (13)$$

$$N_1^* = E_0 - T_0 - F_0 - C_0 + E_1 \qquad (14)$$

$$N_{x+1}^* = N_x - T_x - F_x - C_x + E_{x+1} \qquad (15)$$

where it is understood that women censored or lost to followup in month x have been recoded as C_{x-2} and F_{x-2}, respectively. Furthermore, no woman who enters in month y and terminates as F_{x-2} or C_{x-2} is counted unless $x - 2 \geqslant y$. The $\tfrac{1}{2}E_0$ arises because the first month of use within the period of observation is considered to have contributed half a month of exposure on the assumption that initiation occurred halfway through the calendar month. However, women who enter observation in month x, E_x, are observed for the full month x during the first calendar month of the study.

Methods of Counting

It should be pointed out that the different treatment of exposure attributed in the first month is due to a different method of counting. In prospective studies, the counting normally takes place from date of initiation (insertion of an IUD), and the unit of measure is an ordinal month (from January x to February x). In the partially retrospective studies, for which a multiple increment life table is appropriate, the unit of counting is normally a calendar month (i.e., June, July, August). If the unit of counting in a prospective study is a calendar month, the same rule of a half-month of observation in the first month should be followed. Perhaps an example will make this point clearer. A woman has an IUD inserted on January 15 and is estimated to have become pregnant on July 5. If counting takes place in ordinal months from January 15 then she contributes 1 month of observation in the month of insertion (January 15-February 15) and 6 months of observation in all (January 15-July 15). If the unit of counting is a calendar month, the woman contributes half a month in the month of initiation (January) and a total of 6½ months. On the other hand, if pregnancy had occurred on July 20, the ordinal method of counting would have given 7 months of observation, but the calendar method only 6½. Therefore, both methods lead to the same estimates, on the average. It is clear that the ordinal method is preferable because it is more accurate,

[P] Actually, $y < x - 2$ if the terminal status is F_x or C_x, since F_x and C_x will be recoded as F_{x-2} and C_{x-2}.

but the calendar information is much easier to collect; the data for the 1973 NSFG were coded using the calendar method.

Summary

We have proposed a method for coding women lost to followup and women whose experience is censored by the initiation of a study so that better estimates of terminations of contraceptive use due to pregnancy can be calculated. It must be emphasized that net pregnancy rates are unbiased only if loss to followup and pregnancy are independent. If women are lost to followup *because* they are pregnant, failure rates will certainly be biased downward. No valid assumption regarding nonindependence can be made, however, unless the true status of women lost to followup is known, in which case the problem is irrelevant, since they are no longer lost to followup. Nevertheless, the assumption of independence is a strong one and may not be valid.

In addition, we have suggested a procedure for calculating the associated single decrement contraceptive use failure rates which satisfies the fundamental constraint that the associated single decrement rates replicate the proportion of women still using contraceptives after a given duration of time in the multiple decrement life table. This method admittedly involves a greater number of numerical calculations than does the Potter formula; however, since most analyses are performed with the aid of an electronic computer, this consideration is of little importance.

Notes

It can be shown straightforwardly that the procedure outlined previously will yield an extraneous root in every case of interest. From the previous discussion we know that q^*_{x1} must be bounded by the constraints

$$q_{x1} \leqslant q^*_{x1} \leqslant \frac{q_{x1}}{1 - q_{x2}}, \qquad \text{(A1)}$$

where

$$q^*_{x1} = \frac{2 + q_{x1} - q_{x2} \pm \sqrt{(2 + q_{x1} - q_{x2})^2 - 8q_{x1}}}{2}. \qquad \text{(A2)}$$

Since the expression under the radical equals

$$R_x = 4(1 - q_{x1} - q_{x2}) + (q_{x1} - q_{x2})^2 \qquad \text{(A3)}$$

and since

$$q_x = q_{x1} + q_{x2} < 1, \qquad \text{(A4)}$$

then all roots are real. The reformulation of the expression under the radical as equation A3 leads to a computational saving when calculating q^*_{x2}. Equation A2 is obviously symmetric for q^*_{x2}, and, since the interchange of second subscripts in equation A3 does not alter the value of R_x, then

$$q^*_{x2} = \frac{2 + q_{x2} - q_{x1} \pm R_x^{1/2}}{2} \qquad \text{(A5)}$$

We are faced next with the apparent choice of two possible values of both q^*_{x1} and q^*_{x2}. We can gradually narrow the range of choice. First, the hyperbolas equation (8) are re-expressed in a way that makes the asymptotes evident:

$$q^*_{x2} = 2\left(1 - \frac{q_{x1}}{q^*_{x1}}\right)$$
$$q^*_{x1} = 2\left(1 - \frac{q_{x2}}{q^*_{x2}}\right). \qquad \text{(A6)}$$

These two hyperbolas intersect only twice, as shown in figure I, so that we are left with a choice of either both smaller or both larger values of the q^*'s obtained from equations A2 and A5. Next, we note that equation A4 implies that the upper limit for q^*_{x1} given by equation A1 is less than 1. Therefore, if it can be proved that the greater value of q^*_{x1} given by equation A2 is always greater than or equal to 1, then the solution to equation A6 given by the larger pair of values will always be extraneous. For a given value of q_x,

$$q^*_{x1} = \frac{2 + q_{x1} - q_{x2} + R_x^{1/2}}{2} \qquad \text{(A7)}$$

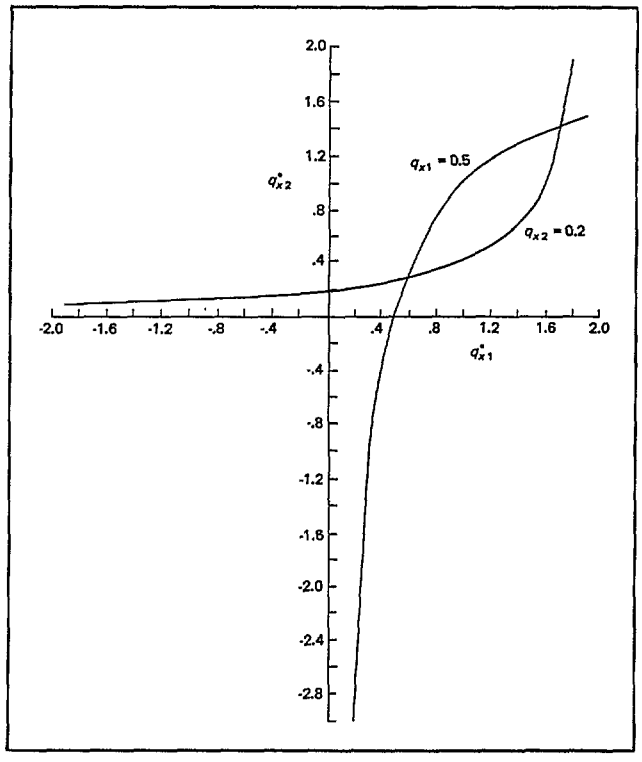

Figure I. Hyperbolas generated by equations 8 if $q_{x1} = 0.5$ and $q_{x2} = 0.2$

reaches a minimum value of $2 - q_x > 1$ when $q_{x1} = 0$. Therefore, when condition A4 holds, the value of q^*_{x1} given by equation A7 will always be greater than 1. The same argument holds for the larger q^*_{x2} value. Hence, the larger pair of roots is extraneous, and $R_x^{1/2}$ is always subtracted to obtain the correct root:

$$q^*_{x1} = \frac{2 + q_{x1} - q_{x2} - R_x^{1/2}}{2} \qquad \text{(A8)}$$

$$q^*_{x2} = \frac{2 + q_{x2} - q_{x1} - R_x^{1/2}}{2}. \qquad \text{(A9)}$$

Finally, we must show that the values given by equations A8 and A9 satisfy equation A1. Figure I demonstrates that both pairs of roots satisfy the constraint that $q^*_{xi} \geq q_{xi}$ as follows from equations A8 and A9. Next we let q^*_{x1} be larger than the upper boundary of equation A1.

$$q^*_{x1} = \frac{q_{x1}}{1 - kq_{x2}} \quad \text{where } k > 1. \qquad \text{(A10)}$$

Then by substituting q^*_{x1} from equation A10 into the first equation in A6, $q^*_{x2} = 2kq_{x2}$; from the second equation in A6, we see that q^*_{x1} must then equal $2(1 - 1/2k)$, which implies that $q^*_{x1} > 1$. But, by an argument similar to the one used above, it can be shown that the maximum value of equation A8 is $q_x < 1$ when $q_{x1} = q_x$. A symmetric argument holds for q^*_{x2}, and the proof is complete.

Finally, from equations A8 and A9 it can be shown that

$$\begin{aligned} p^*_{x1} \cdot p^*_{x2} &= 1 - q_{x1} - q_{x2} \\ &= 1 - q_x \\ &= p_x. \end{aligned} \qquad \text{(A11)}$$

Formula A11 in turn guarantees that constraint (equation 7) will be met.

APPENDIX V

SUMMARY OF PERTINENT PORTIONS OF THE NSFG QUESTIONNAIRE

Question no.

For all currently married respondents:

11 ..... Date of current marriage (mo., day, yr.)

For all post-married respondents and respondents married more than once:

12 ..... Date of first marriage
13 ..... How marriage ended
14 ..... Date of divorce/death
—If marriage ended in divorce:
15 ..... Date stopped living together

For all respondents with any live births:

19A ..... Date of each live birth

For all respondents:

23 ..... Are you currently pregnant?
—If don't know,
Do you think you probably are or probably aren't?

24,25,26 ..... Dates of all pregnancy terminations other than live births

For each closed pregnancy interval ending on or after July 1, 1970:

36 ..... Periods of no intercourse
37 ..... Did you use any method of contraception?
38 ..... List methods
For each method:
39 ..... Date started using
40 ..... Did you skip using (often, sometimes, only once or twice)?

Question no.

41 ..... Date stopped using
42 ..... When did you become pregnant?
—If stopped using last method same month became pregnant:
43 ..... Had you stopped using (METHOD) before becoming pregnant?
—If yes to q. 43 or stopped using before month of conception:
44 ..... Was the reason you stopped because you, yourself, wanted to become pregnant?
45 ..... At the time you became pregnant did you, yourself, actually want a(nother) baby sometime?
Is that how you felt before you became pregnant or did you come to feel that way later?
—If "yes" to q. 45:
46 ..... Did you become pregnant sooner than you wanted, later than you wanted, or just about the right time?

For open pregnancy interval:

49 ..... Periods of no intercourse
50 ..... Did you use any method of contraception?
51 ..... List methods
For each method:
52 ..... Date started
53 ..... Did you skip using (often, sometimes, only once or twice)?
For each method except last:
54 ..... Date stopped
For last method:
55 ..... Still using?

Interviewer then reviews 3-year history with respondent, filling out 3-year month-by-month chart of contraceptive status.

Question no.

For all respondents who have not previously mentioned sterility:

57 ..... Do you have any reason to believe it would be difficult or impossible to have a(nother) baby?

58 ..... Reason it would be difficult or impossible

For all respondents for whom pregnancy is judged to be impossible:

59A ..... Type of operation or accident, illness, unspecified

59B ..... Date of operation/learned of sterility

For operations:

Question no.

59C ..... Was operation at least partly so that you would not have any (more) children?

For all respondents for whom pregnancy is judged possible and who are either currently married or who expect remarriage/reunion:

67 ..... Do you and your husband intend to have a(nother) baby?

—If don't know, disagree, etc.:

73A ..... Smallest number you expect to have

73B ..... Largest number you expect to have

NOTE: The interval file is constructed from responses to questions 19A, 24-26, and 36-55. All other information is contained in the respondent file.

APPENDIX VI

CLASSIFICATION OF CONTRACEPTIVE USE INTERVALS BY CONTRACEPTIVE INTENTION

A contraceptive use interval is any period of exposure to the risk of conception during which a woman was both married and using a method of contraception. Periods of exposure to the risk of conception that began prior to marriage were excluded. A contraceptive use interval was classified as a *delay* interval if the woman's motive for using a contraceptive was to delay her next pregnancy. If her intention was to have no more children, the interval was classified as a *prevent* interval. If the woman's intention at the time of contraceptive use could not be determined, the classification was *indeterminate*. Since all tabulations were separated into prevent and delay categories, indeterminate intervals were excluded from the analysis. Most indeterminate intervals were contraceptive use intervals followed by marital dissolution within the same pregnancy interval; the woman's intention during such an interval could not be deduced from her responses to questions pertaining to the end of the pregnancy interval (either conception or interview). In addition, women who were either sterile or for whom future pregnancies were ruled out for medical reasons were not asked their reproductive intention; thus their intention during the open pregnancy interval for methods other than contraceptive sterilization could not be determined.

The classification pertained only to pregnancy intervals ending after July 1, 1970 and to women who were married contraceptive users during part or all of the interval. The classification was determined in the following manner:

Closed Pregnancy Intervals

Women who answered "no" to q. 37 (. . . This interval, did you ever use any method to delay or prevent a pregnancy?) or who were not married at any time during the pregnancy interval were not considered.

Delay

(A) 1. "Yes" to q. 44 (Was the reason you . . . stopped . . . because you wanted to become pregnant?) *or*

2. "Yes" to q. 45 (At the time you became pregnant . . . did you want to have a(nother) baby at some time?) *and* "before" to q. 45A (. . . is that how you felt *before* you became pregnant or did you come to feel that way later?), *or*

3. "No" to q. 45 *and* "later" to q. 45B (same as 45A), *or*

4. "Don't know; don't care" to q. 45 and "probably yes" to q. 45C (probe), *and*

(B) The marriage during which contraceptive use occurred was intact at conception.

Prevent

(A) 1. "No" to q. 45 *and* "before" to q. 45B, *or*

2. "Yes" to q. 45 *and* "later" to q. 45A, *or*

3. "Don't know; don't care" to q. 45 *and* "probably no" to q. 45C, *and*

(B) The marriage during which contraceptive use occurred was intact at conception.

Indeterminate

The marriage during which contraceptive use occurred dissolved before conception.

Open Pregnancy Intervals

Women who answered "no" to q. 50 (Since your last pregnancy/July 1, 1970, did you ever use any method to delay or prevent a pregnancy?) or who were not married at any time during the pregnancy interval were not considered.

Delay

(A) 1. "Yes" to q. 76 (Is the reason you are not using a method . . . because you . . . want to become pregnant as soon as possible?), *or*

2. "Yes" to q. 67 (Do you and your husband intend to have another baby?), *or*

3. "Don't know" to q. 67 and "greater than zero" to q. 73 (Many people aren't sure but . . . what is the largest number of (additional) babies you expect to have?), *and*

(B) The marriage during which contraceptive use occurred was intact at interview.

Prevent

(A) 1. a. "No" to q. 67, *or*
b. "Don't know" to q. 67 and "zero" to q. 73, *and*

2. The marriage during which contraceptive use occurred was intact at interview, *or*

(B) 1. "Yes" to q. 59C [was the (sterilizing) operation done at least partly so that you would not have (more) children], *and*

2. The method under consideration is contraceptive sterilization.

Indeterminate

(A) 1. Q. 67 not asked (woman is either separated, widowed, or divorced without marital expectations or pregnancy is impossible or ruled out for medical reasons), *or*

2. Marriage during which contraceptive use occurred is not intact at interview, *and*

(B) The method under consideration is *not* contraceptive sterilization.

———— ooo ————

APPENDIX VII

CONTRACEPTIVE FAILURE RATES BY RELATIVE AGE, CONTRACEPTIVE INTENTION, AGE AT LAST LIVE BIRTH, EDUCATION, AND PARITY

Table IV. Percent of married women[1] 15-44 years of age who experienced a contraceptive failure during the first year of use, by relative age, contraceptive intention, age at last live birth, education, and parity: United States, 1970-73

Contraceptive intention, age at last live birth, education, and parity	Relative age				
	Total	Low	Low middle	High middle	High
	Percent				
PREVENT UNWANTED PREGNANCY[2]					
Age at last live birth					
15-19 years	7.1	8.7	5.3	*	*
20-24 years	6.1	9.0	5.5	5.4	4.7
25-29 years	2.9	5.4	2.9	2.6	3.1
30-34 years	1.6	*	*	2.4	1.4
35-39 years	1.1	*	*	*	1.1
Education					
Less than 12 years	4.2	12.8	3.8	1.2	0.7
12 years	3.8	0.7	4.8	4.3	2.7
More than 12 years	2.9	*	5.5	3.1	2.2
Parity					
No live births	5.0	*	*	4.7	6.6
One live birth	4.4	*	6.2	9.3	0.2
Two live births	4.6	12.4	6.7	3.8	2.2
Three live births	3.1	6.9	2.2	2.8	3.0
Four live births	2.1	7.4	3.9	-	1.5
Five live births	1.6	-	6.6	-	-
Six or more live births	4.4	8.2	-	10.9	2.8
DELAY WANTED PREGNANCY					
Age at last live birth					
15-19 years	9.9	10.5	8.4	14.5	*
20-24 years	5.6	10.0	6.2	4.8	6.6
25-29 years	8.4	*	18.8	7.6	7.1
30-34 years	7.3	*	*	*	5.4
Education					
Less than 12 years	8.6	14.1	6.3	-	9.5
12 years	7.2	4.1	8.8	5.9	8.1
More than 12 years	6.5	*	7.4	7.6	5.5
Parity					
No live births	7.5	4.7	12.6	7.0	3.4
One live birth	5.8	9.3	3.6	4.7	7.4
Two live births	9.6	11.7	10.1	8.0	9.7
Three live births	4.1	14.3	-	0.5	*

[1]The results are based on contraceptive use intervals during which the woman was continuously married, but the woman need not have been married during the entire 3-year period covered by the study.

[2]Includes sterilization.

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