## Chapter II

# STANDARD COUPLE-YEARS OF PROTECTION

*Martin Gorosh* and David Wolfers***

It is now generally accepted that evaluation of national family planning programmes must be directed to determining achievements and assessing strategies on a number of levels, including the administrative, demographic, financial and political levels. Furthermore, the results of these assessments must be represented in a convenient form for annual or other appropriate periods. What a family planning programme accomplishes may be measured in many ways. For example, programme achievements may be represented by a mass of statistics on such topics as acceptors by age, parity and method; continuation rates, pregnancy rates, conversions between methods and so on. But in such cases, the larger the number of different indices displayed, the more hopeless becomes the task of drawing comparisons between years or between programmes.[1]

It was to overcome this problem of interpreting achievements from service statistics and clinical records that Wishik[2] introduced the concept of combining the incidence of long-term contraceptive methods with the prevalence of short-term methods into a single index known as couple-years of protection (CYP). This index summarizes the total achievement of a year's programme work into a single figure, satisfying at least some of the needs which demand such an assessment. For the most important tasks, however, it has very serious deficiencies.[3]

It cannot be used to compare successive years or different areas in terms of the impact of the programme on fertility. This limitation exists because, in terms of birth-preventing effect, the couple-years of protection summed to yield the accomplishment index are a mixture of many different values, specifically:

(*a*) Contraception by women of all different ages is given equal weight. Evidence suggests that contraceptive use by parous women under 18 years of age is about 17 times as productive in avoiding births as use by women over 43, with a steeply sliding scale between the groups.[4] Shifts in the age distribution of acceptors from year to year can therefore outweigh changes in the number of acceptors;

(*b*) The physiological state of women at the time of acceptance is not taken into account. In all programmes, it has been found that a large proportion of acceptors adopt contraception shortly after the birth of a child. Of these acceptors, a high proportion may not at the time of acceptance be susceptible to impregnation; they are in a state of post-partum amenorrhoea or anovularity. The first few months of use by such women are without birth-preventing value. There is, furthermore, great variation from time to time within programmes, and always between programmes in the importance of this consideration, particularly where post-partum programmes form different proportions of the total family planning programme effort. The basic assumption of the CYP methodology, that $x$ months of use by $y$ women is equivalent to $y$ months of use by $x$ women, is invalid where use in the post-partum state of anovularity is included in the sum;

(*c*) The quality of contraception is not taken into account. With pregnancy rates (use-effectiveness) varying from zero per 1,000 for sterilization to perhaps 400 per 1,000 in some circumstances for rhythm, one again sees that a shift in the contraceptive mix can be as significant as a change in contraceptive prevalence, or more so;

(*d*) Fertility levels, and thus fertility expectations, are not taken into account. There is wide variation not only between countries in fertility levels but within countries, usually on a rural-urban basis of division. Certainly for international comparison it is necessary to incorporate this parameter into calculations.

Are these four rather serious defects of the CYP methodology remediable? The present authors believe that they are and that within the limitations of the data usually available in such settings, it is possible to devise a

* Assistant Professor, Center for Population and Family Health, Columbia University, New York; and

** Consultant on Family Planning, Ministry of Health, Israel.

[1] This problem arises especially where statistics are not available to support evaluation of the demographic impact of the programme.

[2] Samuel M. Wishik, "Indexes for measurement of amount of contraceptive practice", (SD/Dem/AFPM/14) paper prepared for a meeting of the Expert Group on Assessment of Acceptance and Use-effectiveness of Family Planning Methods, Economic Commission for Asia and the Far East, Bangkok, 11–21 June 1968.

[3] Lee L. Bean and William Seltzer, "Couple years of protection and births prevented: a methodological examination", *Demography*, vol. 5, No. 2 (1968); pp. 947–959; C. Chandrasekaran and K. Srinivasan, "Evaluation of family planning programmes", in *Evaluation of Family Planning Programmes, Report of a Regional Seminar*, Bangkok, 24 November – 12 December 1969 (United Nations publication, Sales No. E.70.II.F.20), pp. 42–55; W. H. Mosley, "Application of demographic methods in population planning", *International Journal of Health Services*, vol. 3, No. 4 (1973), pp. 601–609.

[4] David Wolfers, "Birth averted: important unresolved problems", in *International Population Conference, Liège, 1973* (Liège, International Union for the Scientific Study of Population, 1974), vol. 2, pp. 233–245.

procedure which will yield a single summary figure to describe the annual accomplishment of a programme sufficiently accurately to serve all the purposes described above. What such an index cannot do, however, is to provide a predictor of the time pattern of demographic change that will follow from a year of programme activities. This value is precluded by the nature of the CYP index, which gives credit to the year assessed both for contraceptive use in that year and for the projected effects of the long-term contraceptive use (and sterilization) initiated in that year. The prediction of the time curve of demographic change is a different exercise not considered here.

### A. Standard couple-years of protection approach and formulation

The approach adopted is to express all contraceptive use in terms of a standard couple-year of protection (SCYP). The quantity, arbitrarily selected, is the perfect practice of a 100 per cent effective contraceptive method over a period of one susceptible year by a couple representative of a group with an expected fertility rate[5] of 400 per 1,000 women.

Simple, or crude, couple-years of protection (CCYP) are subjected to a series of modifications based on the age-specific fertility rate applicable during the time of use, the proportion of that time spent in a non-susceptible state, the probability that the user is sterile and the probability of pregnancy developing during use. The effect of these modifications is to render comparable, or commensurate, periods of contraceptive use by different women in different settings with different methods and to generate an index which measures programme accomplishment in a way which has appropriate significance for the objectives of a population programme and does not vary in significance over time and in place.

The data requirements for these computations are naturally more onerous than for the calculation of crude couple-years of protection, but they are not beyond the resources nor outside the routine data collection systems of the average national programme. In certain cases (most importantly, the incorporation of compensation for post-partum amenorrhoea on an age-specific basis), the use of standard tables is recommended. Although inaccuracy is inevitably introduced by such a procedure, the two alternatives, that of generating local data and that of omitting any correction for these factors, are very much less satisfactory. Local data on age-specific mean post-partum amenorrhoea (PPA) or of its age-specific distribution, are obtainable only after laborious long-term prospective studies which do not justify their expense by general utility, while the omission of any correction for post-partum amenorrhoea may, in the case of short periods of contraceptive use, lead to errors as high as 50 per cent. Any reasonably plausible schedule of correction is therefore likely greatly to enhance the accuracy of the calculations, and it is the authors' belief that the procedures recommended here for allowing for this factor are accurate within an error of about 20 per cent, i.e., they eliminate at least 80 per cent of the error that arises from neglect of this factor.

The procedures for calculating couple-years of protection (hereafter termed crude couple-years of protection or CCYP) are fully described in Wishik and Chen,[6] and illustrated in a recent United Nations publication.[7]

The general formula (not applicable to abortions and sterilizations) for transforming CCYP into SCYP is:

$$SCYP = \frac{E\left[CCYP\left(\frac{100-P}{100}\right)-\frac{NA}{12}\right]}{400}$$

The formula must be applied separately for each method and each age group within a method.

In this formula, $E$ is the expected fertility (see section B.1) so that $\frac{E}{400}$ standardizes the couple-year of protection for age and the prevailing fertility rates. If the expected fertility of the users in question is 400 per 1,000, i.e., standard, then each crude couple-year of protection is, as far as the fertility parameter is concerned, equivalent to one standard couple-year of protection. If, however, the expected fertility is only 200 per 1,000, the value of the protection for demographic purposes is halved and it requires two crude couple-years of protection to equal one standard couple-year of protection.

$P$ is the penalty applied for pregnancies and is related to the age-specific pregnancy rate for the method, expressed as a rate per 100 crude couple-years of protection.

$N$ is the number of new acceptors of specific age for a particular method during the year. Alhough continuing users of short-term contraceptive methods are included in the annual accounting, their number does not contribute to $N$.

$A$ is the allowance, in months per new acceptor, for overlap between contraceptive use and post-partum amenorrhoea.

$\frac{NA}{12}$ therefore yields the total period of overlap in years, which is subtracted from the CCYP values.

### B. Derivations

The methods by which $E$ (expected fertility), $P$ (penalty for pregnancy) and $A$ (allowance for overlap between contraceptive use and post-partum amenorrhoea) are derived are discussed below.

[5] For a definition of expected fertility rate, see section B. 1 below.

[6] Samuel M. Wishik and Kwan-hwa Chen, *Couple-Year of Protection: A Measure of Family Planning Program Output*, Manuals for Evaluation of Family Planning and Population Programs, No. 7 (New York, Columbia University, International Institute for the Study of Human Reproduction, 1973).

[7] *Methods of Measuring the Impact of Family Planning Programmes on Fertility: Problems and Issues* (United Nations publication, Sales No. E.78.XIII.2).

## 1. *Expected fertility*

The calculation of $E$[8] rests on a number of differences between the potential or expected fertility of a group of contraceptive acceptors or users and the age-specific marital fertility rates of the population from which they come.

Age-specific fertility rates are generated by the women giving birth at a given age. Women who do not give birth at that age cannot properly be assigned these rates. A group of contraceptive acceptors at age 30 would not, if they had not accepted contraception, have given birth at age 30; nor would they have exhibited the probabilities of miscarriage, stillbirth, live birth and sterility appropriate to and calculable for women aged 30. On average, they would have been subjected to the probabilities applicable to women aged 32 years—the average age that they would have attained when they next gave birth. This figure is, of course, only an average and the two-year differential will be seen to increase for older women and to decrease for younger women. To avoid complications, however, a general two-year discrepancy is computed. The first step in the calculation of expected fertility then is to obtain the age-specific marital fertility rate of women two years older than the group of acceptors. By far the simplest practical way of doing this task is to assemble acceptors in age groups two years younger than those for which age-specific marital fertility rates are available. Thus if, as is standard, rates are available for ages 15–19, 20–24, 25–29 etc., acceptors should be grouped 13–17, 18–22, 23–27 etc., with exact correspondence between the two sets of groups.

The second step is to discount, in the value for age-specific marital fertility rate, the contribution made by first births to elevating it above the level at which it corresponds to the notion of reciprocal duration per birth. As contraception is only rarely used in family planning programmes (in developing countries) to delay a first birth, and as the duration between marriage and first birth is very significantly shorter than for any inter-birth interval, the average duration, if calculated directly from age-specific marital fertility rates, is likely to be shorter than that which is properly applicable to contraceptive acceptors. A correction is applied based on the proportion, $N$, of all births at the appropriate age (age $j+2$ for acceptors at age $j$) that are first births. This correction has the value $\frac{3-N_{j+2}}{3}$ implying a duration per birth for first births of two thirds the length of others. This correction for births is clearly most important in the younger age groups.

The final correction to age-specific marital fertility rates is designed to eliminate the depressing effects of sterility, on the reasonable assumption that contraception will be accepted primarily by women who have had recent evidence of their continued fertility. This correction consists of the division of age-specific marital fertility rates by the proportion of non-sterile $(1-S_j)$ at the time of acceptance. These values must necessarily be taken from standard tables, for there are almost no contemporary useful data. Table 34 is derived from the work of Henry,[9] which is suggested as the most useful source.

TABLE 34. STANDARD DISTRIBUTIONS OF PROPORTION OF STERILE WOMEN BY AGE

| $S_i$ | *Age group* |
|---|---|
| 0.03 | 13–17 |
| 0.03 | 18–22 |
| 0.06 | 23–27 |
| 0.10 | 28–32 |
| 0.16 | 33–37 |
| 0.31 | 38–42 |
| 0.60 | 43–47 |
| 0.98 | 48+ |

SOURCE: Derived from Louis Henry, "Some data on natural fertility", *Eugenics Quarterly*, vol. VIII, No. 2 (1961), pp. 81–91.

The sterility correction is most important for older age groups. The final formula for $E$ is:

$$E_j = \frac{B_{j+2}(3-N_{j+2})}{3(1-S_j)}$$

where $B_{j+2}$ = marital fertility rate, age $j+2$
$N_{j+2}$ = proportion of births at age $j+2$ which are first births;
$S_j$ = proportion of women at age $j$ who are sterile.

Where data on acceptors are available only grouped in conventional age groups, a process of interpolation may be used to reassemble them into the groups required—13–17, 18–22, 23–27 etc.[10]

## 2. *Penalty for pregnancy*

The calculation of $P$, the penalty for pregnancy, is based on the work of Potter,[11] who showed that each pregnancy occurring during contraceptive use "wasted" a period of use equivalent (in the absence of contraception) to the mean period of ovulatory exposure required to yield one pregnancy. To obtain this value, it is necessary first to change expected fertility into duration per birth in months—$\left(\frac{12{,}000}{E}\right)$ and then deduct from it nine months for pregnancy, the appropriate duration of post-partum amenorrhoea (section B.3) and an allowance ($F$) for the contribution of foetal loss to duration per birth. The remainder is the desired penalty; i.e., the mean exposure time required to become pregnant.

[8] This method was originally published in D. Wolfers, *loc. cit.*

[9] Louis Henry, "Some data on natural fertility", *Eugenics Quarterly*, vol. VIII, No. 2 (1961), pp. 81–91.

[10] This process is fully described in Martin Gorosh and David Wolfers, *Standard Couple-Years of Protection: A Methodology for Program Assessment*, Manuals for Evaluation of Family Planning and Population Programs, No. 10 (New York, Columbia University, Center for Population and Family Health, 1977).

[11] Robert G. Potter, "Estimating births averted in a family planning program", in S. J. Behrman, Leslie Corsa, Jr. and Ronald Freedman, eds., *Fertility and Family Planning; A World View* (Ann Arbor, University of Michigan Press, 1969), pp. 413–434.

$$\text{Thus, ovulatory exposure} = \frac{12{,}000}{E} - 9 - PPA - F$$

and the penalty for pregnancies is

$$P_j = \frac{PR_j}{100\,CCYP} \times \frac{\left[\frac{12{,}000}{E} - 9 - PPA_j - F_j\right]}{12} LBP_j$$

where $\frac{PR_j}{100\,CCYP}$ = pregnancy rate per 100 $CCYP$ at age $j$; and $LBP_j$ = proportion of pregnancies at age $j$ expected to proceed to a live birth.

Tables 35 and 36 give standard distributions of values of $F_j$ and $LBP_j$. Table 35 is derived from direct observation of the differences between live-birth intervals at Guayaquil, Ecuador.[12]

TABLE 35. STANDARD DISTRIBUTION OF CONTRIBUTION OF FOETAL LOSS TO DURATION PER BIRTH BY AGE

| *Age group* | *Months contributed* |
|---|---|
| 13–17 | 0.9 |
| 18–22 | 1.5 |
| 23–27 | 1.9 |
| 28–32 | 2.8 |
| 33–37 | 3.0 |
| 38–42 | 3.3 |
| 43+ | 3.3 |

SOURCE: David Wolfers and Susan Scrimshaw, *Child Survival and Interval Between Births in Guayaquil, Ecuador* (New York, Columbia University, International Institute for the Study of Human Reproduction, 1975).

NOTE: For derivation of tables, see foot-note 12 and tables 37–39.

TABLE 36. STANDARD DISTRIBUTION OF LIVE-BIRTH PROPORTION BY AGE

| *Age group* | *Proportion of live births* |
|---|---|
| 13–17 | 0.833 |
| 18–22 | 0.818 |
| 23–27 | 0.805 |
| 28–32 | 0.791 |
| 33–37 | 0.777 |
| 38–42 | 0.765 |
| 43 + | 0.752 |

SOURCE: Louis Henry, "Some data on natural fertility", *Eugenics Quarterly*, vol. VIII, No. 2 (1961), pp. 81–91.

### 3. *Overlap with post-partum amenorrhoea*

To make an accurate estimate of overlap between contraceptive use and post-partum amenorrhoea (which is contraceptive waste-time), it is necessary to know not only the distribution of acceptors by open interval to acceptance (i.e., delivery-to-acceptance intervals) but the age-specific distribution of the duration in months of post-partum amenorrhoea in the population. The latter distributions are so rarely available and so difficult to collect that it is necessary almost everywhere to simulate them. To do this task, one value must be known or estimated, and that value is the mean period in months of post-partum amenorrhoea for the population. Given this value, one then wants to know the mean for each separate age group, which is provided in table 37.

Next, taking each age group with its specific mean, one obtains the distribution of post-partum amenorrhoea durations from table 38.

From these two distributions a very accurate estimate of overlap with post-partum amenorrhoea can be made by using the method described by Wolfers.[13] Since this calculation is tedious (with many different calculations of overlap being needed to account for the age-specific distribution of post-partum anovularity, the method-specific distribution of open interval to acceptance, and the method-specific continuation rate), an abbreviated method is required. This abbreviated method is described below in section E. Its use requires reference to table 39.

The next step is to adjust the number of months of overlap between post-partum amenorrhoea and contraceptive use for discontinuation taking place prior to the end of post-partum amenorrhoea. This procedure is achieved by obtaining the continuation rate for the method for month $\frac{M}{2}$, where $M$ is the mean post-partum amenorrhoea used for the calculation of overlap. (The continuation rate for month $\frac{M}{2}$ is an estimate of the point in time at which one half of the acceptors under consideration discontinue.) The number of months of overlap

[12] David Wolfers and Susan Scrimshaw, *Child Survival and Interval Between Births in Guayaquil, Ecuador* (New York, Columbia University, International Institute for the Study of Human Reproduction, 1975). In the course of this analysis, intervals were computed by age of mother at delivery of the later child, separately restricted by the condition that both pregnancies demarcating the interval should have terminated in live births and for intervals of which only the later pregnancy was required to fulfil this condition. The former set of intervals therefore included, and the latter set excluded, intervals with intervening foetal loss. The difference in months by age of mother between the means of the two types of intervals as found in this population are shown below in the original table (intervals being "termination-to-conception" intervals):

DIFFERENCE IN MONTHS BY AGE OF MOTHER BETWEEN LIVE-BIRTH AND PREGNANCY-TO-LIVE-BIRTH INTERVAL

| *Age* (1) | *Live-birth intervals* (2) | *Pregnancy-live-birth intervals* (3) | *Difference* (4) |
|---|---|---|---|
| 15 | 15.5 | 15.1 | 0.4 |
| 15–19 | 12.4 | 11.5 | 0.9 |
| 20–24 | 17.3 | 15.8 | 1.5 |
| 25–29 | 20.2 | 18.3 | 1.9 |
| 30–34 | 24.1 | 21.3 | 2.8 |
| 35–39 | 26.2 | 23.2 | 3.0 |
| 40–45 | 27.4 | 24.1 | 3.3 |

[13] David Wolfers, "Contraceptive overlap with post-partum anovularity", *Population Studies*, vol. XXII (1971), p. 535–536; and *idem*, "Births averted", in C. Chandrasekaran and Albert I. Hermalin, eds., *Measuring the Effect of Family Planning Programs on Fertility*, published by the International Union for the Scientific Study of Population for the Development Centre of the Organisation for Economic Co-operation and Development (Dolhain, Belgium, Ordina Editions, 1975), pp. 163–214.

is multiplied by the continuation rate to obtain the mean overlap per acceptor, specific for method continuation and mean post-partum amenorrhoea for age.

To obtain the continuation rate for month $\frac{M}{2}$, the following procedure is used:

(*a*) If life-table continuation rates are available, where $M$ is an even number of months, read off the cumulative continuation rate for month $\frac{M}{2}$. Where $M$ is an odd number, just read off the cumulative continuation rates for months $\frac{(M-1)}{2}$ and $\frac{(M+1)}{2}$, sum them and divide by two;

TABLE 37. STANDARD DISTRIBUTION OF AGE-SPECIFIC MEAN POST-PARTUM AMENORRHOEA BY GENERAL MEAN POST-PARTUM AMENORRHOEA

(*Months*)

| *Age group* | *General mean* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* |
| 13–17 | 3 | 3 | 3 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 12 |
| 18–22 | 3 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 13 |
| 23–27 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 14 | 14 |
| 28–32 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 14 | 14 |
| 33–37 | 5 | 8 | 9 | 10 | 11 | 12 | 13 | 13 | 14 | 14 | 14 | 14 |
| 38–42 | 6 | 9 | 10 | 11 | 12 | 13 | 14 | 14 | 14 | 14 | 14 | 14 |
| 43 + | 6 | 9 | 10 | 11 | 12 | 13 | 14 | 14 | 14 | 14 | 14 | 14 |

SOURCE: Based on pattern of increase given in Anrudh K. Jain and others, "Demographic aspects of lactation and postpartum amenorrhoea", *Demography*, vol. 7, No. 2 (May 1970), pp. 255–271.

*Note*: Post-partum amenorrhoea increases with maternal age. Jain and others show that the increase is about two months for each five years of age between ages 20 and 35 and one month for each five years thereafter. Taking the age distribution of mothers at the time of birth of their children in eight countries in Africa, Asia, Latin America and the Middle East, means were disaggregated according to this pattern of increase. Although the distributions of births by mothers' ages differed greatly among countries, the age distributions of post-partum amenorrhoea (rounded to whole number of months) were identical for all the countries considered. Table 37 gives the results of this exercise, constrained so that no mean age-specific post-partum amenorrhoea would be less than three or more than 14 months.

TABLE 38. STANDARD DISTRIBUTION OF PROPORTION PER 1 000 POPULATION OVULATING, BY NUMBER OF MONTHS AFTER DELIVERY, BY MEAN MONTHS OF POST-PARTUM AMENORRHOEA

| *Month* | *Mean months of post-partum amenorrhoea* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* |
| 2 | 444 | 250 | 160 | 111 | 82 | 63 | 49 | 40 | 33 | 28 | 24 | 20 |
| 3 | 740 | 500 | 352 | 259 | 199 | 157 | 126 | 104 | 87 | 74 | 64 | 55 |
| 4 | 888 | 688 | 525 | 407 | 324 | 262 | 216 | 181 | 153 | 132 | 115 | 100 |
| 5 | 954 | 813 | 663 | 539 | 443 | 367 | 309 | 263 | 225 | 196 | 172 | 151 |
| 6 | 981 | 891 | 767 | 649 | 549 | 466 | 399 | 345 | 299 | 263 | 233 | 206 |
| 7 | 992 | 938 | 842 | 737 | 640 | 555 | 483 | 424 | 372 | 330 | 295 | 263 |
| 8 | 996 | 965 | 894 | 805 | 716 | 633 | 560 | 497 | 441 | 395 | 356 | 320 |
| 9 | 998 | 981 | 930 | 857 | 778 | 700 | 628 | 564 | 506 | 457 | 415 | 376 |
| 10 | 999 | 990 | 954 | 896 | 828 | 756 | 688 | 624 | 566 | 515 | 471 | 430 |
| 11 | | 995 | 970 | 925 | 868 | 803 | 739 | 678 | 620 | 569 | 524 | 481 |
| 12 | | 998 | 981 | 946 | 899 | 842 | 783 | 725 | 669 | 618 | 573 | 529 |
| 13 | | 999 | 988 | 961 | 923 | 874 | 820 | 766 | 713 | 663 | 618 | 574 |
| 14 | | 1 000 | 993 | 972 | 942 | 900 | 851 | 802 | 752 | 704 | 659 | 616 |
| 15 | | | 996 | 980 | 956 | 921 | 877 | 833 | 786 | 740 | 697 | 655 |
| 16 | | | 998 | 986 | 967 | 938 | 899 | 859 | 816 | 772 | 731 | 690 |
| 17 | | | 999 | 990 | 975 | 951 | 917 | 882 | 842 | 801 | 762 | 722 |
| 18 | | | 1 000 | 993 | 981 | 962 | 932 | 901 | 865 | 827 | 790 | 751 |
| 19 | | | | 995 | 986 | 970 | 944 | 917 | 885 | 850 | 815 | 778 |
| 20 | | | | 997 | 990 | 977 | 954 | 931 | 902 | 870 | 837 | 802 |
| 21 | | | | 998 | 993 | 982 | 962 | 943 | 917 | 887 | 857 | 824 |
| 22 | | | | 999 | 995 | 986 | 969 | 953 | 930 | 902 | 875 | 844 |
| 23 | | | | 1 000 | 997 | 989 | 975 | 961 | 941 | 915 | 891 | 862 |
| 24+ | | | | | 1 000 | 1 000 | 1 000 | 1 000 | 1 000 | 1 000 | 1 000 | 1 000 |

SOURCE: Derived from J. C. Barrett, "A Monte-Carlo simulation of human reproduction", *Janus* (France), vol. 25 (1969), pp. 1–22; and Robert G. Potter and G. S. Masnick, "The contraceptive potential of early versus delayed insertion of the intrauterine device", *Demography*, vol. 8, No. 4 (November 1971), pp. 507–517. For mean months of post-partum amenorrhoea, see table 37.

*Note*: Following Barrett and also Potter and Masnick, Pascal distributions were fitted to mean post-partum amenorrhoeas so that the proportion experiencing exactly $n+1$ months of anovularity was:

$$n\left(\frac{2}{a}\right)^2\left(1-\frac{2}{a}\right)^{n-1}$$

where $a$ = mean post-partum amenorrhoea in months. Table 38 shows these proportions cumulated to give the proportion ovulating by month after delivery.

TABLE 39. VALUES OF $\Sigma Z_i$ BY MONTH AND MEAN POST-PARTUM AMENORRHOEA WHERE $Z_i$ IS PROPORTION OVULATING $i$ MONTHS AFTER DELIVERY

| Month | Mean post-partum amenorrhoea value | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | 8.992 | 11.008 | 14.012 | 18.002 | 18.031 | 17.054 | 16.080 | 15.193 | 14.320 | 13.508 | 12.774 | 12.049 |
| 2 | 8.992 | 11.008 | 14.012 | 18.002 | 18.031 | 17.054 | 16.080 | 15.193 | 14.320 | 13.508 | 12.774 | 12.049 |
| 3 | 8.548 | 10.758 | 13.852 | 17.891 | 17.949 | 16.991 | 16.031 | 15.153 | 14.287 | 13.480 | 12.750 | 12.029 |
| 4 | 7.808 | 10.258 | 13.500 | 17.632 | 17.750 | 16.834 | 15.905 | 15.049 | 14.200 | 13.406 | 12.686 | 11.974 |
| 5 | 6.920 | 9.570 | 12.975 | 17.225 | 17.426 | 16.572 | 15.689 | 14.868 | 14.047 | 13.274 | 12.571 | 11.874 |
| 6 | 5.966 | 8.757 | 12.312 | 16.686 | 16.983 | 16.205 | 15.380 | 14.605 | 13.822 | 13.078 | 12.399 | 11.723 |
| 7 | 4.985 | 7.866 | 11.545 | 16.037 | 16.434 | 15.739 | 14.981 | 14.260 | 13.523 | 12.815 | 12.166 | 11.517 |
| 8 | 3.993 | 6.928 | 10.703 | 15.300 | 15.794 | 15.184 | 14.498 | 13.836 | 13.151 | 12.485 | 11.871 | 11.254 |
| 9 | 2.997 | 5.963 | 9.809 | 14.495 | 15.078 | 14.551 | 13.938 | 13.339 | 12.710 | 12.090 | 11.515 | 10.934 |
| 10 | 1.999 | 4.982 | 8.879 | 13.638 | 14.300 | 13.851 | 13.310 | 12.775 | 12.204 | 11.633 | 11.100 | 10.558 |
| 11 | 1.000 | 3.992 | 7.925 | 12.742 | 13.472 | 13.095 | 12.622 | 12.151 | 11.638 | 11.118 | 10.629 | 10.128 |
| 12 | | 2.997 | 6.955 | 11.817 | 12.604 | 12.292 | 11.883 | 11.473 | 11.018 | 10.549 | 10.105 | 9.647 |
| 13 | | 1.999 | 5.974 | 10.871 | 11.705 | 11.450 | 11.100 | 10.748 | 10.349 | 9.931 | 9.532 | 9.118 |
| 14 | | 1.000 | 4.986 | 9.910 | 10.782 | 10.576 | 10.280 | 9.982 | 9.636 | 9.268 | 8.914 | 8.544 |
| 15 | | | 3.993 | 8.938 | 9.840 | 9.676 | 9.429 | 9.180 | 8.884 | 8.564 | 8.255 | 7.928 |
| 16 | | | 2.997 | 7.958 | 8.884 | 8.755 | 8.552 | 8.347 | 8.098 | 7.824 | 7.558 | 7.273 |
| 17 | | | 1.999 | 6.972 | 7.917 | 7.817 | 7.653 | 7.488 | 7.282 | 7.052 | 6.827 | 6.583 |
| 18 | | | 1.000 | 5.982 | 6.942 | 6.866 | 6.736 | 6.606 | 6.440 | 6.251 | 6.065 | 5.861 |
| 19 | | | | 4.989 | 5.961 | 5.904 | 5.804 | 5.705 | 5.575 | 5.424 | 5.275 | 5.110 |
| 20 | | | | 3.994 | 4.975 | 4.934 | 4.860 | 4.788 | 4.690 | 4.574 | 4.460 | 4.332 |
| 21 | | | | 2.997 | 3.985 | 3.957 | 3.906 | 3.857 | 3.788 | 3.704 | 3.623 | 3.530 |
| 22 | | | | 1.999 | 2.992 | 2.975 | 2.944 | 2.914 | 2.871 | 2.817 | 2.766 | 2.706 |
| 23 | | | | 1.000 | 1.997 | 1.989 | 1.975 | 1.961 | 1.941 | 1.915 | 1.891 | 1.862 |
| 24 | | | | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

SOURCE: Table 39 is obtained directly from table 38 by reverse cumulation of values, i.e., from the bottom of table 38 upwards.

(*b*) Where only continuation rates for, say, month $a$ $\left(\text{being less than } \frac{M}{2}\right)$ and month $n$ $\left(\text{being greater than } \frac{M}{2}\right)$ are available, divide the $n^{\text{th}}$ continuation rate by the $a^{\text{th}}$ continuation rate, take the $\left(\frac{\frac{M}{2}-a}{n-a}\right)^{\text{th}}$ power of the quotient (using logarithm tables or a modern calculator) and multiply this power by the $a^{\text{th}}$ continuation rate:

$$R_{\left(\frac{M}{2}\right)} = R_a \left(\frac{R_n}{R_a}\right)^{\left(\frac{\frac{M}{2}-a}{n-a}\right)}$$

This formula can be illustrated with the data from table 53, row 1 (see section E.3). Continuation is known to be 0.799 at one month (i.e. $a = 1$) and 0.739 at two months (i.e., $n = 2$). With $M = 3$, then

$$R_{3/2} = 0.799\left(\frac{0.739}{0.799}\right)^{\left(\frac{3/2-1}{2-1}\right)}$$

$$\text{so} \quad R_{1.5} = 0.799\ (0.925)^{0.5}$$
$$R_{1.5} = 0.769$$

Thus, continuation as of 1.5 months is 0.769;

(*c*) Where only one continuation rate for any month $n$ $\left(\text{whether greater or less than } \frac{M}{2}\right)$ is available, take the $\left(\frac{M}{2n}\right)^{\text{th}}$ power of the $n$th month continuation rate as the $\left(\frac{M}{2}\right)^{\text{th}}$ month continuation rate, this rate is expressed as:

$$R_{\frac{M}{2}} = Rn^{\frac{M}{2n}}$$

To illustrate, suppose one knows that continuation is 0.552 at eight months (i.e., $n = 8$). With $M = 11$, then:

$$R_{11/2} = 0.552^{\frac{11}{(2)(8)}}$$

$$\text{so} \quad R_{5.5} = 0.665$$

Thus, continuation as of 5.5 months is 0.665.

## C. Birth control methods

### 1. *Classes of methods*

For the purposes of computing couple-years of protection, birth control methods are classified into four types: recurrent; semi-permanent; permanent; and abortion. Recurrent methods are those for which each prescription is effective only for a limited period of time or number of coitions, e.g., oral contraceptives, condoms, spermicides or injections. Semi-permanent methods are those for which use begins with a single acceptance and supply and which are then assumed to continue for a period of time thereafter as estimated from client follow-up data of some type, e.g., intra-uterine devices (IUD), rhythm or diaphragm. Permanent methods are those which cannot be reversed save by surgical means, e.g., male and female sterilization.

### 2. *Computation of crude couple-years and standard couple-years of protection for classes of methods*

The computation of CCYP with recurrent methods is made by using the quantities distributed (to users not retailers) during the year as the primary source of data. Estimates are made of the proportions of each device or medicament that are wasted, that is to say, dispensed but not used, and of the mean length of time for which each prescription gives protection. From these three quantities, the total number of couple-years of protection provided is computed.

For the semi-permanent methods, apart from the number of persons adopting the method during the year, the essential quantity required is the mean duration of use. In the original CYP manual, use of the median duration for certain methods was recommended; but no unique advantage attaches to this procedure and it is suggested that mean duration of use be computed for all methods in this class. This value is calculated from life tables of continuation based on data derived usually from surveys.

The simplest available formula for calculating mean duration of use ($M$) is $M = a/r$, where $a$ is the proportion of devices retained (or adopters still practicing) "initially", and $r$ the (presumed constant) annual rate of attrition thereafter.

The quantity $r$ is obtained from $R(t_2)/R(t_1) = e^{(t_1-t_2)r}$, $R(t_2)$ being the proportion retained at time $t_2$ after insertion, either one year[14] or two years[15] or other appropriate duration; and $R(t_1)$ is the proportion retained after a shorter duration $t_1$ (not zero months), either one month[16] or six months[17] or other appropriate duration. The quantity $a$ is then obtained from $a = e^{rt_1}[R(t_1)]$. Simple methods of performing these calculations are presented in Gorosh and Wolfers.[18]

Note that for age specificity of fertility expectation in SCYP calculations, the ages of acceptors of these three methods should be increased by $\frac{M}{2}$ years to ensure that the most appropriate fertility expectations shall be employed. (With $M$ denoting mean duration of use, this correction helps reflect the age at which most use actually occurs.) Whole numbers only should be considered.

Thus, where age data are available by single years of

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[14] S. M. Wishik and K. H. Chen, *op. cit.*

[15] Robert G. Potter, "A technical appendix on procedures used in manuscript 'Estimating births averted in a family planning program'", paper prepared for Major Ceremony V, University of Michigan Sesquicentennial Celebration, 1 June 1967.

[16] S. M. Wishik and K. H. Chen, *op. cit.*

[17] R. G. Potter, "A technical appendix on procedures . . .".

[18] *Op. cit.*, p. 8.

age, if $M = 2.5$ years, the acceptors should be assigned fertility rates applicable after $2.5/2 = 1$ year of use. Then, instead of using age groups 13–17, 18–22, 23–27 etc., use groups 12–16, 17–21, 22–26 etc. to correspond to age-specific marital fertility rates at 15–19, 20–24, 25–29 etc.

To avoid excessive complexity, only one uniform age shift should be made, applicable to all age groups and based on the mean duration of use ($M$) for the entire batch of acceptors of each method.

Standard couple-years of protection for permanent methods (sterilization) are calculated directly without an intervening calculation of CCYP. Although this method alters the symmetry of calculations, the authors believe that it is the most straightforward approach to handling sterilizations. CCYP may be derived from SCYP if there is a need to present programme achievement in terms of CCYP:

$$SCYP = \sum \frac{E_i \text{ (total)}}{0.4} \times N_i$$

where $N$ = number of acceptors in age group $i$;
0.4 = standard future births averted per woman per year;
$E_i$ (total) = total future expected fertility of an acceptor in age group $i$.

$E_i$ (total) is the key to the SCYP approach for sterilization. For each age group at acceptance, the estimated future fertility of one woman in that age group is computed by "aging" the woman through 45 and in so doing subjecting her serially to the remaining age-specific "expected" fertility rates modified by the probability that both the woman and her husband will survive to the next age group. Because the age-specific values of $E$ are obtained from a formula that rests on the assumption that all women are fertile at the time they adopt a fertility regulating method, it is necessary to compensate for this factor in assessing a long-term method. $E$(total) is therefore computed from $E_j$ values multiplied by $(1 - S_j)$, the whole being divided by the sterility proportion applicable to the age at sterilization. The formula for $E_i$ (total) is:

$$E_i \text{ (total)} = \frac{2.5\, E_i (1 - S_i)(P'_{i-i+5} \cdot P''_{i+5-i+10}) + 5 \sum_{j=i+5}^{j=48+} E_j (1 - S_j)(P'_{j-j+5} \cdot P''_{j+5-j+10})}{1{,}000(1 - S_i)}$$

where $P'_{j-j+5}$ = probability of a female dying between the ages $j$ and $j+5$;
$P''_{j+5-j+10}$ = probability of a male dying between ages $j+5$ and $j+10$.

The result is the expected fertility averted as a consequence of the sterilization. This quantity (births averted) is divided by 0.4 to obtain the number of standard couple-years of protection provided to each acceptor in the particular age group. This number multiplied by the total acceptors in each age group equals the total number of standard couple-years of protection for all acceptors in the age group.

Adjustments for overlap between sterilization and post-partum amenorrhoea and for the post-vasectomy fertile period are accomplished by appropriately reducing the exposure time of the couple under the expected fertility rate for the wife's age as of sterilization (i.e., by varying the figure 2.5 (years) in the first term of the equation).

The SCYP approach for abortion is based on the differences between abortion and delivery as they affect certain components of the duration per birth:

(*a*) Duration per birth $= \frac{12{,}000}{E}$ months

(*b*) Duration per abortion = the duration per birth minus the differences in gestation and post-partum amenorrhoea associated with births and abortions, respectively;

(*c*) Duration per abortion = CCYP per abortion, which, when modified by expected fertility, live-birth proportion and the standard, equals SCYP per abortion or:

$$\text{CCYP per abortion} = \frac{\frac{12{,}000}{E} - [(GD_B - GD_A) + (PPA_B - PPA_A)]}{12}$$

and SCYP per abortion = CCYP per abortion $\times \frac{E}{400} \times \frac{LBP + 1}{2}$

Where $\frac{12{,}000}{E}$ = duration per birth;
$GD_B$ = gestation duration, birth (nine months);
$GD_A$ = gestation duration, abortion (two or three months);
$PPA_B$ = post-partum amenorrhoea, birth;
$PPA_A$ = post-partum amenorrhoea, abortion (one month);
$E$ = expected fertility;
$LBP$ = live-birth proportion.

## D. Data requirements and sources

For the calculation of programme achievement in terms of standard couple-years of protection, reasonably accurate knowledge of certain data is essential. These data requirements and their sources are given in table 40.

## E. Application

This section is intended to illustrate the steps to be followed in applying the SCYP method. The illustration is based on actual data on population characteristics and oral contraceptive acceptors from Country B.

### 1. *Data base*

*New acceptors of oral contraceptives by age*

The age distribution of new acceptors of oral contraceptives is as follows:

| *Age group* | *New acceptors* |
|---|---|
| 13–17 | 396 |
| 18–22 | 3 737 |
| 23–27 | 6 002 |
| 28–32 | 4 851 |
| 33–37 | 2 265 |
| 38–42 | 1 189 |
| 43–47 | 321 |
| 48 + | 94 |
| TOTAL | 18 855 |

*Population characteristics*

The data on population characteristics are:

(*a*) Mean population post-partum amenorrhoea equals six months, based on data for Thailand;[19]

[19] Jeroen K. Van Ginneken, "Prolonged breastfeeding as a birth-spacing method", *Studies in Family Planning*, vol. 5, No. 6 (June 1974), pp. 200–206.

TABLE 40. DATA REQUIRED TO CALCULATE PROGRAMME ACHIEVEMENT

| *Data requirements* | *Sources of data* |
|---|---|
| 1. Distribution of acceptors by method and age of wife at acceptance | 1. Should be available from routine service statistics. If age data are not available, they can be obtained by sample survey. Efforts should be made to obtain age data by single year of age. |
| 2. Acceptors by open interval at acceptance | 2. Either by routine statistics or by sample survey. It is desirable that this item be made specific, where possible, for method and age. |
| 3. One-month and 12-month (or similar pair of observations) continuation rates for semi-permanent methods of contraception | 3. Follow-up studies are required to determine continuation rates for intra-uterine device, diaphragm (if used) and rhythm. |
| 4. "Wastage" proportions of recurrent methods of contraception together with an estimate of continuation rate at least at one point in time. (Coital frequency by age may be used as a less satisfactory alternative) | 4. See procedure described above in section C and in sources given at end of table. |
| 5. Quantities of recurrent contraceptives provided to intending users | 5. Routine service statistics. |
| 6. Age-specific marital fertility rates (ASMFR) | 6. Calculated from statistics frequently provided by government statistical departments. Where only age-specific fertility rates (ASFR) are available, they may be combined with most recent census data on proportion of women married by age to give marital fertility rates i.e., ASFR ÷ proportion married in age group = ASMFR. |
| 7. Proportions of births that are first births by age of mother | 7. May be available from government statistics (if birth registration is well observed and records age of mother and birth order of child). Otherwise, they may be rapidly computed by numerator analysis of a sample of births from hospital records (e.g., labour-ward books). |
| *Additionally required data that may be derived from local sources or "borrowed" from standards available in the literature* | |
| 8. Age-specific mortality rates or, preferably, recent mortality life table | 8. Government statistical record. Where no figures are available, the appropriate model life table should be used (see end of this table). |
| 9. Mean duration of post-partum amenorrhoea | 9. Not generally available. A number of values for different populations have been published (see end of table) and estimates may be made on judgement, taking into account breast-feeding habits. Accurate measurement is a complex and expensive task involving prospective study of a national sample of births. |
| 10. Age-specific mean durations of post-partum amenorrhoea | 10. Use table 37[a] in the absence of survey data. |
| 11. Distribution of durations of post-partum amenorrhoea | 11. Use table 38[a] in the absence of survey data. |
| 12. Pregnancy rates by method and age | 12. If available, use life-table results from programme. Where not available, use method-specific rates from literature (see end of table). |
| 13. Ages of husbands of sterilization acceptors at acceptance | 13. Should be available in routine records and may easily be added. As a stopgap may be simulated by adding mean husband-wife age difference to wife's age. |
| 14. Age-specific prevalence of female sterility | 14. Use table 34. |
| 15. Contributions of foetal loss to duration per birth by age of woman | 15. Use table 35.[a] |
| 16. Proportion of (diagnosable) pregnancies proceeding to live births by age of mother | 16. Use table 36 in the absence of survey data. |

SOURCES: For No. 4, Martin Gorosh and David Wolfers, *Standard Couple-Years of Protection: A Methodology for Program Assessment*, Manuals for Evaluation of Family Planning and Population Programs, No. 10 (New York, Columbia University, Center for Population and Family Health, 1977); and Jeroen K. Van Ginneken, "Prolonged breastfeeding as a birth-spacing method", *Studies in Family Planning*, vol. 5, No. 6 (June 1974), pp. 200–206. For No. 7, R. T. Ravenholt and H. Frederiksen, "Numerator analysis of fertility patterns", *Public Health Reports*, No. 83 (June 1968), pp. 449–458. For No. 8, *Manual IV. Methods of Estimating Basic Demographic Measures from Incomplete Data* (United Nations publication, Sales No. E.67.XIII.2). For No. 9, J. K. Van Ginneken, *loc. cit.* For No. 12, Frederick S. Jaffe, "Commentary: some policy and program implications of 'Contraceptive failure in the United States'", *Family Planning Perspectives*, vol. 5, No. 3 (Summer 1973), pp. 143–144; K. Kanagaratnam and Khoo Chian Kim, "Singapore: the use of oral contraceptives in the national program", *Studies in Family Planning*, vol. 1, No. 48 (1969), pp. 1–9; Norman B. Ryder, "Contraceptive failure in the United States", *Family Planning Perspectives*, vol. 5, No. 3 (Summer 1973), pp. 133–144; Christopher Tietze and Sarah Lewit, "The IUD and the pill: extended use-effectiveness", *Family Planning Perspectives*, vol. 3, No. 2 (April 1971), pp. 53–55.

[a] For derivations of tables, see foot-note 12 and tables 37–39.

TABLE 41. OPEN INTERVAL TO ACCEPTANCE, ORAL CONTRACEPTIVES

| | Months | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 15 | 18 | 24+ |
| Oral contraceptives.......... | 0.2 | 0.01 | 0.03 | 0.01 | | 0.2 | | 0.1 | | 0.05 | 0.1 | 0.05 | 0.05 | 0.2 |

(*b*) With respect to open interval to acceptance, oral contraceptives were assigned a hypothetical distribution as shown in table 41;

(*c*) Age-specific marital fertility rates using unpublished data for Country B are as shown in table 42;

(*d*) Proportion of births that are first births, by age of mother, are given in table 43.

TABLE 42. AGE-SPECIFIC MARITAL FERTILITY RATE PER 1 000 WOMEN

| *Age group* | *Fertility rate* |
|---|---|
| 15–19 | 609 |
| 20–24 | 452 |
| 25–29 | 331 |
| 30–34 | 209 |
| 35–39 | 121 |
| 40–44 | 58 |
| 45–49 | 11 |

SOURCE: Unpublished data of David Wolfers, 1966.

TABLE 43. PROPORTION OF FIRST BIRTHS, BY AGE OF MOTHER

| *Age group* | *Proportion of first births* |
|---|---|
| 15–19 | 0.745 |
| 20–24 | 0.472 |
| 25–29 | 0.222 |
| 30–34 | 0.069 |
| 35–39 | 0.017 |
| 40–44 | 0.010 |
| 45–49 | 0.0 |

SOURCE: David Wolfers, ed., *Postpartum Intra-uterine Contraception in Singapore* (Amsterdam, Excerpta Medica Foundation, 1970).

*Rates*

Pregnancy and continuation rates are given in tables 44 and 45.

TABLE 44. PREGNANCY RATE BY AGE, ORAL CONTRACEPTIVES

| *Age group* | *Pregnancy rate* |
|---|---|
| 13–17 | 9.00 |
| 18–22 | 9.00 |
| 23–27 | 7.00 |
| 28–32 | 4.50 |
| 33–37 | 1.00 |
| 38–42 | 1.00 |
| 43 + | 1.00 |

SOURCE: K. Kanagaratnam and Khoo Chian Kim, "Singapore: the use of oral contraceptives in the national program", *Studies in Family Planning*, vol. 1, No. 48 (December 1969), pp. 1–9.

TABLE 45. CONTINUATION RATES, ORAL CONTRACEPTIVES

| *One month* | *Six months* | *Twelve months* | *Eighteen months* |
|---|---|---|---|
| 0.799 | 0.627 | 0.531 | 0.448 |

SOURCE: K. Kanagaratnam and Khoo Chian Kim, "Singapore: the use of oral contraceptives in the national program", *Studies in Family Planning*, vol. 1, No. 48 (December 1969), pp. 1–9.

*Quantities of oral contraceptives distributed*

It is reported that 233, 176 cycles of oral contraceptives were distributed.[20]

*Sample data*

On the basis of hypothetical sample data, oral contraceptive wastage amounted to 1,392 cycles wasted out of 25,277 cycles distributed.

*Standard data*

Standard data, such as proportion of women becoming sterile by age, contribution of foetal loss to duration per birth, live-birth proportion and overlap with post-partum amenorrhoea, were taken from tables 34–39 in section B.

2. *Expected fertility*

The first step in applying SCYP methodology is the calculation of $E$, or the expected fertility of acceptors (table 46), as follows:

$$E_j = \frac{B_{j+2}(3 - N_{j+2})}{3(1 - S_j)}$$

TABLE 46. EXPECTED FERTILITY ($E$) OF ACCEPTORS

| *Age group* (1) | $B_{j+2}$ (2) | $N_{j+2}$ (3) | $S_j$ (4) | $E$ (5) |
|---|---|---|---|---|
| 13–17 | 609 | 0.745 | 0.03 | 471.9 |
| 18–22 | 452 | 0.472 | 0.03 | 392.7 |
| 23–27 | 331 | 0.222 | 0.06 | 326.1 |
| 28–32 | 209 | 0.069 | 0.10 | 226.9 |
| 33–37 | 121 | 0.017 | 0.16 | 143.2 |
| 38–42 | 58 | 0.010 | 0.31 | 83.8 |
| 43–47 | 11 | – | 0.60 | 27.5 |
| 48 + | – | – | 0.98 | |

SOURCES: For data in column (3), David Wolfers, ed., *Postpartum Intra-uterine Contraception in Singapore* (Amsterdam, Excerpta Medica Foundation, 1970); for column (4), Louis Henry, "Some data on natural fertility", *Eugenics Quarterly*, vol. VIII, No. 2 (June 1961), pp. 81–91.

[20] K. Kanagaratnam and Khoo Chian Kim, "Singapore: the use of oral contraceptives in the national program", *Studies in Family Planning*, vol. 1, No. 48 (December 1969), pp. 1–9.

Attention is called to the novel age groupings used in this and other SCYP calculations. As explained above, these groupings are used to facilitate the calculation of expected fertility from the conventional age groupings for which fertility rates are usually available. Thus, for the 13–17 age group, $B_{j+2}$ is the 15–19 age group; for the 18–22 age group, $B_{j+2}$ is the 20–24 age group; etc.

### 3. *Oral contraceptives*

*Crude couple-years of protection*

CCYP calculations are based on the following formula (table 47):

$$CCYP = \frac{C(1-W)}{13}$$

where $C$ = number of cycles distributed to individuals (not to distributors);

$W$ = proportion considered to have been wasted.[21]

TABLE 47. CALCULATION OF CRUDE COUPLE-YEARS OF PROTECTION, ORAL CONTRACEPTIVES

| *Age group* (1) | *Number of new acceptors*[a] (2) | *Number of cycles*[a] (3) | $CCYP = \frac{C\left(1-\frac{1\,392}{25\,277}\right)^{b}}{13}$ (4) |
|---|---|---|---|
| 13—17 | 396 | 4 902 | 356.3 |
| 18—22 | 3 737 | 46 215 | 3 359.1 |
| 23—27 | 6 002 | 74 224 | 5 395.0 |
| 28—32 | 4 851 | 59 986 | 4 360.1 |
| 33—37 | 2 265 | 28 009 | 2 036.0 |
| 38—42 | 1 189 | 14 705 | 1 069.0 |
| 43—47 | 321 | 3 968 | 288.4 |
| 48 + | 94 | 1 167 | 85.0 |
| Unknown | – | – | – |
| TOTAL | 18 855 | 233 176 | 16 948.9 |

SOURCE: For columns (2) and (3), K. Kanagaratnam and Khoo Chian Kim, "Singapore: the use of oral contraceptives in the national program", *Studies in Family Planning*, vol. 1, No. 48 (December 1969), pp. 1-9.

[a] Published data not sufficient for computing age group-specific ($W$) values.

[b] See section E.1 of this chapter.

*Calculation of penalty (P) per 100 crude couple-years of protection—oral contraceptives*

The calculation of penalty ($P$) first requires conversion of pregnancy rates to pregnancy rates per 100 crude couple-years of protection. A 12-month cumulative pregnancy rate of 61/1,000 has been reported.[22] The rate includes both intended and unintended pregnancies. It was assumed that 0.5 (3.05 per cent) of the rate was attributable to unintended pregnancies. The same study showed pregnancy rates by age groups as shown in table 48.

TABLE 48. PREGNANCY RATES, ORAL CONTRACEPTIVES

| *Age group* (1) | *Pregnancy rate* (2) | *0.5 of pregnancy rate* (3) |
|---|---|---|
| Under 25 | 18 | 9 |
| 25–29 | 14 | 7 |
| 30–34 | 9 | 4.5 |
| 35 and over | 2 | 1 |

SOURCE: K. Kanagaratnam and Khoo Chian Kim, "Singapore: the use of oral contraceptives in the national program", *Studies in Family Planning*, vol. 1, No. 48 (December 1969), pp. 1-9.

From the data given in table 48, table 49 was constructed. The crude couple-years of protection (see column (2) of table 49) were obtained from age groups two years younger given in table 47.

The values for column (4) of table 49 are obtained by solving the following equation:

$$k = \frac{3.05}{\left[\dfrac{9a+7b+4.5c+1d}{a+b+c+d}\right]} \tag{1}$$

$$k = \frac{3.05}{\dfrac{(9\times 3{,}715.4)+(7\times 5{,}395)+(4.5\times 4{,}360.1)+(1\times 3{,}393.4)}{3{,}715.4+5{,}395+4{,}360.1+3{,}393.4}} \tag{2}$$

$$k = 0.5459 \tag{3}$$

Having derived pregnancy rates per 100 crude couple-years of protection, the penalty for pregnancies per 100 crude couple-years of protection for oral contraceptives (table 50) is calculated as follows:

$$P = \frac{PR}{100\,CCYP} \times \left[\frac{\dfrac{12{,}000}{E} - 9 - PPA - F}{12}\right] \times LBP$$

[21] M. Gorosh and D. Wolfers, *op. cit.*, p. 6.

[22] K. Kanagaratnam and K. C. Kim, *loc. cit.*

TABLE 49. CALCULATION OF PREGNANCY RATES PER 100 CRUDE COUPLE-YEARS OF PROTECTION, ORAL CONTRACEPTIVES

| *Age group* (1) | *Crude couple-years of protection* (2) | *Pregnancy rate* (3) | *Pregnancy rate per 100 crude couple-years of protection* (4) |
|---|---|---|---|
| Under 25 | $a$ = (356.3 + 3 359.1) | 9$k$ | 4.91 (9 × 0.5459) |
| 25–29 | $b$ = (5 395.0) | 7$k$ | 3.82 (7 × 0.5459) |
| 30–34 | $c$ = (4 360.0) | 4.5$k$ | 2.46 (4.5 × 0.5459) |
| 35 or over | $d$ = (2 036.0 + 1 069.0 + 288.4)[a] | 1$k$ | 0.55 (1 × 0.5459) |

[a] Excluding women over 48 years of age.

TABLE 50. CALCULATION OF PENALTY ($P$) FOR ORAL CONTRACEPTIVES

| Age group (1) | Pregnancy rate per 100 crude couple-years of protection (2) | Duration per birth 12 000[a] E (3) | Nine months gestation (−9) (4) | Post-partum amenorrhoea[b] (−6) (5) | Foetal loss (6) | Live-birth proportion (7) | Penalty in years per 100 crude couple-years of protection (8) |
|---|---|---|---|---|---|---|---|
| 13–17...... | 4.91 | 25.4 | 9 | 3 | 0.9 | 0.833 | 4.26 |
| 18–22...... | 4.91 | 30.6 | 9 | 4 | 1.5 | 0.818 | 5.39 |
| 23–27...... | 3.82 | 36.8 | 9 | 6 | 1.9 | 0.805 | 5.10 |
| 28–32...... | 2.46 | 52.9 | 9 | 8 | 2.8 | 0.791 | 5.37 |
| 33–37...... | 0.55 | 83.8 | 9 | 10 | 3.0 | 0.777 | 2.20 |
| 38–42...... | 0.55 | 143.2 | 9 | 11 | 3.3 | 0.765 | 4.20 |
| 43–47....... | – | – | – | – | – | – | 4.20 |
| 48+........ | – | – | – | – | – | – | – |

SOURCES: For data on post-partum amenorrhoea in Thailand, Jeroen K. Van Ginneken, "Prolonged breastfeeding as a birth-spacing method", *Studies in Family Planning*, vol. 5, No. 6 (June 1974), pp. 200–206; for contribution of foetal mortality to duration per birth, David Wolfers and Susan Scrimshaw, *Child Survival and Interval Between Births in Guayaquil, Ecuador* (New York, Columbia University, International Institute for the Study of Human Reproduction, 1975); for live-birth proportions, Robert G. Potter, Jr., "Estimating births averted in a family planning program", in S. J. Behrman, Leslie Corsa, Jr. and Ronald Freedman, eds., *Fertility and Family Planning: A World View* (Ann Arbor, University of Michigan Press, 1969), pp. 413–434.

[a] See calculation of $E$ (expected fertility) illustrated in section E. 2.

[b] Data were not available for the mean duration of post-partum amenorrhoea for Country B. It was estimated that available data for Thailand approximated the reality of Country B. This mean was then disaggregated into age-specific means by reference to table 37.

TABLE 51. COMPUTATION OF MEAN OVERLAP WITH POST-PARTUM AMENORRHOEA ($A$), CONSTRUCTED FOR $M = 3$, ORAL CONTRACEPTIVES

| Month $i$ (1) | $Y_i$[a] (2) | $\Sigma Z_i$[b] (3) | $Y_i \Sigma Z_i$[c] (4) | $Y_i(i-1)$[d] (5) |
|---|---|---|---|---|
| 1 | 0.2 | 8.992 | 1.7984 | 0 |
| 2 | 0.01 | 8.992 | 0.08992 | 0.01 |
| 3 | 0.03 | 8.548 | 0.25644 | 0.06 |
| 4 | 0.01 | 7.808 | 0.07808 | 0.03 |
| 5 | | 6.920 | | |
| 6 | 0.2 | 5.966 | 1.1932 | 1.0 |
| 7 | | 4.985 | | |
| 8 | 0.1 | 3.993 | 0.3993 | 0.7 |
| 9 | | 2.997 | | |
| 10 | 0.05 | 1.999 | 0.09995 | 0.45 |
| 11 ($n$) | 0.4 | 1.000 | 0.4 | 4.0 |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |
| 20 | | | | |
| 21 | | | | |
| 22 | | | | |
| 23 | | | | |
| 24 | | | | |
| TOTAL | | | 4.31529 | 6.25 |

$$n - \Sigma Y_i(\Sigma Z_i) - \Sigma Y_i(i-1) = 0.43471 = A'$$

[a] $Y_i$ = proportion of acceptors accepting $i$ months after last delivery. The last value includes all acceptors adopting $i$ months or later after delivery.

[b] From table 39.

[c] The product of columns (2) and (3).

[d] The product of column (2) and $i-1$.

*Calculation of overlap between contraceptive use and post-partum amenorrhoea ($A$) for oral contraceptives*

The calculation of overlap between contraceptive use and post-partum amenorrhoea ($A$) for oral contraceptives, which is for new acceptors only, is illustrated in table 51. The illustration is for mean $PPA = 3$.

The steps of the calculation are given below:

1. The distribution of $\Sigma Z_i$ that corresponds to a mean post-partum amenorrhoea of three months is copied from table 39 into column (3) of table 51;

2. The distribution for open interval to adoption is entered into column (2) of table 51. The last entry in column (2) should coincide with the last entry in column (3). Add any subsequent distribution of column (2) to the entry that coincides with the last entry in column (3). That is $Y_n$, where $n$ is the month of the last value of $\Sigma Z_i$ in $Y_{i=n}^{i=\infty}$. In this example (section E.1), the distribution of open interval to acceptance covers $1-24+$ months. The last entry in column (3) is at 11 months. Add all values of column (2) beyond 11 months $(0.1+0.05+0.05+0.2 = 0.4)$ and enter the total in column (2) opposite month 11;

3. Entries for columns (2) and (3) are cross-multiplied for each month and the products are entered in column (4);

4. Each column (2) entry is then multiplied by the value of $i-1$ and the product entered in column (5). On line 1, for example, $i$ is 1, and $i-1$ is zero. Therefore, column (5) is also zero;

5. Columns (4) and (5) are summed;

6. The sums of columns (4) and (5) are added together and subtracted from $n$, the number of entries in column (3). In the example, this is $11-(4.31529+6.25)$ or 0.43471;

7. The quantity obtained in step 6 is designated $A'$—the number of months of overlap between post-partum amenorrhoea and contraceptive use.

Steps 1–7 are repeated for overlap with post-partum amenorrhoea where values for $M = 4$, 6, 8, 10 and 11. Values of $A'$ are summarized in table 52.

TABLE 52. VALUES OF POST-PARTUM OVERLAP ($A'$) IN THE ABSENCE OF DISCONTINUATION

| *Mean post-partum Amenorrhoea (M) (months)* | *A' values* |
|---|---|
| 3 | 0.43471 |
| 4 | 0.72000 |
| 6 | 1.52973 |
| 8 | 2.52324 |
| 10 | 3.62444 |
| 11 | 4.16449 |

The $A'$ values are now corrected for observed continuation rates. (See section B.3 for the methodology of calculating continuation rates.) In table 53, the continuation rate in column (4) is multiplied by the $A'$ value in column (5) to obtain $A$ (column (6)), the mean overlap with post-partum amenorrhoea per acceptor, specific for method continuation and mean post-partum amenorrhoea for age.

*Calculation of standard couple-years of protection for oral contraceptives*

The basic SCYP formula is:

$$SCYP = \frac{E\left[CCYP\left(\frac{100-P}{100}\right)-\frac{NA}{12}\right]}{400}$$

The calculation of SCYP for oral contraceptives is given in table 54.

## F. CONCLUSION

A method is presented with which it is possible to summarize, in a single annual figure, the accomplishments of a birth control programme. Based on the couple-year of protection procedures developed by Wishik, it provides a methodology for rendering commensurable periods of contraceptive protection provided by different methods of contraception, sterilization and abortion, and their use by couples of different ages and therefore of different fertility expectations. Overlap between contraceptive use and post-partum amenorrhoea is also considered.

Although inevitably the data requirements of this method are more comprehensive than those of the original CYP methodology, there are no data requirements which cannot be readily met by the average programme or filled in by standard data and tabulations as substitutes for locally derived values with little loss of accuracy.

This method reduces the value of programme acceptances to a single measure in the face of diverse method and age mixes and expected fertility levels. Value gained is stated in terms of births averted and also in terms of the standard unit described. Although these effects are not scheduled by calendar year, the over-all method mix tells the basic picture: if the programme relies predominantly

TABLE 53. CORRECTION OF MEAN OVERLAP WITH POST-PARTUM AMENORRHOEA FOR CONTINUATION RATES, ORAL CONTRACEPTIVES

| *Age group (1)* | *M* | *Continuation rate (a) ((a) = months) (2)* | *Continuation rate (n) ((n) = months) (3)* | *Continuation rate (M/2) (4)* | *Values of post-partum overlap A (5)* | *Mean overlap with post-partum amenorrhoea A (6)* |
|---|---|---|---|---|---|---|
| 13–17 | 3 | 0.799 ($a$ = 1m) | 0.739 ($n$ = 2m) | 0.769 | 0.43471 | 0.334 |
| 18–22 | 4 | | | 0.739 | 0.7200 | 0.532 |
| 23–27 | 6 | | | 0.699 | 1.52973 | 1.069 |
| 28–32 | 8 | | | 0.672 | 2.53234 | 1.702 |
| 33–37 | 10 | | | 0.648 | 3.62444 | 2.349 |
| 38–42 | 11 | 0.648 ($a$ = 5m) | 0.627 ($n$ = 6m) | 0.6375 | 4.16449 | 2.655 |
| 43–47 | 11 | | | 0.6375 | 4.16449 | 2.655 |

upon condoms and oral contraceptives, the benefits are realized chiefly in that year (or nine months later); but if sterilization is the main method the benefits come over many years, descending towards the end. Intra-uterine devices are intermediate. Moreover, in a stable programme, the character of which changes little over several years, the calendar scheduling of births averted becomes in one sense unimportant because the cumulative effect of past activity upon this year's births will about equal the total future contributions of the new programme work in this year. In other words, in a stable state, the benefits felt in each year become constant, and equal the total future effects from the new programme input for each year.

Of course, few active programmes can be safely considered stable. The technique proceeds on a method and age-specific basis and thus is sensitive to changes tied to them as concerns expected fertility and other measures. These measures are then reflected in the estimate of the standard units of protection and in births averted.

As a final form of overview and as a rough methodological comparison, this method was applied to programme data previously published for Country B[23] to obtain results that may be expressed as the number of births averted per acceptor of each method. These results were then put alongside comparative results from other locations, obtained by various adaptations of births averted approaches. The comparative picture appears in table 55.

[23] One modification was used to adapt these heavily post-partum data to the longer open-interval distribution found in most national programmes.

TABLE 54. CALCULATION OF STANDARD COUPLE-YEARS OF PROTECTION, ORAL CONTRACEPTIVES

| *Age group* (1) | *Crude couple-years of protection* (2) | *Penalty for pregnancy P* (3) | *Number of new acceptors per annum N* (4) | *Mean overlap with post-partum amenorrhoea A* (5) | *Total overlap in years NA/12* (6) | *Expected fertility E* (7) | *Standard couple-years of protection* (8) |
|---|---|---|---|---|---|---|---|
| 13–17 .......... | 356.3 | 4.26 | 396 | 0.334 | 11.02 | 471.9 | 389.4 |
| 18–22 .......... | 3 359.1 | 5.39 | 3 737 | 0.532 | 165.67 | 392.7 | 2 957.4 |
| 23–27 .......... | 5 395.0 | 5.10 | 6 002 | 1.069 | 534.68 | 326.1 | 3 738.1 |
| 28–32 .......... | 4 360.1 | 5.37 | 4 851 | 1.702 | 688.03 | 226.9 | 1 950.2 |
| 33–37 .......... | 2 036.0 | 2.18 | 2 265 | 2.349 | 443.37 | 143.2 | 554.1 |
| 38–42 .......... | 1 069.0 | 4.20 | 1 189 | 2.655 | 263.06 | 83.8 | 159.4 |
| 43–47 .......... | 288.4 | 4.20 | 321 | 2.655 | 71.02 | 27.5 | 14.1 |
| 48 + .......... | 85.0 | – | 94 | 2.655 | 20.80 | – | – |
| TOTAL | 16 948.9 | | 18 855 | | | | 9 762.6 |

Births averted (SCYP × 0.4) = 3 905.0

TABLE 55. COMPARISONS OF STANDARD COUPLE-YEARS OF PROTECTION AND OTHER BIRTHS AVERTED CALCULATIONS BY CONTRACEPTIVE METHODS

A. *Births averted per acceptor*

| *Contraceptive method* | *Standard couple-years of protection* | *Other approaches* |
|---|---|---|
| Intra-uterine device .......... | 0.62 | 0.54 (Country F) |
| | | 0.70 (Country F) |
| | | 0.75 (Country F) |
| | | 0.50–0.79 (Country B) |
| | | 0.33 (Country E) |
| | | 0.43–0.65–0.94 (Country E) |
| Sterilization ........ | 1.98 | 2.35 (Country F) |
| | | 2.39 (Country F) |
| | | 2.48 (Country G) |
| | | 2.50 (Country H) |
| | | 1.23–1.64 (Country F) |
| Condom .......... | 0.10 | 0.14 (Country F) |
| | | 0.16 (Country F) |
| Abortion.......... | 0.67 | 0.4–0.9 |
| Oral contraceptives .. | 0.21 | 0.21 |

B. *Births averted per intra-uterine device by age, Country E; and standard couple-years of protection for Country B*

| | *Age group* 20–24 | 25–29 | 30–34 | 35–39 | 40–44 |
|---|---|---|---|---|---|
| Country E ............ | 0.54 | 0.68 | 0.72 | 0.54 | – |
| Country B ............ | 0.70 | 0.57 | 0.55 | 0.40 | – |

C. *Births averted per sterilization by age, Country F; and standard couple-years of protection for Country B*

| | 20–24 | 25–29 | 30–34 | 35–39 | 40–44 |
|---|---|---|---|---|---|
| Country F ............ | 4.24 | 3.02 | 1.83 | 0.92 | 0.29 |
| Country B ............ | 4.44 | 2.83 | 1.58 | 0.74 | 0.28 |

SOURCES: Compiled from John A. Ross and others, *Findings from Family Planning Research*, Reports on Population/Family Planning, No. 12 (New York, The Population Council, 1972); A. K. Jain, "Relative effectiveness of different fertility control methods in reducing community reproduction rates", in *International Population Conference, Liège, 1973* (Liège, International Union for the Scientific Study of Population, 1974), vol. 2, pp. 209–224; and Kap Suk Koh and Douglas J. Nichols, "Measurement of the impact of the national family planning program on fertility in Korea: 1960–1975", Seoul, Republic of Korea, Korean Institute for Family Planning, 1977 (unpublished).