

The Own-Children Method of Estimating Age-Specific Fertility  
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## 1. INTRODUCTION

The own-children method is a procedure for deriving age-specific fertility rates for a ten or fifteen year period from a special census tabulation of children classified by age and age of mother, both ages being given in single years at the time of the census. Age of mother can be determined only for those children who are enumerated in the same household as their mother, i.e., who are "own-children" of a woman present in some enumerated household, hence the name of the method. The method is quite simple in principle, consisting of three basic steps.

- (i) Estimation of the numerators of the age-specific fertility rates, numbers of births in each year preceding the census classified by age of mother. This is accomplished by "reverse survival" of children classified by age and age of mother.
- (ii) Estimation of the denominators of the age-specific fertility rates, numbers of women at each single year of age for each year preceding the census. This is accomplished by reverse survival of the female age distribution.
- (iii) Division of births by mean numbers of women at each single year of age for each year preceding the census to obtain age-specific fertility rates.

The actual implementation of these simple steps involves numerous minor problems and complexities, as will be explicated below.

## 2. DEVELOPMENT OF THE METHOD

The own-children analysis originated in a series of special tabulations of young children by age of mother for the 1910 and 1940 censuses of the United States (Differential Fertility: 1940 and 1910. Part 1. Sixteenth Census of the United States: 1940. Washington, D.C. 1947). Principal use

was made of these tabulations for generating census indicators of current differential fertility, however, and significant development of the basic method was undertaken by Wilson H. Grabill and Lee-Jay Cho in early 1960's (Grabill & Cho, "Methodology for the measurement of current fertility from population data on young children", Demography 2, 1965). Further work on the method was carried in connection with a study of differential fertility in the United States (Differential Current Fertility in the United States, by Lee-Jay Cho, Wilson H. Grabill, and Donald J. Bogue. Chicago: Community and Family Study Center, University of Chicago, 1970). Cho subsequently began working in Korea and Malaysia and, faced with a lack of vital registration data, generalized the method so as to allow the estimation of annual fertility statistics for the ten year period preceding a given census. The necessary tabulations were produced for the first time from the 1966 Korean census under Cho's guidance (Korean Office of Statistics and Research Seoul, Korea, The 1966 Census of Population A Special Tabulation Report, Fertility: Women by Number of Own-Children, August 1970). The method was refined and extended in a number of directions by Cho during the late 1960's and plans for application to the 1970 round of censuses in several Asian countries were made. Since 1970 further developments and analysis of the resulting special tabulation<sup>s</sup> has been carried out by Cho and co-workers at the East-West Population Institute in Honolulu, Hawaii. A report on the application of the

technique to Korea has just been published, Estimates of Current Fertility for the Republic of Korea and its Geographical Subdivisions: 1959-1970 (Seoul: Yonsei University Press 1975). Both publications include a general discussion of the method as well as the application to the particular countries.

### 3. ADVANTAGES AND LIMITATIONS OF THE METHOD

Advantages of the method are: it provides extremely detailed estimates, age-specific fertility rates by single years of age for each of fifteen years prior to the census; only one census is required; the population need not be closed to migration; the method is relatively ins<sup>s</sup>ensitive to recall errors. Limitations of the method are: it requires a special census tabulation; it is sensitive to census undercounting<sup>and</sup> age misreporting errors (these may be adjusted for providing a post-enumerative survey or other census evaluation is available); ~~it requires a special tabulation;~~ it requires a considerable volume of calculation.

### 4. ESTIMATION OF BIRTHS BY REVERSE SURVIVAL

Children aged 0 in completed years at the time of a census were necessarily born during the one year period preceding the census, children aged 2 in the second year preceding the census, and so forth. By inflating

the numbers of children at each age to allow for mortality one obtains estimates of births during each year preceding the census. Note that the word "year" here refers to one year periods beginning and ending at the month and day of the census, not to calendar years.

This procedure for estimating births from the census age distribution is well known and is often applied to test the consistency of census and birth registration data. It requires a life table with  $L_x$  values given by single years of age. For comparisons with birth registration data it is usually necessary to make an adjustment for the difference between calendar years and years beginning and ending on the month and day of the census. Table 1 shows this method applied to Peninsular Malaysia using 1970 census data and birth registration data for 1966-1970. The results suggest an underenumeration of children 0-4 years old on the order of 5 percent, a reasonable figure. The true figure is probably somewhat higher due to some underregistration of births. The derivation of the reverse survived factors is explained below.

#### 5. ESTIMATION OF BIRTHS BY OWN-CHILDREN METHOD

The innovation in the own-children method is the observation that, given a suitably constructed census tabulation, these estimated numbers of births may be distributed by age of mother. The special census tabulation required consists of all persons recorded in the census as being under 15 years of age classified by single year of age and single year of age of mother. Single years of age of mother should normally be tabulated from 10 to 64 and not for any smaller range.

A complication enters in connection with the classification by age of mother. Birth registration statistics normally classify births in a

given year by age of mother in completed years at the time of birth. Own-children tables, by contrast, give the distribution of births by age of mother as of the beginning of the year of birth. It would perhaps not be amiss to reiterate here that "year" in the own-children context means a one year period beginning and ending at the time of the census. This classification by age of mother at the beginning of the year instead of at the time of birth is in fact inevitable. The age of the mother in completed years (if known) is known as of the time of the census, and, by subtraction, one year prior to the census, two years prior to the census, and so on, but age in completed years as of any other time is indeterminate. Consider for example a woman aged exactly 27.5 years at the time of the census with a child aged 0 in completed years. If the age of the child is 3 months, the age of the woman in completed years at birth would have been 27; but if the child is 9 months old, the mother's age would have been 26. One may conclude that the mother's age in completed years at birth was either 26 or 27, but it is impossible to choose between these two ages. This ambiguity is due to knowing age only in completed years and not exact age.

This dilemma may be resolved by assuming that, of the total births occurring during a given year to women aged  $x$  in completed years at the beginning of the year, one half occurred to mothers aged  $x$  in completed years and one half to mothers aged  $x+1$  in completed years. This is analogous to the conventional assumption of a separation factor equal to one half. The number of births during a given year to women aged  $x$  in completed years at birth may then be estimated as the average of births to woman aged  $x-1$  in completed years at the beginning of the year of birth and women aged  $x$  in completed years at the beginning of the year of birth.

## 6. ADJUSTMENTS FOR CENSUS UNDERENUMERATION AND AGE MISREPORTING

It has already been noted that the own-children method is sensitive to census underenumeration and age misreporting errors. The reason is simple enough. Since births are estimated by inflating census counts of children at each single year of age, an underenumeration of children at a given age will result in an underestimate of births a corresponding number of years prior to the census. Likewise, misreporting of children's age will result in incorrect distribution of estimated births among the various years preceding the census. Underenumeration errors on the order of five percent would not be unexpected even in a census well conducted in favorable circumstances and might rise to ten percent or more for particular population subgroups or in less favorable circumstances. There are of course populations for which available data is such that errors of this magnitude may be fairly tolerated. In most circumstances, however, it will probably be desirable to undertake an evaluation of census underenumeration and age misreporting errors and to calculate on this basis a set of adjustment factors to reduce the effect of census errors. Such an evaluation is generally undertaken for principle population subgroups in any case and need not pose much additional burden.

It should be emphasized, however, that adjustment factors calculated for the population at large will not in general be applicable to the populations of geographical subdivisions or to subpopulations defined by various socioeconomic characteristics. Thus, for example, extremely low income or low education groups may suffer considerably greater underenumeration and age misreporting than the population at large. If analysis of fertility differentials is contemplated, therefore, the additional task

of census evaluation for the relevant population subgroups should be undertaken. Such analysis, not normally undertaken as part of post-census operations, involves a labor proportional to the detail of the fertility differentials to be studied.

The example of own-children estimation given below does not include any analysis or adjustment for census underenumeration or age misreporting errors. This was inevitable by reason both of the time available for this presentation and by the absence of any census evaluation analysis at the district level. The crude calculation in Table 1 suggest an underenumeration of about five percent, but there is no basis for supposing this figure applicable to the particular administrative district at Selangor for which the example has been carried out. Were adjustment factors available, they would simply be included along with the factors for mortality and the nonown-children adjustment. All other details of the example given in the following pages would be unaffected.

Although inevitable, the omission of census evaluation analysis and calculation of appropriate adjustment factors is in one respect regrettable, for it will usually be essential to the application of the own-children method in practice. It is also true, however, that the nature of census evaluation analysis will vary from one census to another according to the customs and circumstances of the population, the availability of vital statistics or post-enumerative survey data, and so forth. By contrast, the tabulations and procedure for application of the own-children method apart from the derivation of these adjustment factors are virtually the same for all populations. There is accordingly some logical justification for considering the own-children estimation technique and the census evaluation analysis frequently necessary for its application under separate headings.

## 7. PROCEDURE FOR DETERMINING AGE OF MOTHER

Age of mother is determined from the "current age" and "relationship to head of household" questions on the census form. An illustrative procedure is given in Figure 1. There will be erroneous age determination where adopted children are recorded as sons and daughters of the head of the household, and where the household includes sons and daughters of a male head of household outside the current marriage. It is reasonable to expect, however, that these errors will be minimal in most situations.

## 8. DETERMINATION OF REVERSE SURVIVAL RATIOS FOR CHILDREN

Life tables are rarely given for both sexes combined, hence  $L_x$  values for reverse survival of children must usually be calculated as averages of male and female values weighted according to the sex ratio at birth. Available life tables will not usually provide single years of age, hence some type of interpolation procedure is necessary. For ages 5 and over any of the conventional techniques will usually give satisfactory results, even simple linear interpolation on  $l_x$  values for  $x = 5, 10, \dots$ . These methods will frequently give poor results under age 5, however, and it may be preferable to revert to the Coale-Demeny model life table families to obtain  $l_x$  values for  $x = 2, 3, 4$ . The procedure is exemplified in Table 3 and explained in the notes to this table. A similar procedure may be used to determine model life table values corresponding to Brass estimates of  ${}_xq_0$  based on child survivorship. Once  $l_x$  values are obtained for each sex separately, the  $l_x$  applicable to both sexes together must be calculated by taking a weighted average based on the sex ratio at birth. Values of  $L_x$  for both sexes may then be calculated and the desired reverse

survival ratios obtained as  $l_0 \div L_x$ . The entire procedure is exemplified in Table 4 and described in the notes to this table.

#### 9. ESTIMATION OF FEMALE AGE DISTRIBUTIONS PRIOR TO THE CENSUS

The first step is to determine life table  $L_x$  values for females by single years at age for  $x = 10, \dots, 64$ . Given an abridged life table, any of the various techniques for splitting groups into fifths may be applied directly to the  ${}_5L_x$  values,  $x = 5, 10, \dots, 65$ . Alternatively,  $l_x$  values for single years may be obtained by any of various interpolation techniques and  $L_x$  calculated as  $0.5 \times (l_x + l_{x+1})$ . The latter procedure is exemplified in Table 5 with simple linear interpolation.

The estimated female age distributions one, two, ... years prior to the census are most efficiently obtained by calculating, for each age  $x = 11, 12, \dots, 64$ , the census count of women aged  $x$  divided by  $L_x$ , storing this value in the calculator, and multiplying in turn by  $L_{x-1}$ ,  $L_{x-2}$ , ... . This yields, respectively, estimates of women aged  $x-1$  one year prior to the census,  $x-2$  two years prior to the census, and so on. This corresponds to following the cohort of women aged  $x$  at the time of the census backward in time. The age distributions in Table 6 were estimated in this manner using the  $L_x$  values given in Table 5.

#### 10. PROCEDURE FOR CALCULATING OWN-CHILDREN ESTIMATES OF FERTILITY

The first step is of course to create the special own-children tabulation from the original census schedules. This will always be done by machine, except perhaps for test tabulations for very small population subgroups. The distribution of women aged 10-64 years by single years of

age is also required, but this is almost universally tabulated in any case. All the necessary data may be collected in a single table, exemplified in Table 2. The data in Table 2 refer to Kuala Langat, an administrative district in Selangor, and were obtained from the Department of Statistics worksheet shown in Attachment 1. They were used to illustrate the application of the method. Numbers of children aged 10-14 are not available.

The second step is to obtain male and female life tables applicable to the population during the fifteen years preceding the census. It is possible to utilize several pairs of life tables for different periods to allow for changing mortality, but the quantitative effect on the fertility estimates will usually be too small to justify the extra effort required. For the example worked out here the 1970 life tables for Peninsular Malaysia published by the Department of Statistics were used.

The third step is to perform a census evaluation analysis for under enumeration and age misreporting of children in each population subgroup for which estimates are to be made, and to calculate on this basis adjustment factors to be applied to children at each single year of age.

With these basic data in hand the preliminary computational steps are as follows.

1. Calculate single year  $L_x$  values for females,  $x = 10, \dots, 64$ . This is shown in Table 5.
2. Calculate the age distributions of females prior to the census by reverse survival of the census age distribution. These age distributions are shown in Table 6.
3. Make a table of own-children classified by year of birth and age of mother at beginning of year of birth. This is exemplified in Table 7. This table is nothing more than a copy of the basic own-

children tabulation (Table 2) in a slightly different format and is not required. It is nonetheless advisable when working with a desk calculator to avoid careless errors.

4. Calculate nonown-children adjustment factors for each age  $x = 0, 1, \dots$ , by dividing the total number of children age  $x$  by the number of own-children age  $x$ . Enter these factors at the top of the table which will contain the final estimates of age-specific fertility rate, exemplified in Table 8.
5. Calculate reverse survival ratios for children. This is shown in Tables 3 and 4.
6. Calculate net adjustment factors as the product of the factors 4 and 5 above and the census error adjustment factors, if used.

The final step is to calculate the age-specific fertility rates, working from the age distribution table (Table 6) and the rearranged own-children table (Table 7). For each year, calculate the age-specific fertility rate for age  $x$  as follows.

- (i) Calculate the average of (a) the number of own-children born in this year to women aged  $x$  at the beginning of the year and (b) the number of own-children born in this year to women aged  $x_{\wedge}^{+1}$  at the beginning of the year. For the first year preceding the census and  $x = 27$  years, for example, calculate  $(154 + 165) \div 2 = 159.5$ , the figures in parentheses coming from the last column of Table 7 opposite ages 26 and 27.
- (ii) Multiply this average by the net adjustment factor for the year. This yields an estimate of the number of births during the year to women aged  $x$  at birth. The net adjustment factor for the first year preceding the census is 1.10583 (Table 8, third row, last column), hence the estimated number of births

Exception: When  $x$  is the youngest age for which own-children are tabulated, use the number of own-children to women aged  $x$  plus one-half the number aged  $x+1$ .

in the year preceding the census to women aged 27 at birth is  
 $174.5 \times 1.10583 = 192.96\dots$

- (iii) Divide this estimate of births by the average of the number of women aged  $x$  at the beginning of the year and the number aged  $x$  at the end of the year. The latter average is an estimate of the mean number of women aged  $x$  during the year, and the quotient is the age-specific fertility rate for women aged  $x$  during the given year. Continuing the example begun above, one divides  $192.96\dots$  by  $(562 + 654) \div 2 = 608$ , which yields  $0.3174$  as the age-specific fertility rate for women aged 27 in the year preceding the census.

Note that, as a computational shortcut, the division by 2 in steps (ii) and (iii) may be omitted, as this division occurs in both numerator and denominator of the calculated rate, with the exception of the youngest age group as noted in (i).

## 11. ANALYSIS OF THE RESULTS

The age-specific fertility rates for the first year preceding the census are plotted in Figure 2. Their sum over ages 15-54 gives an estimated total fertility rate of 5.92 children per women. We proceed to compare these results with rates calculated from birth registration data.

The pattern of the age-specific fertility rates in Figure 2 shows a number of minor anomalies which are probably due to errors in the source data. Since the age pattern of the rates reflects the census female age distribution, one looks to age misreporting errors to explain these anomalies. This histogram of the census age distribution shown in Figure 3 suggests considerable age misreporting, but it remains to explain how this misreporting might explain the irregularities in the age-specific fertility rates shown in Figure 2. This is an area in which very little research has been conducted and, accordingly, no conclusions of substance can be drawn. Several general observations may be made, however. First, the effect of age misreporting on the own-children estimates is confounded

by the averaging procedure which occurs in both the numerator and the denominator of the estimated rates. Second, since women and their children are linked together in the estimation procedure, transference of a woman's age classification results in a corresponding transference of her children into the appropriate "age of mother" category. The effect of age misreporting is thus to give a fertility rate for each age which is in fact a sort of weighted average of rates for this and surrounding ages.

Registered births in Malaysia in 1970 were tabulated by age and state of residence of mother as well as by age of mother and state of occurrence of birth. Tabulations of births in administrative districts within states are available, but by district of occurrence only and without the age of mother classification. We cannot, therefore, calculate age-specific birth rates for Kuala Langat directly from the birth registration data. Table 9 shows age-specific birth rates for Selangor state (which includes the administrative district of Kuala Laugat) as a whole, however, and we see at once that the total fertility rate calculated from the birth registration data for the state is far lower than the own-children estimate for the included district--4.43 as against 5.93 children per women, respectively. The quinquennial age-specific birth rates for Kuala Laugat in Table 9 are obtained by averaging the single year own-children estimates in Table 8. The own-children rates are probably somewhat low, if anything, on account of census underenumeration of children aged 0. The rates calculated from birth registration data are probably somewhat low also on account of underregistration of births. Estimates for Peninsular Malaysia as a whole give birth registration completeness of over 95 percent, however, and it is scarcely plausible that underregistration in the district of

Kuala Langat could be so great as account for the difference between 4.43 and 5.93. We therefore conclude, at least provisionally, that the difference between the two figures reflects a difference in fertility between the state of Selangor and its administrative district Kuala Langat. The implication is that the own-children estimate for Kuala Langat is approximately correct and that the much lower fertility in Selangor is due to much lower fertility in the rest of the state.

In view of this substantial fertility differential, one would like to have a direct estimate, based on birth registration data, for Kuala Langat, and some progress in this direction may be made indirectly by utilizing the data on births by district of occurrence. The relevant figures are shown in Table 10. The age-distribution of women aged 15-54 in Kuala Langat is available from the own-children tabulations (column 1). If age-specific fertility rates in the district were the same as those in Selangor State (column 2)--a supposition we have provisionally concluded to be false--there would have been approximately 2,910 births during 1970. Since age-specific fertility rates in the district are, we think, higher than those of Selangor, registered births in the district ought to exceed this figure. The actual number registered accordingly comes as a disconcerting surprise--2,740 births!

At first glance, this leaves us with two obvious alternatives, an own-children estimate on the order of 30 percent too high, or birth under-registration of about 30 percent, both for Kuala Langat district. Neither alternative is plausible, for the reasons referred to above. There is of course the distinction between classification by district of occurrence of birth and district of residence of mother. Is it possible that a substantial number of births to women living in Kuala Langat occurred outside

this district? This might be the case if a considerable proportion (at least 30 percent) of women give birth in hospitals, and if there are no suitable hospitals in the district. Indeed, the two previous alternatives are so unpalatable that one might go so far as to predict the absence of hospital facilities in Kuala Langat. In any case, it happens that there is in fact no district hospital in Kuala Langat (a fact for which I am indebted to Rabiayah Othman Mat, Statistician for Social Statistics, Census and Demography Division, Department of Statistics, Malaysia). As for confinements in hospitals, data on hospital admissions in Peninsular Malaysia for 1969, 1970, and 1971 show maternity admissions in the numbers of 121,884, 116,186, and 124,239, respectively (Social Statistics Bulletin: Peninsular Malaysia 1969-1971, Table 6, pp. 170-172, Department of Statistics, Kuala Lumpur, Malaysia). Registered births during these years under 297,693, 297,358, and 309,378, respectively (Vital Statistics: Peninsular Malaysia 1972, Table 14.01, p. 33, Department of Statistics, Kuala Lumpur, Malaysia). Births occurring in hospitals may accordingly be estimated as 40 percent, 39 percent, and 40 percent respectively. We conclude that the relatively low incidence of births occurring in Kuala Langat is accounted for by women travelling outside the district to give birth in hospitals in other districts.

## 12. ACKNOWLEDGEMENTS

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TABLE XV. Values of  $l_x$  by single years of age from 1 to 5 for regional model life tables ( $l_0 = 100,000$ ) at mortality levels 1 to 24

LEVEL	M O D E L					W E S T					M O D E L					N O R T H														
	$l_1$	$l_2$	$l_3$	$l_4$	$l_5$	$l_1$	$l_2$	$l_3$	$l_4$	$l_5$	$l_1$	$l_2$	$l_3$	$l_4$	$l_5$	$l_1$	$l_2$	$l_3$	$l_4$	$l_5$	$l_1$	$l_2$	$l_3$	$l_4$	$l_5$					
1	63483	55000	51199	48742	46883	58093	50308	46898	44665	43005	58093	50308	46898	44665	43005	58093	50308	46898	44665	43005	58093	50308	46898	44665	43005	58093	50308	46898	44665	43005
2	66338	58557	54936	52595	50824	61657	54152	50865	48712	47112	61657	54152	50865	48712	47112	61657	54152	50865	48712	47112	61657	54152	50865	48712	47112	61657	54152	50865	48712	47112
3	69481	61829	58399	56183	54506	64868	57690	54546	52488	50957	64868	57690	54546	52488	50957	64868	57690	54546	52488	50957	64868	57690	54546	52488	50957	64868	57690	54546	52488	50957
4	72064	64856	61625	59538	57958	67785	60967	57980	56024	54571	67785	60967	57980	56024	54571	67785	60967	57980	56024	54571	67785	60967	57980	56024	54571	67785	60967	57980	56024	54571
5	74427	67671	64643	62686	61205	70454	64015	61195	59348	57976	70454	64015	61195	59348	57976	70454	64015	61195	59348	57976	70454	64015	61195	59348	57976	70454	64015	61195	59348	57976
6	76602	70300	67476	65651	64270	72911	66863	64217	62482	61194	72911	66863	64217	62482	61194	72911	66863	64217	62482	61194	72911	66863	64217	62482	61194	72911	66863	64217	62482	61194
7	78614	72765	70145	68451	67169	75183	69537	67064	65445	64242	75183	69537	67064	65445	64242	75183	69537	67064	65445	64242	75183	69537	67064	65445	64242	75183	69537	67064	65445	64242
8	80482	75084	72665	71101	69918	77294	72052	69756	68253	67135	77294	72052	69756	68253	67135	77294	72052	69756	68253	67135	77294	72052	69756	68253	67135	77294	72052	69756	68253	67135
9	82226	77271	75051	73616	72530	79263	74425	72307	70919	69888	79263	74425	72307	70919	69888	79263	74425	72307	70919	69888	79263	74425	72307	70919	69888	79263	74425	72307	70919	69888
10	83857	79340	77315	76007	75017	81105	76671	74728	73457	72511	81105	76671	74728	73457	72511	81105	76671	74728	73457	72511	81105	76671	74728	73457	72511	81105	76671	74728	73457	72511
11	85388	81300	79468	78285	77389	82835	78800	77032	75875	75015	82835	78800	77032	75875	75015	82835	78800	77032	75875	75015	82835	78800	77032	75875	75015	82835	78800	77032	75875	75015
12	86829	83163	81519	80457	79654	84463	80822	79228	78184	77408	84463	80822	79228	78184	77408	84463	80822	79228	78184	77408	84463	80822	79228	78184	77408	84463	80822	79228	78184	77408
13	88169	84939	83492	82556	81848	86058	82912	81534	80632	79961	86058	82912	81534	80632	79961	86058	82912	81534	80632	79961	86058	82912	81534	80632	79961	86058	82912	81534	80632	79961
14	89452	86720	85496	84705	84106	88864	86523	85498	84826	84327	88864	86523	85498	84826	84327	88864	86523	85498	84826	84327	88864	86523	85498	84826	84327	88864	86523	85498	84826	84327
15	90661	88364	87324	86646	86127	88864	86523	85498	84826	84327	88864	86523	85498	84826	84327	88864	86523	85498	84826	84327	88864	86523	85498	84826	84327	88864	86523	85498	84826	84327
16	91823	89936	89066	88490	88041	90143	88164	87292	86293	85293	90143	88164	87292	86293	85293	90143	88164	87292	86293	85293	90143	88164	87292	86293	85293	90143	88164	87292	86293	85293
17	92934	91419	90709	90232	89854	91379	89790	89056	88561	88184	91379	89790	89056	88561	88184	91379	89790	89056	88561	88184	91379	89790	89056	88561	88184	91379	89790	89056	88561	88184
18	93996	92820	92260	91878	91571	92570	91334	90736	90321	90001	92570	91334	90736	90321	90001	92570	91334	90736	90321	90001	92570	91334	90736	90321	90001	92570	91334	90736	90321	90001
19	95006	94143	93724	93436	93201	93713	92796	92332	92002	91744	93713	92796	92332	92002	91744	93713	92796	92332	92002	91744	93713	92796	92332	92002	91744	93713	92796	92332	92002	91744
20	95966	95392	95109	94912	94749	94807	94179	93847	93606	93415	94807	94179	93847	93606	93415	94807	94179	93847	93606	93415	94807	94179	93847	93606	93415	94807	94179	93847	93606	93415
21	96907	96559	96385	96263	96160	95909	95508	95285	95121	94989	95909	95508	95285	95121	94989	95909	95508	95285	95121	94989	95909	95508	95285	95121	94989	95909	95508	95285	95121	94989
22	97738	97530	97425	97350	97286	96925	96675	96531	96422	96334	96925	96675	96531	96422	96334	96925	96675	96531	96422	96334	96925	96675	96531	96422	96334	96925	96675	96531	96422	96334
23	98484	98377	98321	98282	98248	97856	97719	97636	97573	97521	97856	97719	97636	97573	97521	97856	97719	97636	97573	97521	97856	97719	97636	97573	97521	97856	97719	97636	97573	97521
24	99106	99061	99037	99020	99006	98668	98605	98566	98535	98510	98668	98605	98566	98535	98510	98668	98605	98566	98535	98510	98668	98605	98566	98535	98510	98668	98605	98566	98535	98510

Table 1. Comparison of Census Age Distribution of Children and Birth Registration Statistics: Peninsular Malaysia, 1970 Census

Age	Number of Children	Reverse Survival Ratio	Births Preceding Census	Calendar Year	Adjusted Births	Registered Births	Percent Difference
0	267,922	1.04030	278,719	1970	278,719	297,358	6.7
1	264,495	1.05356	278,661	1969	278,681	297,963	6.9
2	283,217	1.05895	299,913	1968	292,411	309,501	5.8
3	271,529	1.06209	288,388	1967	292,456	301,419	3.1
4	283,265	1.06444	301,519	1966	296,884	309,662	4.3
Total	3,814,128	--	1,447,200	Total	1,439,151	1,515,903	5.3

Source: Age Distributions, p. 86, and Vital Statistics, West Malaysia, 1970, p. 15 (Statistics Department, Kuala Lumpur, Malaysia). Reverse survival ratios from Table 4. Note: The census was taken as of the night of 24/25 August, 1970, which corresponds to 0.647 expressed as the fractional portion of the calendar year. Adjusted births calculated by distributing births during each year preceding census among calendar years on the assumption of uniform distribution of births. This calculation is for illustrative purposes only. A detailed analysis would utilize birth registration data by month of birth.

Table 2. Census Data Required for Application of Own-Children Method of Fertility Estimation: Administrative District 02, State of Selangor, Malaysia 1970

Age	Number of Women	Number of Children at Age:			
		0	1	2	3
(Total Children)		3645	3659	3816	3715
(Non-Own Children)		216	242	246	263
(Own Children)		3429	3417	3570	3452
(Own Children by Age of Mother)					
10	1349	7	2	-	1
11	1193	9	5	4	1
12	1174	35	17	5	3
13	1071	74	39	19	14
14	933	104	62	51	26
15	997	156	108	92	46
16	851	177	132	111	87
17	896	188	190	163	136
18	862	224	201	190	181
19	771	209	203	217	133
20	544	147	163	142	144
21	571	165	194	183	183
22	654	195	187	197	206
23	561	154	184	182	169
24	573	165	182	180	178
25	670	201	186	202	199

31	599	166	164	194	182
32	617	143	156	180	175
33	601	122	129	177	161
34	635	132	123	161	181
35	600	102	147	164	145
36	554	96	96	129	138
37	454	77	85	98	114
38	404	58	68	68	91
39	531	77	85	98	88
40	499	49	70	69	93
41	481	49	53	78	87
42	372	34	48	43	54
43	317	20	26	26	48
44	277	11	12	30	25
45	348	13	15	18	29
46	469	15	17	20	30
47	360	10	12	20	28
48	276	5	11	11	14
49	280	3	7	12	11
50	321	5	6	5	10
51	395	7	9	8	7
52	297	3	1	3	6
53	208	4	4	2	1
54	175	1	2	1	1
55	191	3	2	-	5
56	301	3	4	-	6
57	264	5	2	3	4
58	155	1	-	2	1
59	207	1	3	3	4
60	231	1	2	4	1
61	303	1	-	1	1
62	197	1	1	-	-
63	123	-	-	2	1
64	89	-	-	-	-

Source: Unpublished tabulations, Statistics Department, Kuala Lumpur, Malaysia.

Table 3. Fitting Coale-Demeny "West Female" Model Life Tables to Observed Life Table Survivorship: Peninsular Malaysian Females, 1970

	Life Table Values				Interpolation Constant
	$l_1$	$l_5$	$l_{10}$	$l_{15}$	
Observed <sup>1</sup>	96,293	94,543	93,875	93,469	--
Fitted <sup>2</sup> -1	96,293	95,239	94,817	94,486	0.347503
%Δ	0	-0.73	-0.99	+1.09	--
Fitted-2	95,838	94,543	94,047	93,661	0.866925
%Δ	-0.47	0	+0.18	+0.20	--
Fitted-3	95,742	94,388	93,875	93,476	0.766628
%Δ	+0.58	+0.16	0	-0.00	--
Fitted-4	95,738	94,382	93,868	93,469	0.762629
%Δ	+0.58	+0.17	+0.00	0	--

<sup>1</sup>Abridged Life Tables, Malaysia 1970, p. 23 (Statistics Department, Kuala Lumpur, Malaysia).

<sup>2</sup>Begin by determining the highest model life table level for which the model table  $l_1$  is less than the observed  $l_1$ . In this case, level 20 gives  $l_1 = 96,907$ . Then determine remaining  $l_x$  values, for  $x = 5, 10, \text{ and } 15$ , by linear interpolation. In the case of  $l_5$ , for example, calculate

$$94,749 + \left\{ \frac{96,293 - 95,966}{96,907 - 95,966} \right\} \times (96,160 - 94,749)$$

which equals  $94,749 + \{0.347503\} \times (1,411) = 95,239$ . The quantity in brackets is the same for interpolation to obtain the  $l_{10}$  and  $l_{15}$  values. Thus the interpolated  $l_{10}$  value is

$$94,275 + 0.347503 \times (95,835 - 94,275) = 94,817$$

and the interpolated  $l_{15}$  value is

$$93,906 + 0.347503 \times (95,574 - 93,906) = 94,486$$

The second set of fitted values is obtained in the same manner, but beginning with the  $l_5$  value is less than the observed value, 94,543, is level 19. We therefore interpolate between level 19 and level 20, beginning with the  $l_1$  value,

$$95,006 + \left\{ \frac{94,543 - 93,201}{94,749 - 93,201} \right\} (95,966 - 95,006)$$

which equals  $95,006 + 0.866925 \times 960 = 95,838$ . Observe that the interpolation constant value may be checked by applying the procedure to the  $l_x$  value from which the constant was derived. In the last case, for example, we calculate

$$\begin{aligned} 93,201 + 0.866925 \times (94,749 - 93,201) &= \\ &= 94,542.9999 \end{aligned}$$

or, rounded to five places, the observed value 94,543. The reference for the model life tables is Regional Model Life Tables and Stable Populations, by Ansley J. Coale and Paul Demeny (Princeton University Press, 1966)

Table XV - copy follows

96,966

Table 4. Calculation of Reverse Survival Ratios for Children. Peninsular Malaysia, 1970

Age-x	Female $\ell_x^1$	Male $\ell_x^2$	Total $\ell_x^3$	Total $L_x^4$	Reverse Survival Ratio
0	(.488)	(.512)	100,000	96,126	1.04030
1	100,000	100,000	95,235	94,916	1.05356
2	95,838	94,661	93,995	94,433	1.05895
3	95,226	93,995	94,596	94,154	1.06209
4	94,925	93,645	94,270	93,946	1.06444
5	94,716	93,393	94,039	93,797	1.06613
6	94,543	93,193	93,852	93,686	1.06740
7	94,444	93,071	93,741	93,574	1.06867
8	94,345	92,948	93,630	93,462	1.06995
9	94,245	92,826	93,518	93,352	1.07121
10	94,146	92,703	93,407	93,254	1.07234
11	94,047	92,581	93,296	93,168	1.07333
12	93,970	92,487	93,211	93,082	1.07432
13	93,893	92,393	93,125	92,996	1.07532
14	93,815	92,298	93,038	92,910	1.07631
15	93,738	92,204	92,953	--	
	93,661	92,110	92,867		

<sup>1</sup>Based on level 19.866925 as given in Table 3. The observed and fitted values are so close in all cases in Table 1 that the particular fit which is chosen is of no consequence. As a general rule one should choose the fit which minimizes extreme deviations of fitted from observed values. If very poor fits are obtained, percent deviations of over 2 or 3 percent, for example, the model life tables should perhaps not be used. A study of the accuracy of the observed life table values is called for in this case. The values of  $\ell_2$ ,  $\ell_3$ , and  $\ell_4$  are interpolated in the table of single year  $\ell_x$  values given in Coale and Demeny, Table XV, pages 42-43, using the interpolation constant  $x^{0.866925}$ . The single year values between 5 and 10 and 10 and 15 are obtained by interpolation between the fitted values of  $\ell_5$ ,  $\ell_{10}$  and  $\ell_{15}$  given in Table 1. Simple linear interpolation was used in this case for ease of calculation, but quadratic interpolation might be preferable in general for giving a smoother series of interpolated values.

<sup>2</sup>Based on level 19.866925, "West Male" model life table.

<sup>3</sup> Calculated as  $(100/100+SRB) l_x$  [female] plus  $(SRB/100+SRB) l_x$  [male], where SRB denotes the sex ratio at birth. For Peninsular Malaysia during 1966-1970, SRB = 776,691-739,212 = 1.05, here the weight applied to females is 0.488 and the weight applied to males is 0.512. Vital Statistics, West Malaysia: 1970, page 15 (Department of Statistics, Kuala Lumpur, Malaysia).

<sup>4</sup> Calculated as average of  $l_x$  and  $l_{x+1}$  except when  $x=0$ . When  $x=0$ ,  $L_x$  is calculated separately for males and females according to the procedure described on page 20 of Coale and Demeny, which gives  $L_0$  equal to 96,566 and 95,707 for females and males, respectively. These values are then averaged, using the same weights as before.

<sup>5</sup> Calculated as  $l_0 \div L_x$ .

Table 5. Calculation of Single-Year Life Table  $L_x$  Values for Females: Peninsular Malaysia 1970

Age-x	Female $l_x$	Female $L_x$	Age-x	Female $l_x$	Female $L_x$
10	93,875	93,834	38	89,326	89,190
11	93,794	93,754	39	89,055	88,920
12	93,713	93,672	40	88,784	88,650
13	93,631	93,590	41	88,397	88,204
14	93,550	93,510	42	88,010	87,816
15	93,469	93,414	43	87,623	87,430
16	93,360	93,306	44	87,236	87,042
17	93,251	93,197	45	86,849	86,580
18	93,143	93,088	46	86,311	86,042
19	93,034	92,980	47	85,773	85,504
20	92,925	92,853	48	85,236	84,967
21	92,781	92,709	49	84,698	84,429
22	92,637	92,564	50	84,160	83,740
23	92,492	92,420	51	83,321	82,901
24	92,348	92,276	52	82,481	82,062
25	92,204	92,109	53	81,642	81,222
26	92,014	91,918	54	80,802	80,382
27	91,823	91,728	55	79,963	79,386
28	91,633	91,538	56	78,810	78,234
29	91,442	91,347	57	77,657	77,080
30	91,252	91,141	58	76,504	75,928
31	91,030	90,918	59	75,351	74,774
32	90,807	90,696	60	74,198	73,298
33	90,585	90,473	61	72,398	71,498
34	90,362	90,251	62	70,598	69,698
35	90,140	90,004	63	68,797	67,897
36	89,869	89,734	64	66,997	66,097
37	89,598	89,462	65	65,197	--

Note: Values of  $l_x$  for  $x = 10, 11, \dots, 65$  taken from life table given on page 23 of Abridged Life Tables: Malaysia 1970 (Department of Statistics, Kuala Lumpur, Malaysia). Values of  $l_x$  for intermediate values of  $x$  obtained by linear interpolation. Values of  $L_x$  calculated as  $(l_x + l_{x+1}) \div 2$ .

Table 6. Age Distributions of Women 10-60 Years Old Prior to Census Estimated by Reverse Survival: Administrative District 02, State of Selangor, Malaysia 1970

Age	Number of Women				Census Age Distribution
	4	3	2	1	
10					1349
11				1194	1193
12				1175	1174
13				1072	1071
14				934	933
15	937	1075	1177	998	997
16	1002	936	1073	852	851
17	855	1000	935	897	896
18	901	854	999	863	862
19	867	900	853	772	771
20	776	866	899	545	544
21	547	775	865	572	571
22	575	547	773	655	654
23	659	574	546	562	561
24	565	658	573	574	573
25	578	564	657	600	670
26	676	576	563	619	599
27	604	674	575	602	617
28	623	603	673	637	601
29	607	621	602	601	635
30	641	605	620	556	600
31	606	640	604	454	554
32	560	604	538	405	454
33	558	558	603	533	404
34	409	557	557	503	486
35	537	408	456		
36	506	536	406		
37	489	505	534		
38	378	487	503		
39	323	377	486		

40	282	321	375	483	499
41	354	281	320	374	481
42	479	353	279	318	372
43	368	477	351	278	317
44	283	366	474	350	277
45	287	281	365	472	348
46	330	285	279	362	469
47	407	328	284	278	360
48	308	405	326	282	276
49	216	306	402	324	280
50	182	214	303	399	321
51	199	180	212	300	395
52	316	197	179	210	297
53	278	312	195	177	208
54	164	275	309	193	175
55	220	162	272	305	191
56	247	217	160	268	301
57	327	243	213	157	264
58	215	322	239	210	155
59	135	211	317	236	207
60					231
61					303
62					197
63					123

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Table 7. Own-children Classified by Year of Birth and Age of Mother at Beginning of Year of Birth:  
Administrative District 02, State of Selangor, Malaysia 1970

Age	Year Preceding Census				Age	Year Preceding Census				
	4th	3rd	2nd	1st		4th	3rd	2nd	1st	
10					37	87	69	85	58	(77)
11					38	54	78	70	77	
12					39	48	43	53	49	
13					40	25	26	48	49	
14					41	29	30	26	34	
15	26	19	17	9	42	30	18	12	20	
16	46	51	39	35	43	28	20	15	11	
17	87	92	62	74	44	14	20	17	13	
18	136	111	108	104	45	11	11	12	15	
19	181	163	132	156	46	10	12	11	10	
20	133	190	190	177	47	7	5	7	5	
21	144	217	201	188	48	6	8	6	3	
22	183	142	203	224	49	1	3	9	5	
23	206	183	163	209	50	1	2	1	7	
24	169	197	194	147	51	5	1	4	3	
25	178	182	187	165	52	6	-	2	4	
26	199	180	184	195	53	4	-	2	1	
27	182	202	182	154	54	1	3	4	3	
28	175	194	186	165	55	4	2	2	3	
29	161	180	164	201	56	1	3	-	5	
30	181	177	156	166	57	1	4	3	1	
31	145	161	129	143	58	-	1	2	1	
32	138	164	123	122	59	1	-	-	1	
33	114	129	147	132	60	-	2	1	1	
34	91	98	96	102	61	-	-	-	1	
35	88	68	85	96	62	-	-	-	-	
36	93	98	68	77	63	-	-	-	-	

Table 8. Estimates of Single Year Central Age-Specific Fertility Rates: Administrative District 02, State of Selangor, Malaysia 1970

Age	Year Preceding Census			
	4th	3rd	2nd	1st
(Non-Own Children Factor)	1.07619	1.06891	1.07082	1.06299
(Reverse Survival Factor)	1.06209	1.05895	1.05356	1.04030
(Product of Factors)	1.14301	1.13192	1.12817	1.10583
10				0.0078
11				0.0205
12				0.0537
13				0.0982
14				0.1489
15				0.1992
16				0.2309
17				0.2590
18				0.2930
19				0.2991
20				0.3092
21				0.3247
22				0.3174
23				0.3108
24				0.3253
25				0.3196
26				0.2805
27				0.2404
28				0.2269
29				0.2094
30				0.1894
31				0.1898
32				
33				
34				
35				
36				

0.1738  
0.1593  
0.1349  
0.1104  
0.1074  
0.0865  
0.0576  
0.0423  
0.0378  
0.0333  
0.0260  
0.0159  
0.0146  
0.0184  
0.0159  
0.0153  
0.0144  
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Table 9. Comparison of Age-Specific Fertility Rates: Own-Children Estimates for District of Kuala Langat, Selangor, and Birth Registration Data for Selangor, 1970

Age Group	State of Selangor			Kuala Langat
	Number 1 of Woman	Number of Births 2	Fertility Rate	Fertility Rate <sup>3</sup>
10-14	102,953	032	0.0003	--
15-19	92,039	3,889	0.0423	0.0657
20-24	81,838	15,972	0.1952	0.2562
25-29	54,915	13,849	0.2522	0.3175
30-34	51,396	10,525	0.2048	0.2554
35-39	39,473	5,007	0.1268	0.1694
40-44	30,768	1,513	0.0492	0.0808
45-49	25,038	289	0.0115	0.0255
50-54	21,532	067	0.0031	0.0152
MR	--	031	--	--
TOTAL			4.4270	5.9285

<sup>1</sup> Age Distributions, Table 19, p. 170 (Department of Statistics, Kuala Lumpur, Malaysia).

<sup>2</sup> Vital Statistics: West Malaysia 1970, Table 20.10, p. 63 (Department of Statistics, Kuala Lumpur, Malaysia). Classification by residence of mother.

<sup>3</sup> Own-children estimate. Obtained by averaging single year rates in Table 7.

Table 10. Estimation of Total Fertility Rate for Kuala Langat, Selangor, Malaysia: 1970

Age Group	Number <sup>1</sup> of Women	Birth <sup>2</sup> Rates	Births <sup>3</sup>
10-14	--	0.0003	--
15-19	5,720	0.0423	242.0
20-24	4,377	0.1952	854.4
25-29	2,903	0.2522	732.1
30-34	3,122	0.2048	639.4
35-39	2,543	0.1268	322.5
40-44	1,946	0.0492	95.74
45-49	1,733	0.0115	19.93
50-54	1,396	0.0031	4.33
TOTAL	--		2910

<sup>1</sup>From Table 5.

<sup>2</sup>For state of Selangor from Table 8.

<sup>3</sup>By multiplication of first two columns.

Births registered in Administrative District 02 (Kuala Langat), Selangor, 1970: 2740.<sup>4</sup>

<sup>4</sup>Wild Statistics: West Malaysia 1970, Table 12.00, p. 23 (Department of Statistics, Kuala Lumpur, Malaysia).

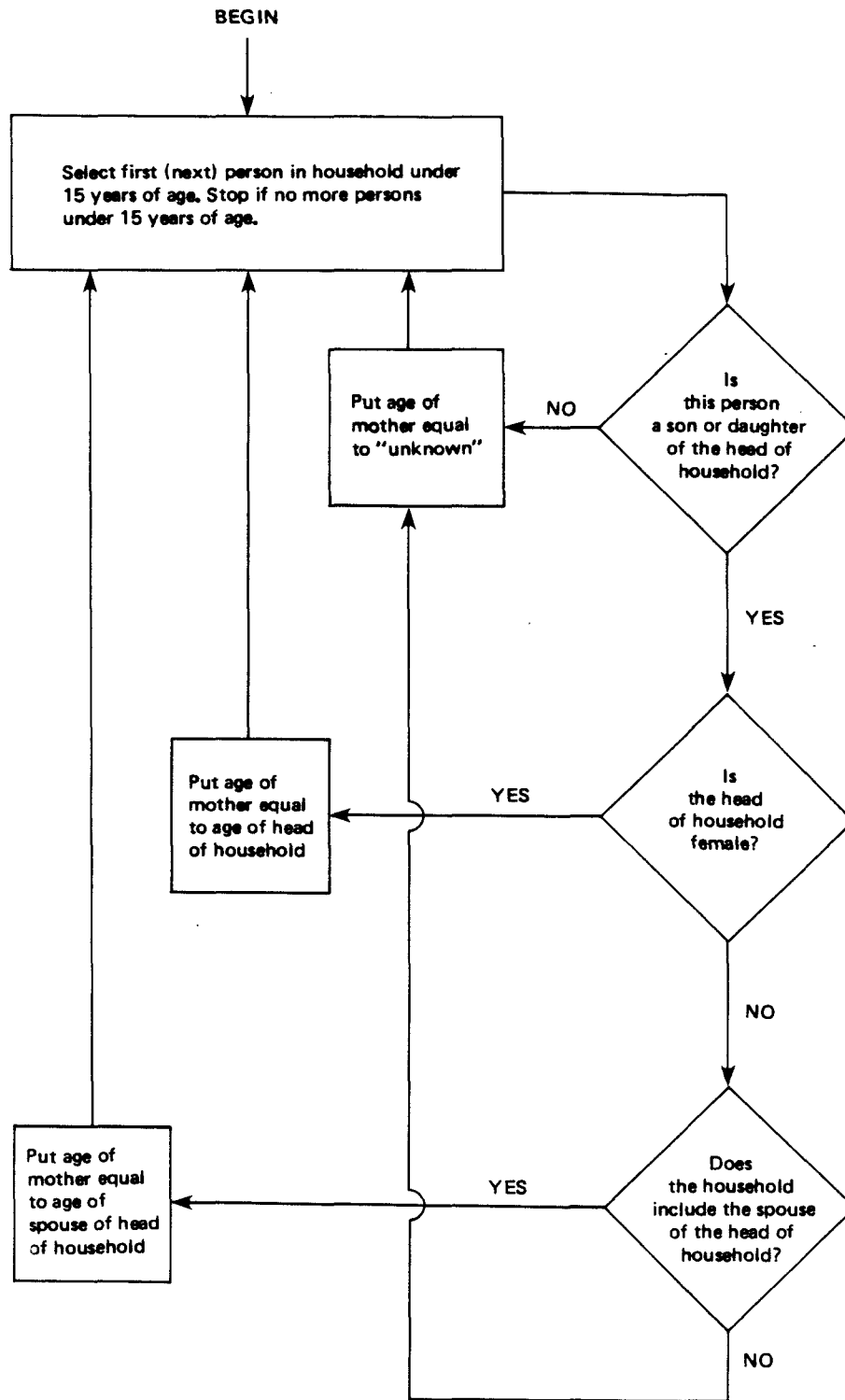
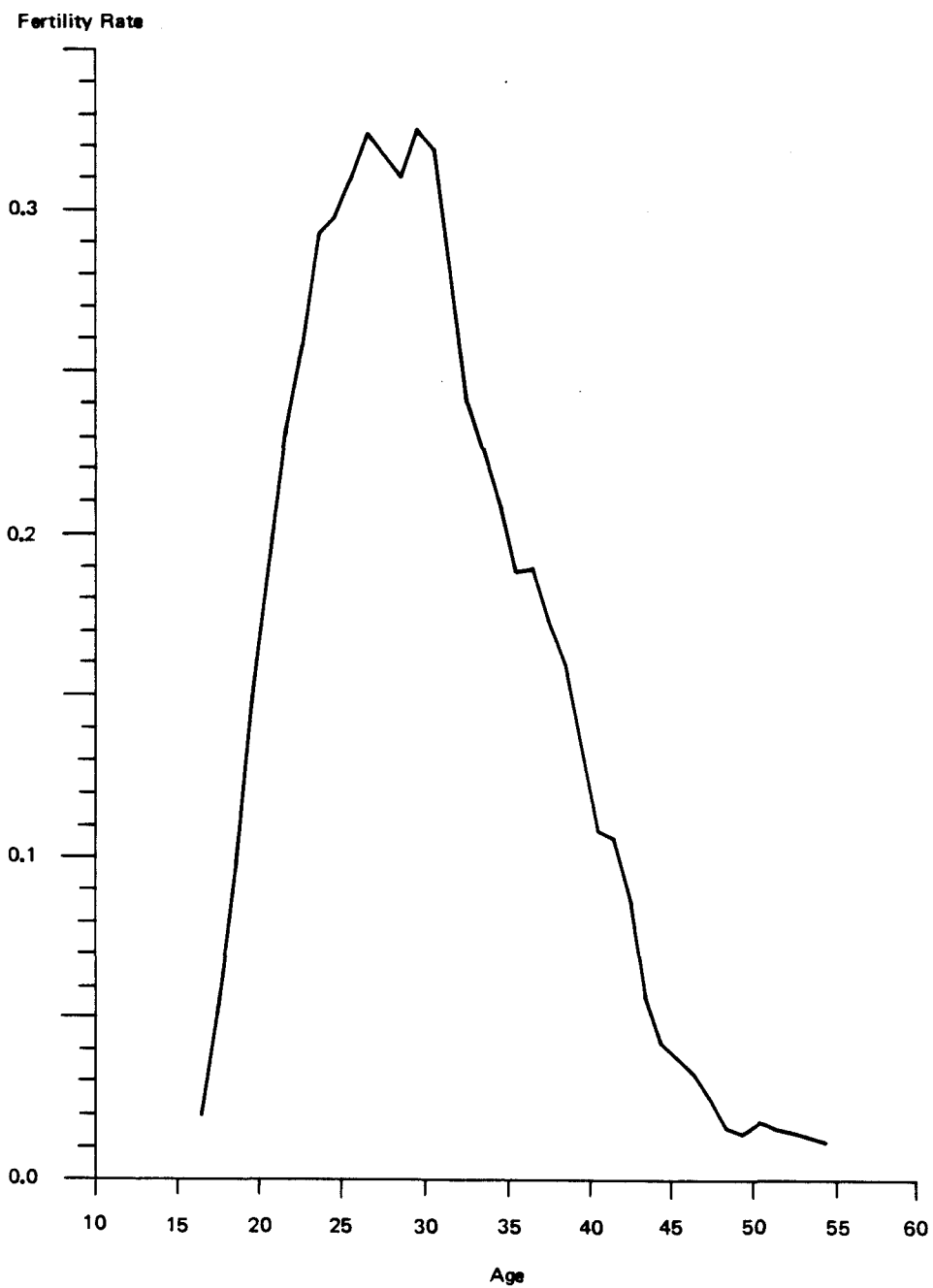


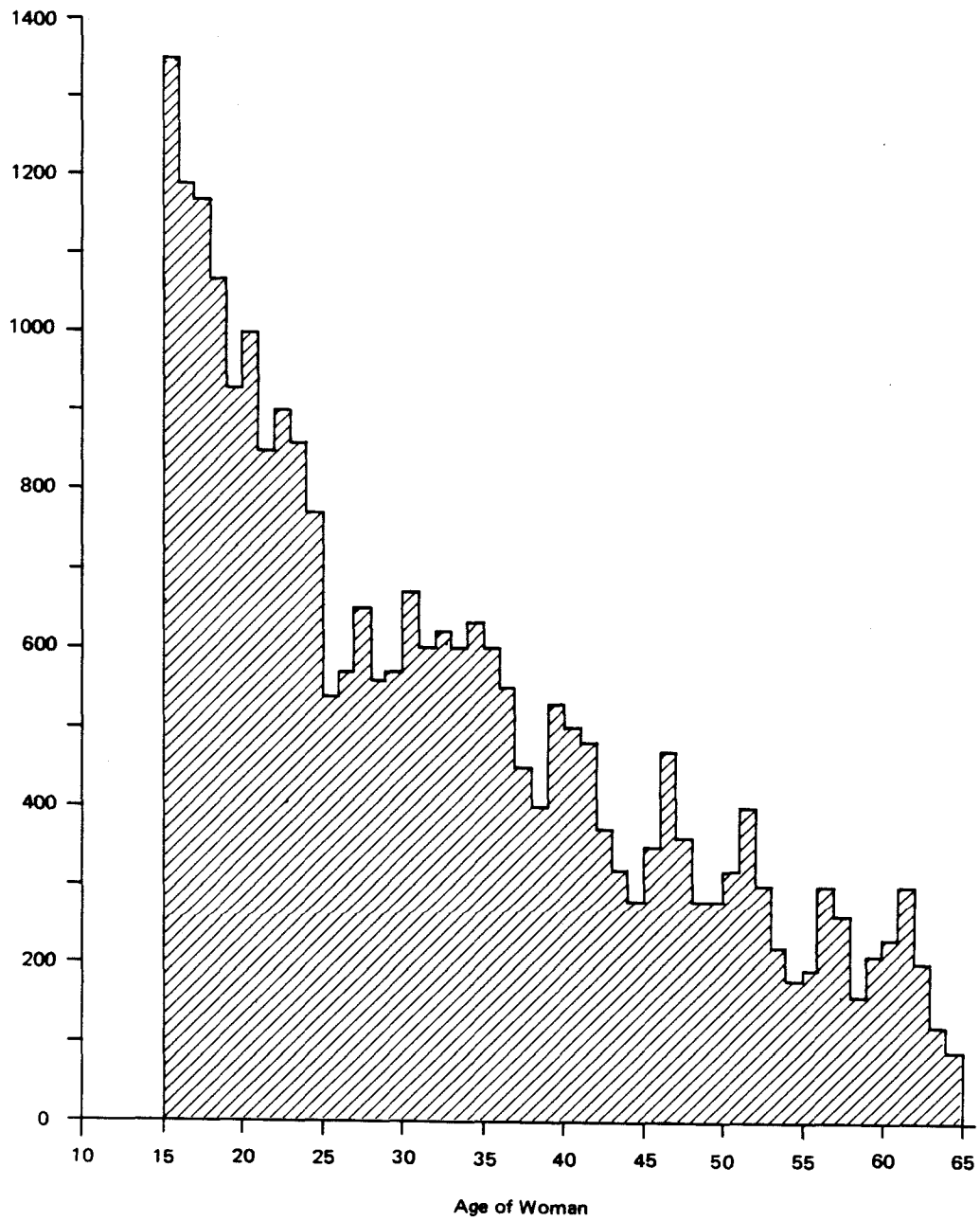
Figure 1 Flow diagram indicating procedure for assigning age of mother from census forms



Source: Table 8

Figure 2 Central age-specific fertility rates estimated by own-children method: Kuala Langat, Selangor, Malaysia, 1970

Number of Women



Source: Table 6

Figure 3 Age distribution of females 15–64 years old: Kuala Langat, Selangor, Malaysia, 1970