COHORT ANALYSIS OF FERTILITY IN ENGLAND AND WALES, 1939-50

BY

WALLIS TAYLOR

Department of Medical Statistics, University of Birmingham, and Central Statistical Office, City of Birmingham

(1) INTRODUCTION

The relevance to social medicine of changes in the age-structure of a community needs little amplification. A previous communication (Taylor, 1951) demonstrated the importance of adequate provision for a community in which survival to a level previously entitled "old age" would be commonplace. Since mortality is so low in the middle age ranges, this communication focuses on the other end of life and seeks to interpret the recent rapid changes in the birth rate with a view to appropriate provision of hospital and ancillary services, the need for which depends on the current number of maternities. Though the issue is of importance in other spheres, *e.g.* in the demand for educational services, it has special relevance to the National Health Service, if we reflect upon the cost of maternity and child welfare services before, during, and after birth.

Since a falling birth rate does not necessarily mean a decline in primiparae (which of all parities mainly occupy hospital beds), it is essential to interpret a changing birth rate in terms of parities and size of family if the outcome is to be a basis for costing medical services. Before the 1939-45 war, the steadiness of the gross and net reproduction rates made the accurate forecasting of future births under different assumptions a matter of arithmetic. Dispute was then about assumptions rather than about method. Since 1939, the rapid fluctuation of the rates (Fig. 1) has made prognostication fruitless without recourse to more refined analysis. The need for new methods is imperative; and this paper sets out one such, the cohort method, new in this context although previously employed in medical research (*vide infra*). This method is then used to analyse recent fertility in England and Wales and to estimate its significance for replacement.

In one of the very few recent analyses of fertility applicable to England and Wales, Hajnal (1947) asks the following questions:

Is the elimination of the complications due to marriage . . . all that demographic analysis can do? Is the next stage to resort to "sociological" explanation, such as that the increased fertility rates are due to "full employment", "family allowances", etc.? . . .

If demographic analysis can reveal no regularity underlying irregular fluctuations in fertility rates as large as those which have recently occurred, it would provide very little basis for a reasoned discussion of population trends. For all such discussion assumes that a reasonably orderly and smooth development of fertility rates may be expected.

Hajnal's questions imply a doubt widely current among well-informed persons, *viz.*: What relevance to the contemporary scene have the demographic studies undertaken in the inter-war period, when the methods exploited by R. Kuczynski, Enid Charles, and other demographers were adequate to demonstrate consistently falling fertility and its immediate effect on the age-composition of the population.

A temporary reversal of the pre-war trend during the war and the immediate post-war years has encouraged the idea that earlier work on the social agencies which determine fertility has little relevance to present conditions, and that forecasts suggested by the course of events during the inter-war period are invalid.

This idea is due in part to a reason adumbrated in earlier remarks. The credentials of composite indices of fertility such as the gross and net reproduction rates presume a relatively static situation; in a rapidly-changing situation the picture they disclose may be highly misleading. For instance, a newly-imposed and powerful incentive to earlier marriage may result in a sudden rise of such rates shortly followed by a spectacular fall during a period in which fertility* does not materially change.

* Throughout this communication the term "fertility" is used, as all demographers use it, to indicate the current rate of producing progeny. Biologists use the term with emphasis on the ability to produce progeny, a concept for which demographers use the term "fecundity".

FIG. 1.—Fertility and marriage rates, England and Wales, 1868-1951.

It is the writer's aim to show that smooth trends did exist in the disturbed period from 1939 to 1949, and are apparent by recourse to analytical methods necessarily more intricate than previously required. Contrary to many opinions expressed in the recent past, we shall see that replacement is not happening in England and Wales, and that a further decline in fertility is indicated. Such is the cohort method.* The earliest publications illustrating cohort analysis seem to be those of Kermack, McKendrick, and McKinlay (1934) on mortality rates, and of Barclay

and Kermack (1937-8) on fertility; but these pioneer contributions are the more creditable against the background of inadequacies of source material then available. Until 1939, when the Registrar-General was first able to publish a breakdown of births by maternal age, requisite data for application of the cohort method to fertility were not available. Karmel (1949) has apparently since prepared material suitable for a cohort analysis, but uses it to develop an annual measure—the index of current marriage fertility in Australia.

In the U.S.A. a monograph by P. K. Whelpton has apparently substantially advanced the analysis of American fertility by cohort methods. Although the work is as yet unpublished, a review by Kiser (1952) describes a novel approach, overcoming the defects of less refined data than are available in Great

* This is, of course, analogous to a Family Census, and *en passant* it is perhaps advisable to detail the reasons for not using the Family Census conducted by the Royal Commission on Population. The first is that the Census took place in 1946—before the birth boom. It is not possible to continue the analysis. The second is that the published volume (1950) has tables for Great Britain not split for age and parity. It is impossible to understand the situation without a complete analysis. The third is that the marriage populations used seem to be erroneous. Fourthly, the Census (a sample census) was voluntary, and of course excluded all data for mothers who had died before the Census date.

Britain by the use of "actual" and "hypothetical" cohorts.

(2) THE COHORT METHOD

In the domain of mortality or morbidity, the statistical procedure referred to as the cohort method is comparatively simple both in conception and in execution. Given a breakdown of deaths by age over a sufficiently long period, it is possible to assemble for all persons born in a given calendar year, *i.e.* of one and the same cohort, the death and survival rates at each year of life up to the age attained by the cohort at the latest date to which the statistics are referable. For completed cohorts it is thus possible to make a life-table which summarizes the mean duration of life of persons subjected to the same initial handicaps, in terms of conditions prevailing at time of birth, in contradistinction to the customary composite life-table which embodies what would happen if current risks of death at each age remained constant throughout a generation. The constitution of such a cohort life-table is naturally more laborious than that of the alternative, but is otherwise straightforward.

While the cohort life-table gives a much more precise picture of the changing hazards of health, it is evidently of limited utility, since it can be complete only for cohorts already extinguished at the current calendar year, and will, therefore, be most instructive only when our concern is with trends referable to a much earlier date. From this point of view, the cohort approach is of much greater utility in relation to our present theme because the period of fertile married life, especially under modern conditions, is quite a small fraction of a generation. On the other hand, its application involves special difficulties apart from the fact that a breakdown of births by maternal age or duration of marriage is available only in recent British statistics (since 1939) and is not as yet obtainable for most countries. For cohort analysis of mortality, we need to know only births and deaths by calendar year and age at death, in order to relate deaths at age x in calendar year y_m back to birth year $y_m - x$. For cohort analysis of fertility we need to know births, marriages by age, and both calendar year and duration of marriage at birth.

A special difficulty besetting the use of the cohort method in connection with fertility in contradistinction to morbidity when the requisite data are indeed available arises from the fact that procreation is not, as is death, a unique event. To marriages in one and the same year there may and will commonly be more than one birth before the extinction of the fertility cohort, *i.e.* termination of the reproductive

period. This, of course, makes the assembly of relevant data referable to one and the same cohort somewhat more laborious, even if we confine our attention to total births. If figures tabulated by parity as well as by duration of marriage for one and the same calendar year are available, we can also make, but with considerable additional labour, a more refined analysis, exhibiting how the proportion of first, second, etc., births is changing *pari passu* with the changing size of the completed family. Such refinement is useful for the reason already stated, *i.e.* that primiparae are subject to peculiar hazards, but it is also essential if we are to draw any legitimate conclusions about current trends on the basis of cohorts as yet unextinguished in the sense defined.

Thus, if we investigate fertility over a short period, and the cohort has achieved substantial fertility at the durations investigated, any change in the rate may have a small effect measured as a proportion of *all* the previous cohort births. By segmenting into parities, it may, however, be obvious that external events have stimulated fertility in, for example, families already having three children, so that a high proportion of such families, which may themselves be only a small proportion of a segmented cohort, have added a further birth. The importance of this knowledge is obvious if we wish to measure the relative efficacy and reaction of external stimulus to fertility.

In the application of the cohort method to the study of fertility, our problem is for a further reason less simple than those which arise in the study of mortality. When our concern is with mortality experience, the year of birth of a constituent individual is a sufficient criterion for the identification of the cohort. When our concern is with fertility experience, we have to reckon with the fact that in one and the same calendar year individuals marry at different ages. Since age at marriage influences both total fertility and the fertility pattern, *i.e.* spacing of births, it will thus be necessary to follow separately not merely the history of all marriages referable to a particular calendar year, but all marriages referable to different age groups in the one calendar year. The reader may here ask whether it would be necessary to make this distinction if we adopted the same criterion by identifying the constitution of the cohorts for problems of either type, *i.e.* if we define our fertility cohorts by the mother's year of birth. The answer is that our special concern in this context is to evaluate the fertility trend obscured by agencies simultaneously and successively promoting both earlier marriage and delay of procreation. From this point of view,

the fertility experience of a woman born in a particular calendar year tells us very little if we do not know her age at marriage, *e.g.* the fertility experience of a woman born in 1900, up to the end of her reproductive life (say 1945) will be different if she is married in 1930 from what it will be if she is not married until 1940. Similarly, the fertility experience of a woman married in 1940 at the age of 30 will be different from that of a woman married in the same year at the age of 20.

A helpful metaphor to bring into focus the differences between indices such as the expectancy of life in the customary life-table and the gross reproduction rate on the one hand, and what emerges from the cohort approach on the other, is to liken the first to a snapshot of a procession and the second to a moving picture. If the procession is orderly and uniform, the latter may give little information beyond that disclosed by the former, and our acceptance of the customary life-table indices as informative measures of community health is consistent with experience when the community is not subject to major epidemics or calamities. If we imagine the occurrence of some such great catastrophe, the inadequacies of the snapshot approach of the actuary will be evident. In the year of an epidemic, prevailing death rates rise over a wide range of age groups, and the so-called mean expectation of life, *i.e.* mean duration calculated on the basis of current rates, falls accordingly; but the effect is operative for each completed cohort during one year only and is diluted accordingly by the prevailing risks in previous years. Consequently there is no distortion of the secular trends except in so far as the risk of death depends on the age reached by the cohort during the year of epidemic. The situation which is our concern in this investigation is essentially an epidemic situation in which for comparable, though more diverse, reasons the snapshot approach is wholly misleading. We have to deal with a period in which two variables distort the picture. There have been large fluctuations of nuptiality in circumstances which have both hastened and delayed the assumption of the responsibilities of parenthood.

The essential difference between the snapshot and the moving picture is felt in more than one medical situation. Since it would be true to say that hospital reports still publish figures of duration of stay based on current-year averages, it is not trivial to remark that only two indices of duration are meaningful. We might adopt the snapshot approach by taking a census on a given date and applying the conventional life-table method to interpret its meaning as an overall picture of current

conditions; but the usefulness of this procedure, not as yet applied to the writer's knowledge, is open to question because the figures available for any one census day, being small, are liable to a large sampling error. In practice, therefore, we have no option in choosing an appropriate procedure, *i.e.* we must base any figures for duration of stay on patients already discharged, and therefore to figures of duration referable to admissions not all necessarily in the same calendar year. In short, circumstances force us to adopt what is in principle the cohort method; but we then do so less because hospital populations are subject to violent fluctuation than because the snapshot approach would be inconvenient and the disadvantages of the cohort approach *vis à vis* the end in view, *i.e.* a statement referable to current conditions, are trivial in most situations.* With regard to duration of stay in hospital one may say that the snapshot approach duplicates and exaggerates all the disadvantages of crude birth and death rates.

It may help to clarify the need for a new approach to an evaluation of current trends of fertility if we schematically contrast situations in which the incidence of marriages and births, singly or simultaneously, may alter without any concurrent change in fertility as exhibited in Tables I – III below.

Table I exhibits the fertility experience of a hypothetical static population with fixed size of the completed family throughout the period covered, the only variable to the total number of births being a temporary rise in the marriage rate followed by a compensatory temporary fall below the former stable level to which it eventually returns. For illustrative purposes, we assume that all marriages produce 2-child families spaced in the same way, a first birth occurring in the second year of marriage and a second birth in the fifth year of marriage. Here there is evidently no difficulty in recognizing the significance of the relevant situation.

Table II exhibits a hypothetical static population with fixed nuptiality. As before, fertility is also constant over the period covered and at the same level the spacing of the family being initially as in Table I. Here, however, we interpolate a temporary phase during which the second birth follows more rapidly after the first, the second birth then occurring in the third year of marriage. Thus we may distinguish three periods. In the first and in the last, all second births will be referable to one cohort but during the middle period they will be referable to different cohorts. Again it is not difficult to see what has really happened.

* Mental hospitals constitute a special case since clearance for most other types of hospital cases does not involve a delay of more than 18 months if we base our figures on discharge dates.

TABLE I
CHANGE IN INCIDENCE OF MARRIAGE (BIRTHS BEING CONSTANT)

Marriages			Births				Total
Number	Year	Phase	First		Second		
			Number	Corresponding date of marriage of cohort	Number	Corresponding date of marriage of cohort	
100	y	1 (stable)	—	—	—	—	—
100	$y + 1$		100	y	—	—	—
100	$y + 2$		100	$y + 1$	—	—	—
100	$y + 3$		100	$y + 2$	—	—	—
100	$y + 4$		100	$y + 3$	100	y	200
100	$y + 5$		100	$y + 4$	100	$y + 1$	200
200	$y + 6$	2 (temporary rise)	100	$y + 5$	100	$y + 2$	200
200	$y + 7$		200	$y + 6$	100	$y + 3$	300
50	$y + 8$	3 (secondary fall)	200	$y + 7$	100	$y + 4$	300
50	$y + 9$		50	$y + 8$	100	$y + 5$	150
50	$y + 10$		50	$y + 9$	200	$y + 6$	250
50	$y + 11$		50	$y + 10$	200	$y + 7$	250
100	$y + 12$	4 (stable at y th year level)	50	$y + 11$	50	$y + 8$	100
100	$y + 13$		100	$y + 12$	50	$y + 9$	150
100	$y + 14$		100	$y + 13$	50	$y + 10$	150
100	$y + 15$		100	$y + 14$	50	$y + 11$	150
100	$y + 16$		100	$y + 15$	100	$y + 12$	200

TABLE II
CHANGE IN INCIDENCE OF BIRTHS (MARRIAGES BEING CONSTANT)

Marriages			Births						Total
			First		Second				
Number	Year	Phase	Number	Corresponding date of marriage of cohort	Number	Corresponding date of marriage of cohort	Number	Corresponding date of marriage of cohort	
100	y	1	—	—	—	—	—	—	—
100	$y + 1$		100	y	—	—	—	—	—
100	$y + 2$		100	$y + 1$	—	—	—	—	—
100	$y + 3$		100	$y + 2$	—	—	—	—	—
100	$y + 4$		100	$y + 3$	100	y	—	—	200
100	$y + 5$		100	$y + 4$	100	$y + 1$	—	—	200
100	$y + 6$	2	100	$y + 5$	100	$y + 2$	—	—	200
100	$y + 7$		100	$y + 6$	100	$y + 3$	—	—	200
100	$y + 8$		100	$y + 7$	100	$y + 4$ and 100	$y + 6$	300	
100	$y + 9$	3	100	$y + 8$	100	$y + 5$ and 100	$y + 7$	300	
100	$y + 10$		100	$y + 9$	—	—	100	$y + 8$	200
100	$y + 11$		100	$y + 10$	—	—	—	—	100
100	$y + 12$		100	$y + 11$	—	—	—	—	100
100	$y + 13$		100	$y + 12$	100	$y + 9$	—	—	200
100	$y + 14$		100	$y + 13$	100	$y + 10$	—	—	200
100	$y + 15$		100	$y + 14$	100	$y + 11$	—	—	200
100	$y + 16$		100	$y + 15$	100	$y + 12$	—	—	200

Within the framework of the same highly schematic assumptions common to the two foregoing situations, namely fixed fertility and a static population, we may simultaneously vary, as in Table III, both the nuptiality rate and the spacing of the family for a brief period, returning to a pre-existing stable level of both. Evidently the record of *total* births now discloses a much more blurred picture. From this we can discern the significance of changes in birthrate, with a view to disclosing the true change in fertility suspected to have occurred, *only* if we can separately evaluate the fertility of marriages referable to one calendar year. If this is true of a situation so highly simplified for heuristic purposes,

it must be true *a fortiori* of any real situation we are likely to encounter, since a real population will *not* be static and the effect of any major change with respect to nuptiality, family spacing, or total fertility will be confused by minor fluctuations, especially in communities where family limitation has become progressively more common.

The nature of the cohort method of exhibiting current trends of fertility and the reason why it is essential to adopt such a method in present circumstances has thus been briefly indicated. It will suffice if we relegate to the Technical Appendix (p. 242) details of assembling the requisite data from the available official statistics. Here, for illustrative

TABLE III
COINCIDENT CHANGES IN INCIDENCE OF MARRIAGE AND SECOND BIRTHS

Marriages		Births						Total
		First		Second				
Number	Year	Number	Corresponding date of marriage of cohort	Number	Corresponding date of marriage of cohort	Number	Corresponding date of marriage of cohort	
100	y	—	—	—	—	—	—	—
100	y + 1	100	y	—	—	—	—	—
100	y + 2	100	y + 1	—	—	—	—	—
100	y + 3	100	y + 2	—	—	—	—	—
100	y + 4	100	y + 3	100	y	—	—	200
100	y + 5	100	y + 4	100	y + 1	—	—	200
200	y + 6	100	y + 5	100	y + 2	—	—	200
200	y + 7	200	y + 6	100	y + 3	—	—	300
50	y + 8	200	y + 7	100	y + 4	and 200	y + 6	500
50	y + 9	50	y + 8	100	y + 5		200	y + 7
50	y + 10	50	y + 9	—	—	50	y + 8	100
50	y + 11	50	y + 10	—	—	—	—	50
100	y + 12	50	y + 11	—	—	—	—	50
100	y + 13	100	y + 12	50	y + 9	—	—	150
100	y + 14	100	y + 13	50	y + 10	—	—	150
100	y + 15	100	y + 14	50	y + 11	—	—	150
100	y + 16	100	y + 15	100	y + 12	—	—	200

purposes, the values for one, the 1939 cohort, are given (Appendix Table A, p. 243).

(3) CONTEMPORARY PICTURE

The foregoing sections have briefly indicated the nature of the problem with which this communication deals, and the need for more refined methods than have hitherto sufficed for basing an intelligent prognosis upon data which provoke us to ask: Do recent events force us to repudiate conclusions suggested by the experience of the inter-war years?

What immediately follows states briefly what is essentially new about the fertility experience of the decade 1939-49, and how we propose to employ the cohort method outlined in Section 2 to an evaluation of the situation.

In the two decades 1919-39, available data with regard to Britain as a whole point to the size of the completed family interpreted within the framework of the cohort approach as steadily decreasing without major fluctuations. Meanwhile the mean age of marriage and the proportion of married both remained at much the same level and in any case were likewise subject to no major fluctuation in Britain. From the introduction of conscription in 1938 we enter on a new period. Nuptiality rates undergo drastic fluctuations and annual total births within the next decade do likewise. Though, for the reasons stated, we have no comprehensive numerical data before the Population Statistics Act (1938), we have very good reason for believing that the *fertility pattern* was also unstable, in the sense that any appropriate index of spacing of births would also have disclosed abrupt changes. Thus we have a situation in which all the

difficulties disclosed by the heuristic approach leading up to Table III coexist with the concomitant difficulties arising from the fact that war itself entails temporary but considerable changes in the age-composition of the civilian population. Such then is the situation which has understandably provoked scepticism with reference to forecasts based on the experience of the inter-war years. Such also is the situation which we can expect to clarify only by the approach outlined in Sections 1 and 2.

We shall first attempt (in Section 4 below) to bring into perspective the significance of the disputable immediate post-war birth boom. We shall then attempt (in Section 5) to evaluate current (*i.e.* 1939-50) fertility in terms of replacement by an index referable to the cohort procedure which we employ throughout the succeeding sections. It will then be appropriate in Section 6 to use the cohort method to disclose what is the size of the completed family referable to different ages at marriage. Finally, in Section 7, we shall review an issue first raised by Kuczynski in relation to the possible consequences of encouragement of early marriage under the Nazi régime, *i.e.* whether seemingly sustained lower level of age at marriage will suffice to restore fertility to replacement level.

(4) EVALUATION OF THE POST-WAR BIRTH BOOM

The first duty of a summarizing index is to summarize. In this sense crude live birth, marriage, and reproduction rates are valuable indices in so far as they condense information relevant to a stable situation. A second and not subsidiary requirement is to disclose underlying trends in a changing situation. The obvious solution of averaging by one

method or another is rarely satisfactory. If a situation has changed, it is desirable to know the fact as early as possible, yet a short-term average is ephemeral in a period when indices are rapidly fluctuating and a long-term average is unrevealing. Though the 1947 birth boom was hailed as a substantial change in fertility habits, we shall now see that the change in *family building* accounts for a great part of the boom. Despite the fact that the 1947 cohort is of somewhat higher fertility than in recent years, fertility has fallen ever since. Such is the argument we shall now seek to substantiate.

Fig. 1 (p. 227) shows the great variations in both fertility and marriage indices that occurred during the period. With a falling family size more variation in fertility rates is to be expected, since first births, which follow rapidly after marriage, become increasingly important, and the arithmetical "damping" of oscillations which the necessarily delayed higher parities may produce disappear. Any variation of marriage incidence will thus affect the crude live birth rate more than was previously true.

To exhibit the fluctuations in annual fertility,

FIG. 2.—Cohort live birth rates by duration of marriage, arranged by calendar year.

FIG. 3.—Cohort live birth rates by duration of marriage, arranged by cohort.

TABLE IV
YEARLY PERCENTAGE CHANGE IN COHORT FERTILITY RATES
(Mothers aged 21-25 years at marriage)

Year	Cohort										
	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
<i>First Parity</i>											
1940	- 13	—	—	—	—	—	—	—	—	—	—
1941	- 51	+ 4	—	—	—	—	—	—	—	—	—
1942	- 14	- 32	+ 14	—	—	—	—	—	—	—	—
1943	- 27	- 29	- 38	+ 21	—	—	—	—	—	—	—
1944	- 33	- 32	- 33	- 42	+ 18	—	—	—	—	—	—
1945	- 29	- 40	- 40	- 44	- 56	0	—	—	—	—	—
1946	0	+ 37	+ 34	+ 19	- 15	- 44	+ 24	—	—	—	—
1947	- 34	- 37	- 30	- 20	- 9	- 27	- 45	+ 32	—	—	—
1948	- 53	- 58	- 57	- 59	- 58	- 54	- 53	- 62	- 17	—	—
1949	—	- 43	- 50	- 44	- 41	- 41	- 43	- 45	- 58	- 18	—
1950	—	—	- 30	- 33	- 40	- 38	- 39	- 41	- 44	- 56	- 14
<i>Second Parity</i>											
1941	+ 97	—	—	—	—	—	—	—	—	—	—
1942	+ 10	+ 155	—	—	—	—	—	—	—	—	—
1943	- 3	+ 14	—	—	—	—	—	—	—	—	—
1944	+ 12	+ 23	+ 188	—	—	—	—	—	—	—	—
1945	- 36	- 20	- 14	+ 7	+ 177	—	—	—	—	—	—
1946	+ 43	+ 29	+ 24	+ 22	+ 30	+ 221	—	—	—	—	—
1947	- 22	- 14	0	+ 10	+ 15	+ 29	+ 271	—	—	—	—
1948	- 40	- 36	- 32	- 25	- 18	- 14	+ 10	+ 222	—	—	—
1949	—	- 29	- 29	- 26	- 15	- 15	- 13	0	+ 136	—	—
1950	—	—	- 19	- 21	- 31	- 26	- 20	- 15	- 4	+ 100	—

we have related fertility rates to the year in which they occurred (Fig. 2). Thus each vertical column contains rates due to different cohorts, but represents the fertility rates of any one calendar year (each vertical box refers to rates produced by different cohorts). Fig. 3, where rates for the same cohort in successive years are vertically imposed, shows a much more regular appearance. The rapid fluctuations of Fig. 2, which is already standardized for fluctuation in marriage numbers, virtually disappear, and reasonable prognostication becomes possible.*

It is now clear that external events affect not only marriage, but also fertility. Whereas marriage in Gt. Britain is committal in the sense that it cannot legally occur more than once without the intervention of a protracted interval, the births produced in one year do indeed affect future occurrences of a like nature in the same family. We may, therefore, speak meaningfully of births as postponed or expedited. Thus Fig. 2 shows that the high values of 1947 fell rapidly in 1948—a change which should be fairly equally distributed over all cohorts (Fig. 3).

Table IV classifies the changes in cohort habits by year of occurrence for the most important age group by exhibiting the percentage fall or rise of succeeding years relative to the immediately preceding year. Algebraically the values tabulated are:

$$\left\{ \frac{\text{Specific Fertility Rate of Cohort } x \text{ Duration } (n+1) - \text{Specific Fertility Rate of Cohort } x \text{ Duration } n}{\text{Specific Fertility Rate of Cohort } x \text{ Duration } n} \right\} \times 100$$

* In Fig. 2 approximate values referring to complete cohorts for marriages before 1939 have been inserted. They are not relevant to Fig. 3 and do not appear there.

Here, therefore, a calendrical change affecting all cohorts will appear as a horizontal change. Clearly a change occurred in all parities and all cohorts in the 1946-48 period. In 1946 many values are reversed in sign, and the negative values are much smaller than customary. Some values are positive in 1947, but after this date all except one are negative.† It is clear, therefore, that 1946 and 1947 showed a reversal of trends at *all durations of marriage* in all cohorts. By 1948 this effect has disappeared and a more normal situation prevails.

We now compare the cumulative effects of fertility. Tables V and VI (overleaf) show live birth rates classified by duration of marriage and cohort year. In these Tables the values for the same duration of each cohort appear on the same horizontal line. First are shown the cumulative rates (V) and after this the actual yearly rates (VI). The cumulative rates show how far in advance or in arrears is the fertility of any particular cohort at any time, and the yearly rates show in which years the changes which led to this situation took place. Thus Table V will show the effect and Table VI the incidence of changes in fertility.

Two types of comparison are admissible. First we may postulate a norm and measure the difference between each cohort and this norm. Alternatively we may measure the differences between different cohorts. To represent the norm we take a simple

† The final horizontal value on each line is the percentage change in the second year of marriage and, being heavily affected by its proximity to marriage, should be ignored in this argument.

TABLE V
CUMULATIVE FERTILITY RATES (TOTAL BIRTHS)

Duration of Marriage	Cohort												Average
	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	
Age Group 16-20													
1	465	324	256	255	275	299	284	295	400	416	430	410	342
2	748	602	521	525	572	579	577	645	763	777	760	—	643
3	978	843	728	744	779	810	853	911	1,051	1,042	—	—	874
4	1,187	1,046	919	924	998	1,057	1,077	1,139	1,287	—	—	—	1,070
5	1,368	1,242	1,073	1,146	1,247	1,260	1,269	1,334	—	—	—	—	1,242
6	1,547	1,400	1,279	1,382	1,433	1,428	1,429	—	—	—	—	—	1,414
7	1,691	1,620	1,484	1,550	1,596	1,568	—	—	—	—	—	—	1,585
8	1,873	1,816	1,626	1,681	1,720	—	—	—	—	—	—	—	1,743
9	2,027	1,954	1,735	1,792	—	—	—	—	—	—	—	—	1,877
10	2,145	2,066	1,826	—	—	—	—	—	—	—	—	—	2,012
Age Group 21-25													
1	232	189	177	182	203	237	216	235	313	296	266	246	233
2	464	406	396	419	463	497	505	575	617	585	530	—	496
3	630	600	574	612	635	713	747	803	845	795	—	—	695
4	797	771	743	761	818	928	934	996	1,037	—	—	—	865
5	948	937	874	947	1,019	1,090	1,093	1,162	—	—	—	—	1,009
6	1,100	1,067	1,050	1,137	1,167	1,230	1,229	—	—	—	—	—	1,140
7	1,217	1,241	1,215	1,271	1,299	1,344	—	—	—	—	—	—	1,264
8	1,362	1,392	1,330	1,382	1,400	—	—	—	—	—	—	—	1,373
9	1,484	1,497	1,415	1,471	—	—	—	—	—	—	—	—	1,467
10	1,569	1,579	1,488	—	—	—	—	—	—	—	—	—	1,545
Age Group 26-30													
1	180	155	160	164	185	220	189	224	283	256	228	220	207
2	380	337	355	374	421	455	461	535	559	521	467	—	442
3	517	510	521	552	581	657	670	743	760	710	—	—	622
4	664	666	674	689	754	844	831	916	924	—	—	—	774
5	802	813	795	853	922	990	968	1,060	—	—	—	—	900
6	938	930	945	1,005	1,048	1,106	1,079	—	—	—	—	—	1,007
7	1,044	1,077	1,080	1,118	1,160	1,195	—	—	—	—	—	—	1,112
8	1,166	1,199	1,175	1,206	1,238	—	—	—	—	—	—	—	1,197
9	1,266	1,284	1,243	1,269	—	—	—	—	—	—	—	—	1,265
10	1,335	1,346	1,298	—	—	—	—	—	—	—	—	—	1,326
Age Group 31-35													
1	174	147	157	157	172	191	178	192	222	209	190	188	181
2	350	313	337	348	378	394	417	454	450	422	390	—	387
3	473	446	479	493	516	564	585	622	600	560	—	—	534
4	591	568	607	609	653	705	716	755	719	—	—	—	658
5	700	683	707	727	773	806	818	861	—	—	—	—	759
6	799	768	809	825	861	884	896	—	—	—	—	—	835
7	872	851	891	894	926	937	—	—	—	—	—	—	895
8	938	914	946	940	966	—	—	—	—	—	—	—	941
9	986	953	976	967	—	—	—	—	—	—	—	—	970
10	1,014	976	995	—	—	—	—	—	—	—	—	—	995

Italics = < Average.

average over the period. If, in fact, the 1947 cohort represents a new level of fertility likely to be followed by successive cohorts, the norm will not be meaningful, but as we have seen this is unlikely.

For comparison of the alternative type, we assume that a cohort for which we have more data has reached a more stable position. We shall, therefore, compare the 1939 cohort with other cohorts. It should be noted that the averages of the lower durations here necessarily refer to larger numbers.

Perhaps the most striking features of Tables V and VI are the high fertility and distinctive character of the 1939 sub-cohort of women married in the age group 16-20. It is different both from later cohorts married at the same age and from those married in the same year at different ages. The very high fertility in the first year of marriage has been sufficient to keep this cohort higher than the average

throughout the whole period.* We may only speculate about the reason for this. For instance, it may have been due to the 1938 political situation, possibly to conscription in 1938 of the 21-year-old male age group, to relaxation from the 1938 war scare, and to belief in "peace in our time". The highest incidence actually seems to have been in the third quarter of the year, but no returns are available for occurrences in months or quarters by age of mother. Certainly it was not due to the outbreak of war which occurred far too late in 1939 to have any effect upon the fertility of that year.

It is also noticeable that in the 21-25 age group the first year of the 1939 cohort showed an extremely high rate of fertility. The same is not true of the older cohorts. It is interesting to see that the 1939

* If the averages are re-calculated after the 1946-48 cohorts have experienced ten years of marriage this may not necessarily be true.

TABLE VI
YEARLY FERTILITY RATES (TOTAL BIRTHS)

Duration of Marriage	Cohort												Average
	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	
Age Group 16-20													
1	465	324	256	255	275	299	284	295	400	416	430	410	342
2	283	278	265	270	297	280	293	350	363	361	330	—	306
3	230	241	207	219	207	231	276	266	288	265	—	—	243
4	209	203	191	180	219	247	224	228	236	—	—	—	215
5	181	196	154	222	249	203	192	195	—	—	—	—	199
6	179	158	206	236	186	168	160	—	—	—	—	—	185
7	144	220	205	168	163	140	—	—	—	—	—	—	173
8	182	196	142	131	124	—	—	—	—	—	—	—	155
9	154	138	109	111	—	—	—	—	—	—	—	—	128
10	118	112	91	—	—	—	—	—	—	—	—	—	107
Age Group 21-25													
1	232	189	177	182	203	237	216	235	313	296	266	246	233
2	232	217	219	237	260	260	289	340	304	289	264	—	265
3	166	194	178	193	172	216	242	228	228	210	—	—	203
4	167	171	169	149	183	215	187	193	192	—	—	—	181
5	151	166	131	186	201	162	159	166	—	—	—	—	165
6	152	130	176	190	148	140	136	—	—	—	—	—	153
7	117	174	165	134	132	114	—	—	—	—	—	—	139
8	145	151	115	111	101	—	—	—	—	—	—	—	125
9	122	105	85	89	—	—	—	—	—	—	—	—	100
10	85	82	73	—	—	—	—	—	—	—	—	—	80
Age Group 26-30													
1	180	155	160	164	185	220	189	224	283	256	228	220	205
2	200	182	195	210	236	235	272	311	276	265	239	—	238
3	137	173	166	178	160	202	209	208	201	189	—	—	182
4	147	156	153	137	173	187	161	173	164	—	—	—	161
5	138	147	121	164	168	146	137	144	—	—	—	—	146
6	136	117	150	152	126	116	111	—	—	—	—	—	130
7	106	147	135	113	112	89	—	—	—	—	—	—	117
8	122	122	95	88	78	—	—	—	—	—	—	—	101
9	100	85	68	63	—	—	—	—	—	—	—	—	79
10	69	62	55	—	—	—	—	—	—	—	—	—	62
Age Group 31-35													
1	174	147	157	157	172	191	178	192	222	209	190	188	181
2	176	166	180	191	206	203	239	262	228	213	200	—	206
3	123	133	142	145	138	170	168	168	150	138	—	—	147
4	118	122	128	116	137	141	131	133	119	—	—	—	127
5	109	115	100	118	120	101	102	106	—	—	—	—	109
6	99	85	102	98	88	78	78	—	—	—	—	—	90
7	73	83	82	69	65	53	—	—	—	—	—	—	71
8	66	63	55	46	40	—	—	—	—	—	—	—	54
9	48	39	30	27	—	—	—	—	—	—	—	—	36
10	28	23	19	—	—	—	—	—	—	—	—	—	23

Italics = < Average.

cohort keeps ahead in several age groups, thus suggesting that it may ultimately represent a maximum for the period. For example, the 26-30 age group of the 1941 sub-cohort, which started lower than 1939, twice reached a higher value only to be surpassed by the 1939 cohort. It is true that the 1939 cohort is quite often less fertile in comparison with the very recent cohorts during the earlier years of marriage, particularly for the higher age groups. It is clear, however, that in general 1947 represents a peak, and in several cases the most recent values are similar to those of 1939.

It is now of interest to separate the cumulative values to see in which years cohorts differed from the average for the whole period covered and from the marriages of 1939. Table VI now shows with the same construction yearly total live birth rates, by age at marriage, duration of marriage, and

cohort year. Apart from the 1939 cohort, which is a case *sui generis*, the cohorts fall again into two types:

- (i) pre-1946,
- (ii) 1946 and after.

For all the pre-1946 cohorts have a period at the start when they are below the average for duration, followed by a period, usually of 2 years, when they are higher, which is followed by another low period which always includes 1949 and often 1948. The 1946 and later cohorts are with one exception always higher than the average. This fact again clearly demonstrates the experience of 1946 and 1947 as a *temporary phase*. All cohorts without exception are affected, and all cohorts having more than 4 years' duration recorded show a low value for succeeding fertility. In addition many show at least one year of preceding fertility lower than 1939.

In discussing the cumulative rates, we saw that for the 1939 cohort married at the age of 16–20, the high initial year is followed by 6 years of low fertility; yet, as we have seen, the final value is, and in fact all cumulative values are, higher than the duration averages. The 1939 cohort married at the age of 21–25 behaves in a somewhat different way, and loses place for durations of less than 9 years. For the ninth year it is actually above average. We may thus say that the post-war boom had only a temporary effect on all cohorts of earlier date than 1946, and that subsequently they show no evidence of any new trend. We have little evidence from which to estimate the future fertility of the later cohorts (1946 and after), but they show less tendency to be abnormally high after 1947. Thus 1947 seems to be a peak and not a new plateau, and subsequent fertility, though high, falls proportionately from the 1946 and 1947 level.

(5) EXTRAPOLATION OF THE COHORT FERTILITY RATES AND A COHORT REPLACEMENT INDEX

For two reasons it is not possible to determine fertility rates accurately beyond the tenth year of marriage in the period dealt with. First, the relevant statistics originated in 1939 (the first full year)—so that only for the earliest cohort are data for a longer period available. Secondly, data published for

durations of marriage over 10 years are grouped in quinquennia.

Accordingly, we shall attempt to extrapolate the known values with due regard to two criteria:

- (a) the fitted curve must have its maximum at the end of the reproductive period (approx. 45 years of age);
- (b) the fitted curve must incorporate relevant information with reference to fertility experience in the period covered.

The result is best shown graphically, and in Fig. 4 fertility referable to each cohort for the group married at the age of 16–20 is plotted on the same graph. Similar graphs prepared for each age group show the same pattern.

All attempts to fit a single curve to the entire 10-year figures were unsuccessful in that they either showed a maximum inconsistent with (a) above, or distorted the known fertility pattern. However, taking each group by age at marriage separately, a quadratic parabola fitted to the average of the cumulative values of all cohorts at durations of 7, 8, 9, and 10 years, satisfied both conditions.

Although for those married young less than half their *fecund* married life is complete by the end of the first 10 years' duration of marriage, it is clear that this covers by far the most substantial part of *fertile* married life. For those married older

FIG. 4.—Cumulative fertility rates for all cohorts married at the age of 16–20 years.

this is even more true. The influence of tendencies to smaller family size may accelerate this trend.

REPLACEMENT INDEX.—It is now possible to construct an index appropriate to the current tempo of changing fertility and nuptiality. By multiplying the percentage married at each age during the period by the extrapolated number of live births which each age group will produce by the end of its fertile life we have a weighted Index of Marital Fertility (Table VII). This index is independent of shifts in numbers married, since it is based on proportions. It is strictly applicable only to the period under discussion, but the subsequent extension of the cohorts, as more data are available, will permit a revaluation of the trend of fertility at yearly intervals.

TABLE VII
COHORT INDEX OF MARITAL REPLACEMENT

Age at Marriage	Total Births (from extrapolation)	Marriages at Given Age (per cent. for period)	Product
16-20	3.309	19.7	65.1873
21-25	2.259	46.6	105.2694
26-30	1.605	19.3	30.9765
31-35	1.006	7.7	7.7462
36-40	0.450	4.2	1.8900
41-45	0.075	2.5	0.1875
Total		100.0	211.2569

Sex ratio = 0.4852

Replacement index = 1.025

Whilst the index is at present based on an extrapolation of the known data, the relative steadiness of the cohorts is a measure of its value. The gross replacement rate so derived does not present an encouraging picture of replacement but substantiates the previous analysis, *i.e.* the experience of 1939-50 does not register a reversal of fertility trends. The mean figure of 1.02 female children would be just above replacement if all women married. It is not sufficient to compensate for the failure of some women to marry, although being referable to the completed fertility of *all* women married at existing mortality rates, the figure cited compensates for married women who die before reaching the end of fecund life.

Fig. 4 shows that the 1947 and later cohorts are above the average in fertility, but the yearly decrease of total fertility from the peak in the first year of marriage is in general steeper than for earlier cohorts. There are, therefore, three admissible conclusions:

- (i) that the higher initial values of more recent years will be compensated by a decrease in later years.
- (ii) that their total fertility will eventually be higher, although the gradient at later durations

may not differ from that of the earlier cohort years at those durations.

- (iii) that fertility of the later cohorts (1947-49) will be above that of the earlier cohort values, with regard to both height and gradient.

A reason for favouring conclusion (ii) is that such a projected average as the high fertility prescribed by our third assumption has never been experienced in the history of the period. Further, the rate of decrease at low durations is higher than in most previous cohorts, and seemingly compensates for the initial high level. The tendency since 1947 has been one of falling fertility; and this is most likely to be continued in marriages of higher duration, thus possibly causing a more than proportionate subsequent fall. It would therefore seem that active measures are necessary if the present generation of mothers are to replace themselves.

(6) FAMILY SIZE

From the cohort fertility rates, we can extract, for given durations of marriage, the size of family in terms of live births of current marriages, *i.e.* without reference to children by a previous marriage. Whilst this is of ulterior interest, it also makes possible an analysis of the progress of each cohort and an estimation of the present birth situation in terms of completed fertility.

Table VIII (overleaf) exhibits the history of cohorts married during the most common age range (21-25) in the years 1939-50, at successive stages of the duration of marriage throughout the decennium; each entry exhibits the proportions of families of given size referable to a particular cohort after a specified duration of marriage.

It is noticeable that only 5 per cent. of families even at high duration (*e.g.* after 10 years of marriage) have more than three children, and that approximately 20 per cent. have none, the mean number of children at this duration being approximately 1.5. Whilst as yet we have no break-down by parity for the extrapolation (*vide supra*), it is unlikely that many of the 20 per cent. infertile marriages do in fact produce a live-born child, and we should here note that the very much smaller proportion of infertile marriages in the smaller earlier married cohort (16-20 not shown here) is in great part due to the large proportion of pre-nuptial conceptions. Indeed, these marriages have produced an average of 2.0 children after 10 year's marriage. The mean percentage of infertile marriages at selected durations for the group aged 21-25 is as follows:

Duration of Marriage (years)	2	4	6	8	10
Percentage Infertile	54	35	27	23	21

TABLE VIII
SIZE OF FAMILY (LIVE BIRTHS)
Cohorts compared at Same Durations of Marriage (Mothers aged 21-25 at marriage)

Duration of Marriage (yrs)	Cohort	Number of Live Births by Present Marriage					Duration of Marriage (yrs)	Cohort	Number of Live Births by Present Marriage						
		0	1	2	3	4			0	1	2	3	4	5	6 and over
1	1939	77.3	22.4	0.3	—	—	5	1939	33.5	43.8	18.6	3.7	0.4	—	—
	1940	81.5	18.3	0.2	—	—		1940	33.6	44.1	18.7	3.2	0.4	—	—
	1941	82.6	17.3	0.1	—	—		1941	37.1	42.8	17.1	2.7	0.3	—	—
	1942	82.1	17.8	0.1	—	—		1942	32.7	44.8	19.1	3.0	0.4	—	—
	1943	80.1	19.7	0.2	—	—		1943	29.4	45.1	21.2	3.9	0.4	—	—
	1944	76.8	23.0	0.2	—	—		1944	26.6	44.7	23.6	4.5	0.6	—	—
	1945	78.9	20.9	0.2	—	—		1945	28.0	42.2	24.2	4.9	0.6	0.1	—
	1946	77.0	22.8	0.2	—	—		1946	25.3	41.9	26.4	5.4	1.0	—	—
	1947	69.3	30.4	0.3	—	—	6	1939	29.4	40.6	23.0	5.9	1.0	0.1	—
	1948	71.2	28.4	0.4	—	—		1940	29.8	41.6	22.8	4.9	0.8	0.1	—
2	1939	57.6	39.0	3.2	0.2	—		1941	30.4	41.8	22.3	4.7	0.7	0.1	—
	1940	62.3	35.3	2.3	0.1	—		1942	26.1	42.7	24.9	5.3	0.9	0.1	—
	1941	62.7	35.5	1.8	—	—		1943	26.0	41.0	25.7	6.2	1.0	0.1	—
	1942	60.5	37.5	2.0	—	—		1944	24.0	40.1	27.7	6.8	1.3	0.1	—
	1943	56.5	41.0	2.3	0.1	—		1945	25.7	37.7	27.6	7.4	1.3	0.3	—
	1944	53.5	43.9	2.5	0.1	—	7	1939	26.5	38.8	24.9	7.8	1.6	0.3	0.1
	1945	52.8	44.6	2.5	0.1	—		1940	24.6	38.7	27.9	7.1	1.4	0.3	—
	1946	46.7	49.9	3.3	0.1	—		1941	25.7	38.8	26.9	7.0	1.3	0.3	—
	1947	43.7	51.5	4.7	0.1	—		1942	23.4	38.9	28.3	7.6	1.5	0.3	—
	1948	47.5	47.4	4.9	0.2	—		1943	24.0	36.6	28.8	8.5	1.7	0.4	—
3	1949	51.8	43.7	4.3	0.2	—		1944	22.4	36.4	29.9	8.8	2.1	0.4	—
	1939	47.9	42.6	8.8	0.7	—	8	1939	23.6	35.0	28.3	10.0	2.3	0.6	0.2
	1940	49.2	42.8	7.5	0.5	—		1940	21.3	35.0	31.6	9.4	2.2	0.4	0.1
	1941	50.4	42.9	6.4	0.3	—		1941	23.7	35.6	29.2	9.0	1.9	0.6	—
	1942	48.0	43.9	7.7	0.4	—		1942	21.9	35.6	29.9	9.8	2.1	0.7	—
	1943	46.2	45.3	8.0	0.5	—		1943	22.8	33.4	30.3	10.2	2.5	0.8	—
4	1944	40.5	49.2	9.7	0.6	—	9	1939	21.7	31.7	30.3	12.0	3.1	0.9	0.3
	1945	38.5	50.0	10.7	0.8	—		1940	19.9	31.9	33.3	11.1	2.9	0.7	0.2
	1946	35.3	51.0	12.9	0.8	—		1941	22.7	32.9	30.6	10.4	2.5	0.9	—
	1947	32.9	51.7	14.3	1.0	0.1		1942	20.9	32.8	31.1	11.3	2.8	1.1	—
	1948	37.0	48.5	13.2	1.3	—		1939	20.8	29.5	30.9	13.2	3.9	1.2	0.5
	1939	39.6	44.2	14.1	2.0	0.1	10	1940	19.1	29.5	34.1	12.5	3.5	0.9	0.4
	1940	39.9	45.7	12.8	1.5	0.1		1941	22.0	30.6	31.4	11.6	3.1	1.3	—
	1941	42.1	44.0	12.5	1.3	0.1									
	1942	41.0	44.4	13.1	1.4	0.1									
	1943	37.4	46.2	14.6	1.7	0.1									

It is clear that by the end of 10 years the percentage is changing very slowly.

The form of Table VIII is useful to shed light on the recent and extremely disordered situation previously discussed. It is quite clear that the 1947 cohort has relatively high fertility. It is also clear that the 1948, 1949, and 1950 cohorts have successively fallen from this level. The latest information of the 1947 cohort is at 4 years' duration of marriage, referable to fertility in the calendar year 1950. Here the cohort has the lowest proportion of infertile marriages: 26.8 per cent. against 42.1 per cent. at this duration for the lowest cohort, 1941. The 1947 cohort is, however, only 2.2 per cent. lower than the 1946 cohort. The 1947 cohort has also the highest percentage of 2- and 3-child families at this duration. The 3-child families at this duration are a very small proportion, *viz.*, 3.5 against 2.5 per

cent. for 1945 and 2.8 per cent for 1946; but the percentage of 2-child families is high, although again not appreciably greater than for the 1946 cohort, *i.e.* 21.8 against 20.9 per cent.; and for 1-child families it is 47.6 against 47.0 per cent.

It is here that the cohort system demonstrates its claim to prominence in fertility research. For it is clear that the high rates of 1947 which misled many into claiming a reversal in the trend of fertility were largely due to a change in the incidence of births within marriages without any substantial increase in quantity. In so far as the 1947 cohort is at present of slightly higher fertility than the others, this is due to an increase in 2- and 3-child families. This tendency is, however, less outstanding in 1950 than previously.

For cohorts 1948, 1949, and 1950, we have successively less knowledge; but each later cohort

has successively lower fertility at each duration. At duration 3, the 1948 cohort is lower than the 1947 cohort for the two significant sizes (1- and 2-child families). At duration 2, the 1949 cohort has fewer 1-child families than any previous cohort since 1943. However, the 1949 cohort has a very few more 2-child families than other cohorts before 1947. It seems that there is a slight tendency for the 2-child family to be more popular, but this is not sufficient *per se* to achieve replacement, since for this an *average* of over two children per completed marriage is necessary.

The 1950 cohort is well below its immediate predecessors and very little above the 1939 cohort, which, as we shall see later, is itself well below replacement level at later durations. If we now score these values according to relative size in each duration (Table IX) it is clear that some of the war years have still some lost ground to make up. Further they have been less successful in making up later parities than first parity births. Thus the relatively high number of *births* in 1951 and 1952 may be due in part to postponed higher parities. When the Registrar-General's Reviews for these years are available, it may well be seen that the fall in the

TABLE IX
RELATIVE POSITION OF COHORTS (TABLE VIII VALUES)
(Constant 12-point grading)

Cohort	Duration of Marriage (years)										Average
	1	2	3	4	5	6	7	8	9	10	
First Parity											
1939	7	9	12	11	7	8	4	7	12	9	8.6
1940	10	12	11	8	6	5	8	7	8	9	8.4
1941	12	11	10	12	9	3	4	2	1	1	6.5
1942	11	10	8	9	3	1	1	2	5	—	5.6
1943	9	8	7	6	1	6	10	12	—	—	7.4
1944	5	5	5	1	4	10	12	—	—	—	6.0
1945	8	4	3	5	10	12	—	—	—	—	7.0
1946	6	2	2	4	12	—	—	—	—	—	5.2
1947	1	1	1	2	—	—	—	—	—	—	1.2
1948	2	3	6	—	—	—	—	—	—	—	3.7
1949	3	6	—	—	—	—	—	—	—	—	4.5
1950	4	—	—	—	—	—	—	—	—	—	4.0
Second Parity											
1939	—	5	7	8	10	8	12	12	12	12	9.6
1940	—	9	11	11	9	10	8	1	1	1	6.8
1941	—	12	12	12	12	12	10	9	8	6	10.3
1942	—	11	10	9	7	6	5	6	5	—	7.4
1943	—	9	8	6	6	5	3	4	—	—	5.9
1944	—	7	6	5	4	1	1	—	—	—	4.0
1945	—	7	5	4	3	3	—	—	—	—	4.4
1946	—	4	3	3	1	—	—	—	—	—	2.8
1947	—	2	1	1	—	—	—	—	—	—	1.3
1948	—	1	2	—	—	—	—	—	—	—	1.5
1949	—	3	—	—	—	—	—	—	—	—	3.0
Third Parity											
1939	—	—	6	6	7	6	5	4	1	—	4.5
1940	—	—	9	9	9	10	10	9	8	6	8.8
1941	—	—	12	12	12	12	12	12	12	12	12.0
1942	—	—	11	11	10	8	8	6	5	—	8.4
1943	—	—	9	8	6	5	3	1	—	—	5.3
1944	—	—	7	5	4	3	1	—	—	—	4.0
1945	—	—	4	4	3	1	—	—	—	—	3.0
1946	—	—	4	2	1	—	—	—	—	—	2.3
1947	—	—	2	1	—	—	—	—	—	—	1.5
1948	—	—	1	—	—	—	—	—	—	—	1.0

fertility of the 1951 and 1952 cohorts is even greater than the crude figures suggest.

The 1941 cohort will serve to pinpoint this. Its first parity values are almost always least until the calendar year 1946, when they exceed the 1939 and 1940 cohorts. For the second parity it gains one place (over 1939) in 1947, but is not here pre-eminent. For the third parity it is always lowest. The same pattern can be seen in the 1942 cohort. Since the cohorts are aged 31-35 after 10 years of marriage a further increase in fertility is still possible.

Fig. 5 shows the proportions of different family sizes for one cohort (1939). We see clearly that the effect of later age at marriage is to lower fertility. This relationship between age at marriage and fertility is discussed in the next section.

FIG. 5.—Family size at end of 10 years' marriage, by age at marriage, for 1939 cohorts.

(7) AGE AT MARRIAGE AND FERTILITY

In the 1930s disagreement existed between demographers who claimed that a partial reversal of the falling birth rate could be achieved by persuading enough women to marry earlier, and those who claimed that a change of age at marriage would not necessarily change fertility habits. The protagonist

TABLE X
CUMULATIVE LIVE BIRTH RATES (TOTAL BIRTHS)
Older Age Groups compared with 16-20 Age Group at Marriage

Cohort...		1939			1940			1943			1945		
Age Group		16-20	21-25	26-30	16-20	21-25	26-30	16-20	21-25	26-30	16-20	21-25	26-30
Duration of Marriage (yrs)	1	100	49.9	38.7	100	58.3	47.8	100	73.8	67.3	100	76.1	66.5
	2	100	62.0	50.8	100	67.4	56.0	100	80.9	73.6	100	87.5	79.9
	3	100	64.4	52.9	100	71.2	60.5	100	81.5	74.6	100	87.6	78.5
	4	100	67.1	55.9	100	73.7	63.7	100	82.0	75.6	100	86.7	77.2
	5	100	69.3	58.6	100	75.4	65.5	100	81.7	73.9	100	86.1	76.3
	6	100	71.1	60.6	100	76.2	66.4	100	81.4	73.1	—	—	—
	7	100	72.0	61.7	100	76.6	66.5	100	81.4	72.7	—	—	—
	8	100	72.7	62.2	100	76.6	66.0	—	—	—	—	—	—
	9	100	73.2	62.4	100	76.6	65.7	—	—	—	—	—	—
	10	100	73.1	62.2	100	76.4	65.2	—	—	—	—	—	—

of the first part was the Registrar-General (Statistics for 1938, publ. 1944) and that of the second part Kuczynski (1942).

The issue has a special relevance to the war and immediate post-war years. During the period with which this study deals, external circumstances induced a greater proportion of people to marry at younger ages. In 1939, the most common age of spinster marriage was 23. It fell rapidly during the war, and is now 21. This means that a substantially greater number of women are marrying at the age of 16-20. This age group is of special interest because fertility is highest among married women assignable to it. *Ceteris paribus*, and with due regard to the prevailing high level of nuptiality, a downward shift of the mean age of marriage involving an increase in the 16-20 age group of married women should result in the relationship of the 16-20 group with the other groups remaining unchanged. It would also signify an increased *total* fertility. Similar remarks apply to the next youngest group, those aged 21-25 at marriage. This is next highest in fertility and its proportionate size has increased. Table X shows that there has been a consistent fall of fertility in the younger age groups *relative* to the older age groups, whereas the arguments of the Registrar-General had led us to expect the situation to remain unchanged.

We now compare the *total* fertility of groups married at different ages. One might expect greater fertility from those married younger, if only because they have a longer fecund married life. We shall therefore compare fertility when standardized for length of marriage. We shall do this first at the point where our exact knowledge ends, *viz.*, after 10 years' duration of marriage. A similar comparison of fertility by age at marriage for *completed* marriage is made possible by using the previous extrapolation. As both Table XI and Fig. 6 show, fertility is consistently lower with higher marriage age, not only *in toto* but per year of fecund marriage.

TABLE XI
AGE AT MARRIAGE AND RELATIVE FERTILITY

Cohort Age Group at Mar- riage	Live Births after 10 years' Duration of Marriage		Total Fertility		Length of Fecund Marriage in Years	Fertility per Year	Per cent. Fertility
	Number	Per cent. of 16-20	Number	Per cent. of 16-20			
16-20	2.106	100	3.309	100	29	0.114	100
21-25	1.574	74.8	2.259	68.3	24	0.094	82
26-30	1.341	63.7	1.605	48.5	19	0.084	74
31-35	0.995	47.3	1.006	30.4	14	0.072	63
36-40	0.436	20.7	0.436	13.2	9	0.048	42
41-45	0.082	3.9	0.082	2.5	4	0.020	18

(8) BIOLOGICAL AND DEMOGRAPHIC VIEWS OF FERTILITY

The controversy raised in Section 7 has implications which call for comment. Biologists and demographers do not use the term "fertility" in the same sense. (see p. 226, footnote). Hence confusion is almost unavoidable if interpretation involves matters of judgment concerning the relative importance of social agencies and physiological processes or states. When the demographer asserts that fertility falls off steadily in successive quinquennia of the reproductive period (15-45), the statement merely expresses the fact that the mean number of children born to a fixed number of married women within these age groups declines accordingly. It carries with it no legitimate implication that we know why or in what circumstances. When a physiologist speaks of low fertility, he means specifically that ovulation is less frequent, that fertilizability of the ovum is less, or that the chances of survival *in utero* of the fertilized ovum are lower for reasons inherent in the normal reproductive cycle or attributable to particular external agencies, such as nutrition. On the other hand, any figures referable to the incidence of live births to married women of different ages in a community which practises

FIG. 6.—Live births, by age at marriage.

family limitation are open to interpretation on quite a different level.

If the community *mores* prescribe a certain target level of family size, it is evident that women who marry younger will attain the target level earlier than women who marry later. Hence no figures which do not take into account duration of marriage have any presumptive bearing on whether the incidence of live births among married women at different ages is attributable to social pressures or to the various mechanisms with which biologists customarily associate the term fertility.

In the two extreme age groups of reproductive life, it is plausible to assume that physiological differences in the broadest sense of the term, including differences with respect to genetic make-up, are of no mean importance; but we are not in fact able to delimit any age range about which we are able to make a definite assertion of this sort. The

intrinsic plausibility of any such assumption has no bearing whatsoever on the likelihood that a small shift in the mean age at marriage will have a uniquely predictable consequence without due regard to the social pressures operative in a community in which some measure of birth control is universal.

Such social pressures are evidently of different kinds at different social levels. Thus it is highly likely that early marriages in the social groups from which the professions largely recruit themselves will encourage motherhood as a whole-time career when delay of marriage would accommodate a smaller family to a woman's continuance in another vocation. It is equally obvious that different social pressures operate in the wage-earning community, among women who customarily undertake work outside the home when their older children are able to assume some responsibility for care of the younger. It is indeed safe to presume that the net effect of

social pressures in different groups is different with respect both to the direction in which it affects fertility in the demographic sense of the term and to the extent to which it does so. It is not unlikely that a very big shift of the mean age of marriage would have foreseeable consequences, it is by no means admissible that our knowledge of the agencies determining the size of the completed family entitles us to express any opinion about the consequences of raising or lowering the mean age of marriage by two or three years above or below its present level in Britain.

SUMMARY

(1) Fertility indices computed from annual data are misleading if the end in view is the assessment of fertility under unstable conditions. This communication describes an alternative method based on cohorts of married women and sets forth its advantages.

(2) The method is used to show that the high birth rates of 1946–48 were due to a complex of causes unrelated to any substantial increase in fertility, and that fertility has indeed fallen annually since that period.

(3) An estimate of completed fertility is made from which a new index of fertility is computed. The use of this index makes it possible to show that in England and Wales fertility is now below replacement level. Moreover fertility is not yet stable, but is still falling.

(4) Fertility, expressed as total fertility or as fertility per year of fecund married life, is inversely related to age of marriage. Nevertheless the recent decrease in age at marriage has not been associated with the increase in mean family size anticipated by the Registrar-General in 1938.

(5) The proportions of families of different sizes after 10 years of marriage are estimated according to age at marriage for women married in England and Wales in the period 1939–50.

Acknowledgments are due to Dr. Enid Charles and Professor Lancelot Hogben, F.R.S., for advice and criticism.

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TECHNICAL APPENDIX

CALCULATION OF COHORT AGE-SPECIFIC LEGITIMATE LIVE BIRTH RATES BY PARITY FOR ENGLAND AND WALES, 1939–50

All the material for the rates here computed is available in the Registrar-General's Annual Statistical Review, Civil Tables, vols 1938–50, and all reference to tables are given in the form in which they are therein designated.

(1) The population for the rates comprises spinsters married at such a date that they are of the duration of marriage stated during the calendar year attached to the cohort. If maternities were tabulated by date of marriage, and not, as exclusively at present in England and Wales, by 12-monthly durations since marriage, these populations would be unequivocally determined for each duration. In the absence of census data recording age and duration of marriage for all women the appropriate population can be derived only from the record of previous marriages. Several empirical solutions have been proposed by the Registrar-General

and others. It can however be shown by means of a new graphical technique that previous formulae are incorrect and a more exact solution has been found.

(2) Legitimate Maternities are taken from Tables "SS", "QQ", "OO", and "II", adjustment being made for the fact that 1939 and 1940 are tabulated by date of registration but not of occurrence.

(3) Adjustment was made for incomplete data. For the worst year, 1940, information is complete for 98·6 per cent. and entirely absent for only 0·28 per cent.

(4) The quinquennial groups, aged 16–20, 21–25, 26–31, . . . to 46–50, at maternity during the first year of married life were used as basic cohorts. As such they were clearly defined annually by duration, since, e.g. those aged 21–25 in 1939 in the first year of marriage (duration 1)

APPENDIX TABLE A
LIVE BIRTH RATES PER 1,000 MARRIED WOMEN
(1939 Cohort)

Age in 1939	Average Cohort Age	Duration of Marriage	Parity													
			Total		0		1		2		3		4		5	
			Yearly	Accum.	Yearly	Accum.	Yearly	Accum.	Yearly	Accum.	Yearly	Accum.	Yearly	Accum.	Yearly	Accum.
16-20	18	1	465	465	458	458	3	3	—	—	—	—	—	—	—	—
	19	2	283	748	202	660	78	81	2	2	—	—	—	—	—	—
	20	3	230	978	88	748	129	210	12	14	0	0	—	—	—	—
	21	4	209	1,187	56	804	116	326	34	48	3	3	—	—	—	—
	22	5	181	1,368	36	840	88	414	47	95	9	12	1	1	—	—
	23	6	179	1,547	25	865	80	494	53	148	18	30	2	3	0	0
	24	7	144	1,691	19	884	50	544	49	197	19	49	5	8	1	1
	25	8	182	1,873	20	904	70	614	53	250	25	74	10	18	2	3
	26	9	154	2,027	10	914	49	663	49	299	28	102	13	31	4	7
	27	10	118	2,145	6	920	27	690	36	335	25	127	14	45	6	13
	28	11	115	2,260	—	—	—	—	—	—	—	—	—	—	—	—
	29	12	105	2,365	—	—	—	—	—	—	—	—	—	—	—	—
21-25	23	1	232	232	227	227	3	3	—	—	—	—	—	—	—	—
	24	2	232	464	197	424	31	34	2	2	—	—	—	—	—	—
	25	3	166	630	97	521	61	95	5	7	0	0	—	—	—	—
	26	4	167	797	83	604	67	162	14	21	1	1	—	—	—	—
	27	5	151	948	61	665	65	227	20	41	3	4	0	0	0	0
	28	6	152	1,100	41	706	73	300	29	70	7	11	1	1	1	1
	29	7	117	1,217	29	735	47	347	28	98	9	20	3	4	8	3
	30	8	145	1,362	29	764	67	414	33	131	11	31	4	4	1	2
	31	9	122	1,484	19	783	52	466	32	163	12	43	4	12	1	3
	32	10	85	1,569	9	792	31	497	25	188	13	56	5	17	2	5
26-30	33	11	71	1,640	—	—	—	—	—	—	—	—	—	—	—	—
	34	12	60	1,700	—	—	—	—	—	—	—	—	—	—	—	—
	28	1	180	180	173	173	3	3	—	—	—	—	—	—	—	—
	29	2	200	380	177	350	19	22	1	5	—	0	—	—	—	—
	30	3	137	517	83	433	48	70	4	15	0	1	—	—	—	—
	31	4	147	664	76	509	57	127	10	29	3	4	0	0	0	0
	32	5	138	802	60	569	58	185	14	50	5	9	1	1	1	1
	33	6	136	938	44	613	63	248	21	71	5	14	1	2	5	1
	34	7	106	1,044	28	641	50	298	21	97	8	22	3	8	1	2
	35	8	122	1,166	28	669	55	353	26	122	9	31	3	11	1	3
31-35	36	9	100	1,266	18	687	42	395	25	141	9	40	3	—	—	—
	37	10	69	1,335	9	696	27	422	19	—	—	—	—	—	—	—
	38	11	45	1,380	—	—	—	—	—	—	—	—	—	—	—	—
	39	12	40	1,420	—	—	—	—	—	—	—	—	—	—	—	—
	33	1	174	174	163	163	3	3	—	—	—	—	—	—	—	—
	34	2	176	350	150	313	19	22	1	6	1	1	—	—	—	—
	35	3	123	473	71	384	43	65	5	16	2	3	1	1	—	—
	36	4	118	591	52	436	51	116	10	31	3	6	1	2	—	—
	37	5	109	700	42	478	47	163	15	50	6	12	1	3	1	1
	38	6	99	799	28	506	43	206	19	65	6	18	1	5	1	2
36-40	39	7	73	872	18	524	30	236	15	79	6	24	2	7	1	2
	40	8	66	938	15	539	28	264	14	91	5	29	2	9	1	3
	41	9	48	986	10	549	19	283	12	98	4	33	2	—	—	—
	42	10	28	1,014	4	553	9	292	7	—	—	—	—	—	—	—
	43	11	14	1,028	—	—	—	—	—	—	—	—	—	—	—	—
	44	12	—	1,028	—	—	—	—	—	—	—	—	—	—	—	—
	38	1	124	124	113	113	3	3	—	—	—	—	—	—	—	—
	39	2	100	224	82	195	12	15	1	4	1	2	—	—	—	—
	40	3	70	294	39	234	25	40	3	10	1	3	1	1	—	—
	41	4	59	353	24	258	27	67	6	17	1	5	0	0	0	0
41-45	42	5	38	391	13	271	16	83	7	23	2	7	1	2	0	0
	43	6	23	414	6	277	8	91	6	26	2	8	0	2	0	0
	44	7	17	431	5	282	6	97	3	28	1	8	0	2	0	0
	45	8	10	441	3	285	3	100	2	29	0	8	0	2	0	0
	46	9	6	447	1	286	1	101	1	30	1	9	—	—	—	—
	47	10	3	450	0	286	1	102	1	—	—	—	—	—	—	—
	43	1	43	43	38	38	1	1	—	—	—	—	—	—	—	—
	44	2	23	66	17	55	3	4	1	1	—	—	—	—	—	—
	45	3	12	78	9	64	2	6	0	1	—	—	—	—	—	—
	46	4	5	83	2	66	1	7	0	1	—	—	—	—	—	—
	47	5	2	85	0	66	1	8	0	2	—	—	—	—	—	—
	48	6	1	88	0	66	1	9	0	2	—	—	—	—	—	—
	49	7	0	88	—	66	—	9	—	2	—	—	—	—	—	—
	50	8	0	88	—	66	—	9	—	2	—	—	—	—	—	—
	51	9	0	88	—	66	—	9	—	2	—	—	—	—	—	—
	52	10	0	88	—	66	—	9	—	2	—	—	—	—	—	—

Separation into parities cannot be accurately made after 10 years' duration of marriage.

became 22–26 in 1940 in the second year of marriage (duration 2). They are, as we have seen, less easily described in terms of marriage. Those aged 21 and less than 22 in 1939 in the first year's duration of marriage were married at the age of 20 or 21 in either 1938 or 1939. For this reason, the estimation of the correct population for each cohort made necessary the estimation of numbers married by age for each quarter of the year. To aid typography the Registrar-General's term $n < n - 1$ is herein designated duration $n - 1$, so that the first year of married life (Registrar-General's $0 < 1$) is referred to as Year 1. Each successive year the cohorts were advanced one year in age and one year in duration of marriage. Thus one cohort in subsequent years was aged 16–20, 17–21, 18–22, 19–23, 20–24, etc.

(5) Owing to the condensed form of the Registrar-General's Tables, it is not at present possible to compute accurate values for durations after the first 10 years.

Whilst, therefore, higher values for the two earlier cohorts are shown in Fig. 4, the values estimated are *not* used in the analysis.

(6) The maternity rates were finally reduced to live birth rates. The results for one cohort, 1939, are given in Appendix Table A.

(7) The labour involved in these computations is directly related to the condensed form of the Registrar-General's Tables. If durations of over 10 years of marriage were tabulated by single years, and separate parities given by single years of age, the value of the Tables would be immensely enhanced. It is a measure of the English *mores* that the Registrar-General's Tables of Fertility occupy 36 pages, whereas the Tables of Mortality occupy about 300. Presumably the community is more interested to learn that fewer females are dying of International List Classification 162 ("Old Age") than to know whether the community is or is not replacing itself.