AN IMPROVED METHOD OF CALCULATING BIRTH-RATES.

PART II. RESULTS.

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In the last number of the *Journal of Hygiene* we described an improved method of calculating birth-rates, by means of which exact correction can be made, in comparing the birth-rates of two communities or of the same community at different periods, for variations in the proportion of married women at childbearing ages, and for the different fertility-rates at different ages of childbearing life. The value of this method consists in the fact that by its means true differences in childbearing can be discovered, the differences due to variations of age or marital condition being eliminated.

In this paper it is proposed to illustrate these points by examples taken chiefly from the official statistics relating to the counties of England and Wales, leaving detailed tables and the discussion of more extended data for publication elsewhere. Throughout this paper, the termination *shire* is omitted from the name of each county.

The following examples compare the English population in 1881 with that in 1901 or 1903. The year 1881 has been chosen, partly because of its convenience in being a census year, chiefly because it represents a point very near the year 1876 when the highest recorded birth-rate in England and Wales occurred.

The subject can best be approached in stages, each illustrating an important aspect of the corrections required in ascertaining the true value of crude birth-rates.

(1) *Changes in the proportion of women aged* 15—45 *in the population.*

In the year 1881 the number of women aged 15—45 per 1000 of the total population was 230·6; in 1901 it had increased to 249·7. This result would naturally follow from the steady lowering of the birth-rate since 1876. In 1881 and in 1901 alike London had a higher proportion of women aged 15—45 in every 1000 of its population than any of the 40 counties, viz. 273·7 in 1901 and 261·7 in 1881. Worcester, Surrey, Lancashire, and Middlesex were the next highest in 1881, and Surrey, Middlesex, and Lancashire in 1901. The lowest proportion both in 1881 (196·9) and in 1901 (211·4) was in Huntingdon; Wilts, Salop, and Rutland being nearest to Huntingdon at both dates.

(2) *Changes in the proportion of wives among women aged* 15—45.

In 1881 Durham had the highest number of wives per 1000 women aged 15—45, viz. 579, Glamorgan coming next with 551, and Stafford third with 546. In 1901 Glamorgan had the highest number, 548, Monmouth coming next with 537, and Durham third with 534. At the bottom of the list in 1881 were Sussex 433, Surrey 423, Westmorland 422, and Cornwall 416; and in 1901 Hereford 418, Surrey 412, Sussex 391, and Westmorland 385.

In the above examples it will be seen that while the proportion of women of childbearing age to the total population has increased, the number of wives in every 100 women of these ages has declined. The same holds good for England and Wales as a whole, in which, while the proportion of women at the childbearing ages in the entire population has increased 8·3 per cent., the number of wives at these ages has declined 4·7 per cent. between 1881 and 1901.

It will be remembered that we are dealing throughout with legitimate birth-rates. The crude legitimate birth-rate of England and Wales was 33·0 per 1000 of population in 1871 and 27·4 in 1903. The crude illegitimate birth-rate was 2·0 in 1871 and 1·1 in 1903. We are not concerned in this paper with the decline in the illegitimate birth-rate, which is still greater than that in the legitimate birth-rate.

(3) *Comparison of standard birth-rates.*

The above data, although interesting and suggestive, do not determine the question whether the decline in the legitimate birth-rate between 1881 and 1901 has been partially, and if so, to what extent it has been caused by alterations in the proportion of wives in the population, and in the ages of these wives. We have still to ascertain by the method described in our former paper the changes due to altered proportion of wives, and to the varying fertility of these wives at ages 15—, 20—, 25—,...40—45.

The first step in this determination is to ascertain standard birth-rates, *i.e.* the birth-rates which would occur in each county assuming that the birth-rates of Sweden at ages 15—, 20—, 25—,...40—45, held good for the married women in each county at the corresponding ages. Standard birth-rates thus obtained are the only accurate index of the capability for a legitimate birth-rate possessed by the population of each county. The comparison of 1901 with 1881 in this respect brings out some important results. In 1881 Durham had the highest standard, *i.e.* potential birth-rate, 38·33 per 1000, London coming next, 37·66, Lancashire third, 37·34, and Nottingham fourth, 37·24; followed in order by Glamorgan, York, Worcester, Warwick, and Stafford. In 1901 at the upper end of the scale Glamorgan came first, 38·78, Durham second, 38·04, Nottingham next, 37·22, then Warwick, 37·19, followed in order by London, Essex, Middlesex, York, Lancashire, and Stafford.

At the lower end of the scale Cornwall had the lowest potential birth-rate in 1881, 26·67. It was ten places from the lowest in 1901 when it was 29·95. Rutland was next lowest in 1881, and lowest of all in 1901, being 27·10 in 1881 and 26·09 in 1901; Salop was 27·18 in 1881 and 27·45 in 1901. With the exception of Cornwall which is only partially so, the counties having the lowest potential birth-rates are nearly all of them purely agricultural counties.

Sixteen counties have a rather lower potential birth-rate in 1901 than in 1881. If the rate for 1881 be taken as 100, the greatest decrease was that for Hereford, whose proportional figure was 91 in 1901, and that for Worcester, which was 94 in 1901. Taking 1881 again as 100, the greatest increase was in Cornwall 112, in Essex 110, Middlesex and Monmouth 109, and Northumberland 107. Twenty-five counties showed some increase in their potentialities for a high birth-rate in 1901 as compared with 1881.

(4) *Comparison of crude legitimate birth-rates.*

Before applying the corrections which the standard birth-rates enable us to apply to the crude birth-rate, and before by this means separating the extrinsic or arithmetical changes from the intrinsic changes caused by alterations in fertility, it is convenient at this stage to make a preliminary comparison of the crude birth-rates of the counties in 1881 and 1901.

In 1881 Durham had the highest crude birth-rate, 37·88, Stafford coming next, 36·14, followed in order by Glamorgan, Lancashire, Nottingham, Derby, and Leicester. The lowest crude birth-rate in 1881 was in Hereford 25·44, the next lowest Salop 27·08, Cornwall 27·09, after which came in order Huntingdon, Westmorland, Dorset, Devon, Rutland, and Sussex.

In 1903 the crude birth-rate of every county except Monmouth (the crude birth-rate of which was 6 per cent. higher than in 1881) was much lower than the corresponding birth-rate in 1881. Taking the birth-rate in 1881 as 100, the counties in which there was the least decline in 1903 were Glamorgan 95, Northumberland 93, Salop 91, Durham 90; the counties in which there was the greatest decline being Rutland 69, Sussex 73, Oxford 74, Westmorland and Northampton 75, Bedford 76, Somerset 77, Berks and Devon 78. On the whole the rural counties have suffered from a decline of the legitimate crude birth-rate more than the industrial and urban counties.

(5) *Comparison of corrected legitimate birth-rates.*

Compare these results with the corresponding results when due correction has been made as already described. In 1881 the corrected legitimate birth-rate of England and Wales was 32·7 per 1000 of population; in 1903 it was 27·4, the comparative figures being 100 and 84. In 1881 the highest corrected county birth-rate was in Rutland 36·39, next came Cumberland 35·99, Cornwall 35·46, and Stafford 35·42. In 1903 the four highest were Monmouth 33·13, Durham and Salop 31·43, and Cumberland 31·13. The four lowest in 1881 were Worcester 30·43, Hereford 30·83, London 30·92, and Yorks 31·34. In 1903 the four lowest were Sussex 24·15, Devon 24·28, Northampton 24·59, and Bedford 25·09. The significance of the changes produced by the correction will be more clearly seen when they are stated in tabular form:

BIRTH-RATES.

	1881		1903	
	Crude	Corrected	Crude	Corrected
Durham	37·88	34·50	34·25 (90)	31·43 (91)
Stafford	36·14	35·42	31·30 (87)	30·04 (85)
Glamorgan	35·96	34·38	34·31 (95)	30·89 (90)
Lancaster	34·48	32·24	28·21 (82)	26·93 (84)
Nottingham	34·44	32·28	30·34 (88)	28·46 (88)
⋮	⋮	⋮	⋮	⋮
Westmorland	27·81	35·32	20·96 (75)	27·02 (77)
Huntingdon	27·46	33·38	23·64 (86)	28·90 (87)
Cornwall	27·09	35·46	21·54 (80)	25·11 (71)
Salop	27·08	34·78	24·71 (91)	31·43 (90)
Hereford	25·44	30·83	22·25 (87)	29·52 (96)

The above illustrations are taken from the upper and lower ends of a table calculated for all the counties. The proportional figures in brackets enable an exact comparison to be made between the decline in the birth-rate as indicated by the crude and corrected rates respectively.

It will be noted that in some instances the differences between the birth-rates of 1881 and 1903 are nearly the same whether the crude or the corrected birth-rate be taken as the test. In other instances, however, the difference is so considerable as to indicate the desirability of eliminating extrinsic arithmetical factors of variation before considering true differences in fertility. Thus in Glamorgan the true reduction is from 100 in 1881 to 90 in 1903, instead of to 95, as indicated by the crude birth-rate; in Cornwall the reduction is from 100 to 71, instead of to 80. These are instances where the real decrease in fertility is greater than that indicated by the crude birth-rates. In other instances the difference is on the opposite side. Thus in Hereford the reduction is from 100 to 96 and not to 87, and in Rutland from 100 to 72 and not to 69. In more than half the counties the changes shown in each individual county between 1881 and 1903 by the corrected were nearly the same as in the crude birth-rates. The correction is not on this account superfluous, for we have to deal not only with (*a*) comparisons of the same community at different times, but also with (*b*) comparisons between different communities. The differences are much more striking when the second set of comparisons is made, as is especially well shown when the corrected birth-rates of the counties of England are compared with those of Scotland and Ireland and with

those of other countries. Even in more limited comparisons it is obviously desirable to eliminate an extrinsic cause of variation which may unexpectedly in any given instance introduce a source of fallacy.

(6) *Counties in order of merit as to birth-rate.*

We use the term Order of Merit as meaning the position in which a county stands in relation to other counties similarly treated, when its actual is stated in proportion to its potential birth-rate. There are two ways of calculating the Order of Merit, both giving the same result. The crude birth-rate of any county may be stated as a percentage of its standard birth-rate; or the corrected birth-rate may be stated as a percentage of the standard birth-rate of England and Wales. Thus if the county of Durham be taken as an example:

Durham, crude birth-rate in 1903 = 34·25,
„ standard „ „ 1901 = 38·04,
„ corrected „ „ 1903 = 31·43,
England and Wales standard „ „ 1901 = 34·91.

Then $\frac{3143}{3491} = \frac{3425}{3804} = \cdot 90$.

The statement of Order of Merit represents the proportion of potentiality to actuality, assuming that the capacities for childbearing are equal in the Swedish and English populations. We know of no reason for doubting that this is so. The counties of England and Wales thus compared show changes in this respect, which if diminution of the birth-rate be regarded, as it is regarded by us, as a matter of serious national import, are of great importance. It is satisfactory to be able to frame such an Order of Merit, from which extrinsic arithmetical considerations, as distinguished from considerations of fertility, have been eliminated.

The figures for 1881 will first be considered. In only six was the crude above the standard or potential birth-rate (= 100). In Rutland it was 104·2, in Cumberland 103·1, in Cornwall 101·6, in Stafford 101·5, in Westmorland 101·2, and in Oxford 100·4. At the other end of the scale in Worcester it was 87·2, in Hereford 88·3, in London 88·6, in Yorks 89·8, in Hants 91·5. Even in 1881 therefore there were in operation causes which were lowering the actual below the potential birth-rate to a very varying extent in the different counties of England and Wales.

In 1901 a very different story has to be told. Not one county is up to the Standard of Merit constituted by Sweden (=100). The highest is Monmouth 94·9, next Durham and Salop 90·0, then Cumberland 89·2 and Glamorgan 88·5. At the other end of the scale are Sussex 69·2, Devon 69·6, Northampton 70·5, Bedford and Cornwall 71·9, and Hants 72·0.

Having compared counties between themselves, we may next consider the changes in each county between 1881 and 1903. The corrected birth-rate of each county is stated as 100, and the corrected birth-rate in 1903 in proportion to this. Thus stated, Monmouth is at the head of the list with 98 in 1903, as compared with 100 in 1881. Hereford comes next, 96, then Durham 91, Salop, Glamorgan, and Worcester 90, Nottingham 88, and Northumberland and Huntingdon 87. At the other end of the scale are Cornwall 71, Rutland 72, Northampton 73, Devonshire and Sussex 74.

Certain counties stand out prominently in order of infertility. Thus Sussex is lowest in the list in 1903, with only 69·2 per cent. of the births it ought to have according to the standard taken. It also gives with three exceptions the heaviest decline in its order of merit. But in 1881 it was already low down on the list, being 33rd on the list of 41 counties, beginning with the county having the highest corrected birth-rate; and it has since 1881 managed to make one of the heaviest percentage decreases from its former low position, and stands in 1903 at the bottom of the list.

The instance of Cornwall is only a little less striking. It has fallen from the third place in 1881 to the 37th place in 1903. Possibly the absence of husbands in South African or other mines, or their return debilitated by lung diseases, may partially account for this instance, which in this way may be exceptional. The other Celtic populations of Wales, the Highlands, and Ireland have all high corrected birth-rates, some of them much higher than any in England.

Rutland shows the second greatest decrease. It has fallen from the 1st to the 32nd place. This result in a purely rural county is remarkable. Devon and Westmorland are however not far behind, and it would appear that the decline in the corrected birth-rate has affected the rural as much as if not more than the manufacturing and mining counties.