

## REPRINTS AND REFLECTIONS

# Medical issues in historical demography

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For the demographer and economic historian all movements of population are important and deserve, so far as possible, to be explained; but for the student of social and medical history the modern rise of population is a unique event whose interpretation is not only of the greatest historical interest but is also essential to an understanding of some of the most formidable contemporary problems.

The distinction between the earlier recurrent changes of population and the modern rise is of particular significance in the eighteenth century. The methods as well as the aims of enquiry are different according to whether the increase in numbers is regarded as analogous to that in previous periods (given particular but not necessarily unique significance because of its coincidence with the Agricultural and Industrial Revolutions), or whether it is considered as the beginning of the modern expansion whose dimensions and continuity distinguish it from all previous changes.

If eighteenth-century growth is no more than the most remarkable of many movements of population, it is permissible to argue by analogy and to invoke the same kinds of explanations as are accepted for earlier periods. This treatment has been adopted by some economic historians, for example when a decline of mortality has been attributed to cyclic changes in the behaviour of infectious diseases.<sup>1</sup> But if the eighteenth century saw the beginning of the modern rise of population such explanations are clearly inadequate, for as the event was unprecedented so too, it seems reasonable to believe, must be the explanation for it.

There is no serious doubt that in Britain the modern rise of population did begin during the eighteenth century. It was certainly well established before registration of births and deaths (1838) and even at the time of the first census (1801) the increase in numbers was much greater than that which occurred in earlier periods. For the purpose of interpreting the modern rise of population it is unnecessary, and probably impossible, to state precisely when it started. It is sufficient to know that whatever the explanation in the early years of the eighteenth century, at some time before its end the first phase of the unique expansion had begun.

## II Methods of investigation

For interpretation of this expansion there is no more important decision than the choice of methods by which it is to be investigated. I should like to make four suggestions concerning them.

Data for the eighteenth century are not available, and are unlikely to become available, which put the major issues beyond dispute.

It is therefore desirable to begin by examining post-registration data and to consider the uncertainties in the eighteenth century in the light of conclusions concerning the later period.

Some of the most important questions which arise are medical in character.

In the pre-registration period, the issue which has preoccupied many economic historians—the relative importance of changes in birth rate and death rate—is less significant than the question what disturbed either rate.

### (a) Eighteenth-century data

The inadequacy of eighteenth-century sources is notorious, but this has not deterred investigators from advancing explanations that would be hard to sustain on twentieth-century evidence. Some have been prepared to write confidently about specific causes of death in a period when the death rate is unknown, and even to attribute the remarkable growth of population before registration to the behaviour of a single disease. In fact the data are so unreliable that it is all too easy for the investigator to persuade himself that he has found evidence to support any hypothesis which appeals to him: an increase in fertility,<sup>2,3</sup> a decrease in mortality;<sup>4</sup> the appearance of the potato,<sup>5</sup> the disappearance of plague;<sup>1</sup> the effectiveness of variolation,<sup>6</sup> the ineffectiveness of all medical measures.<sup>4</sup>

The lack of evidence which makes it difficult to sustain an hypothesis makes it almost equally difficult to refute it. When, for example, it is asserted that the rise of population in the eighteenth century was due to the introduction of inoculation against smallpox,<sup>6</sup> even a virologist cannot be expected to produce historical or other evidence which proves conclusively that it was not.<sup>7</sup> He can state only that such an interpretation seems most improbable in the light of his knowledge of the disease and its behaviour in a later period for which data are more tangible. It therefore adds nothing to the acceptability of an hypothesis that convincing evidence cannot be mounted against it from contemporary sources, and we must rely largely on later information and the judgement of those whose experience enables them to give an informed opinion.

But while recognizing the limitations of existing data, some demographers and economic historians have high hopes from new material which may become available, for example, by investigation of parish registers and of selected population groups such as peers. In assessing what can be expected from such sources one can only express a personal opinion, that the evidence which can be assembled for the eighteenth century is very unlikely of itself to answer the main questions, and conclusions will still be largely influenced by prior hypotheses. This somewhat pessimistic judgement is based not only on the obvious limitations of contemporary sources, but on recognition of the difficulties presented by the major issues. On the last

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point it is salutary to be reminded that in countries such as Ceylon, where a rapid expansion of population has occurred within the past few decades, there are considerable differences of opinion between informed observers about the relative contribution of malaria control, other medical measures and a rising standard of living, particularly nutrition.<sup>8,9</sup>

### **(b) Post-registration data**

If conclusions concerning the eighteenth century must be largely influenced by prior hypotheses, it is clearly important to decide on what evidence they are to be based. The best evidence, I suggest, is from the time when there is sufficient information to support an interpretation; and the minimum requirements are data concerning birth rate, death rate and cause of death. The birth rate and death rate are needed to assess the contribution of an increase of the one or a decrease of the other to population growth, the issue which has had so much attention in eighteenth-century studies; and cause of death is essential for appraisal of the influences which contributed to the decline of mortality. In England and Wales these minimal data are available from 1838.

The problem of extrapolating from the later to the earlier period is in some respects less difficult than it appears to be. For example, if in the light of knowledge of the diseases which declined after 1838 it is concluded that specific measures of preventing or treating disease in the individual made no significant contribution to the reduction of the death rate during the nineteenth century,<sup>10</sup> it seems reasonable to conclude that such measures are very unlikely to have been effective a hundred years earlier. Since the introduction of improved sanitation coincided with the decline of the bowel infections in the 1870's<sup>10</sup> we can be fairly confident that this was not a significant influence during the eighteenth century. And if a reminder is needed that mortality from a single infection may fluctuate apparently without medical or other intervention, in a period when more important influences are changing the whole pattern of disease, it is provided by experience of scarlet fever in the nineteenth and twentieth centuries.

The failure to make full use of nineteenth century evidence before turning to the uncertainties of the earlier period, although regrettable, is understandable. Historians have been particularly interested in the association between population growth and the beginning of the Industrial Revolution, one of the important issues in economic history, and they have been less concerned with the nineteenth century when the relationship seemed more obvious and therefore less challenging. But whether the focus of interest is the eighteenth century, or interpretation of the modern rise of population as a whole, the most promising approach to an understanding of the first phase of population growth is through investigation in the years immediately after registration, when the data are sufficient to raise discussion above the level of speculation.

### **(c) Both before and after registration some of the most important questions raised by investigation of population growth are medical in character. They include the following**

#### *The reason for the reduction of mortality from tuberculosis*

Mortality from this disease was declining rapidly from the time of registration of cause of death and this appears to have been

responsible for nearly half of the total reduction of mortality (from all causes) between that time and the end of the nineteenth century. No treatment was effective, and the main issue is the relative importance of a change in the character of the disease and of improvement in the environment.<sup>10</sup>

#### *Reliability of certification of cause of death*

There must be uncertainty concerning the acceptability of diagnoses, not only before the discovery of the bacterial origin of infectious disease, but throughout the nineteenth century because of the limitations of methods of investigation. It is particularly important to decide whether the reduction of mortality from tuberculosis can be attributed substantially to changes in diagnostic practice, resulting in a transfer of deaths from this to other causes.

#### *Interpretation of the behaviour of mortality from infections in the absence of intervention by medical or other measure*

Although this matter should present no great difficulty to biologists who recognize the unstable relationship of organism and host, the attention given to it in the literature shows that it has been a source of misunderstanding by some economic historians. The significance attributed to the disappearance of plague<sup>1</sup> is an example of the failure to distinguish between the changing pattern of infectious disease and the type of explanation which must be sought for the beginning of the unprecedented modern rise of population.

#### *The effects on fertility of advancement or postponement of age of marriage*

This is largely a matter for the demographer but there is one issue on which judgement is influenced by acquaintance with contemporary medical evidence. No one familiar with this evidence could, I believe, be in any doubt that infant mortality due to infectious disease rises sharply with increasing birth rank. There could be no better indication of the treacherous character of early data when viewed without reference to later medical evidence than the conclusion by a distinguished demographer that this association is not supported by a study of bourgeois families in Geneva between the sixteenth and nineteenth centuries.<sup>11</sup>

#### *The effectiveness of inoculation against smallpox*

It is significant that the claim that this measure contributed substantially to control of the disease, and even to the total decline of mortality and rise of population in the eighteenth century, has not been advanced by medical writers but has been disputed by some of the best informed among them.<sup>7,12</sup> This matter will be referred to later and is mentioned here only as an example of a medical question which has perhaps been given undue prominence.

These are among the medical issues which arise in investigation of the most important problem in historical demography, the explanation of the modern rise of population. It seems remarkable that so far they have had little attention from medical historians, but interpretation of the decline of mortality has not been a theme of medical history in the way that interpretation of population growth has been a theme of economic history. Medical writers have been interested in the behaviour of individual infectious diseases and a considerable literature is concerned with possible reasons for the decline of mortality from smallpox, typhus, scarlet fever, typhoid and other infections. But there have been few attempts to assess the

contribution of medical and other influences to the trend of mortality as a whole, or the relation between mortality and growth of population. And in so far as such questions have been considered, there has been an unfortunate tendency to confuse very different measures—environmental, preventive, therapeutic—under the large umbrella of scientific medicine.

#### (d) The relative importance of birth and death rate

One of the consequences of the focus of interest on the eighteenth century has been the disproportionate attention given to the birth rate-death rate controversy; when neither rate is known the way is open to interpretations which are as difficult to support conclusively as they are finally to refute. However interesting this discussion may be to economic historians, in relation to investigation of the reasons for the modern rise of population it is of secondary importance compared to the question what disturbed either rate. For if the first phase of the modern rise cannot be attributed to medical measures or to fortuitous change in the infections—and this is the conclusion which emerges from examination of post-registration evidence (discussed below)—the deduction is inescapable that the standard of living rose in the eighteenth century, whether its most significant effect was an increase in the birth rate or a decrease in the death rate. This is not to suggest that discussion need stop at this point; on the contrary it leads to a more realistic appraisal of the features of the environment which were ameliorated and their likely effect on births and deaths.

Adopting the procedure suggested above I shall now consider in turn the possible reasons for the rise of population after and before registration.

### III Population growth after registration of births and deaths

The figure summarises the data concerning birth rate, death rate and population in England and Wales from the times when national statistics put them beyond serious doubt. It shows that an excess of births over deaths was established before registration and has continued until the present time. The birth rate remained high until 1880 when it began to fall; mortality was fairly constant until about the same time when it too began to decline. The growth of population from 1838 was clearly due to the margin of births over deaths established before and maintained after registration, and to the decline of mortality from the eighth decade which compensated to some extent for a declining birth rate. The main task is to account for the reduction of mortality in the late nineteenth century, and in the light of the conclusions to investigate the margin between birth rate and death rate already apparent at the time of registration.

The national data on cause of death, available only for Britain from so early a date, are indispensable for examination of these problems. The decline of mortality between 1840 and 1900 was restricted to the infections and McKeown and Record<sup>10</sup> showed that five diseases or groups of diseases were responsible for it: tuberculosis for a little less than a half; typhus, typhoid and continued fever for about a fifth; scarlet fever for a fifth; cholera, dysentery and diarrhoea for nearly a tenth; and smallpox for a twentieth. Investigation of reasons for the changes in each disease or disease group, and if possible



Figure 1 Data from national statistics concerning birth rate, death rate and population in England and Wales.

formulation of a general hypothesis based on the conclusions, is one of the most important tasks confronting medical historians. It has not yet had the attention it deserves.

McKeown and Record<sup>10</sup> suggested that the possibilities for each disease can be considered under three headings: specific medical measures of preventing or treating disease in the individual; a 'spontaneous' decline of mortality not attributable to medical effort or environmental change, analogous to that which must have contributed throughout man's history to the changing pattern of infectious disease; and improvement in the environment. The last comprises a wide range of influences but at the outset it is convenient to group them under the same heading.

Of the diseases which declined, only smallpox was influenced significantly by specific medical measures and even if the whole of its decline is attributed to vaccination it can account for only a small part of the total reduction of mortality. Scarlet fever is the outstanding example of an infective organism whose virulence changed over quite a short period, apparently independently of medical or other intervention, and its decline can be attributed confidently to the second heading ('spontaneous' change).

Since the reduction of mortality from bowel infections began in the eighth decade when sanitary reform began to make its impact on water supplies and sewage disposal, there is also no serious doubt that it was due mainly to improved sanitation. In the case of typhus (which is not identified from typhoid in national statistics before 1871) this explanation may not be adequate, but for the two groups as a whole (typhus, typhoid and continued fever; and cholera, dysentery and diarrhoea) it seems acceptable.

The chief difficulty, already referred to, is in explaining the early, rapid and continuous decline of mortality from tuberculosis. It occurred from the time of registration (and almost certainly preceded it), at least several decades before the reduction of mortality from the other main causes. The decline

was not due to treatment, which did not become really effective until after the Second World War, and McKeown and Record<sup>10</sup> concluded that it was due mainly to a rising standard of living, particularly of nutrition. Their reasons for not accepting as more probable 'spontaneous' change in the disease, the explanation favoured by some epidemiologists, were (a) because so large a reduction of mortality would be unlikely to occur in this way in a population already exposed to the disease for several centuries, and (b) because substantial movements of population from country to town were too late to explain a large decrease in the fourth decade (if it is assumed that the rural population of Britain had not long been exposed to the disease). Nevertheless it is impossible to be confident about so complex an issue, one of the most important in medical history, which fully merits further study.

In summary of the conclusions in respect of each of the main diseases (or groups) it was suggested that in order of relative importance the influences responsible for the reduction of mortality in the second half of the nineteenth century were: (a) a rising standard of living, of which the most significant feature was possibly improved diet (responsible mainly for the decline of tuberculosis and, less certainly and to a lesser extent, of typhus); (b) hygienic changes, particularly improved water supplies and sewage disposal, introduced by sanitary reformers (responsible for the decline of the typhoid and cholera groups); and (c) a favourable trend in the relationship between infectious agent and human host (which accounted for the decline of mortality from scarlet fever and may have contributed to that from tuberculosis, typhus and cholera). The influence of specific prevention or treatment of disease in the individual was restricted to smallpox and made little contribution to the total reduction of the death rate.

Is it possible to be confident, if not in detail at least about the main lines of this interpretation? There are three reasons for believing that specific medical measures contributed little: the reduction of mortality was due to the decline of infectious diseases; smallpox was the only infection on which medical measures then had an applicable effect; and only about a twentieth of the total reduction of mortality between 1838 and 1900 was due to the decline of smallpox.

It is not possible to be equally confident about the relative importance of environmental influences (a rising standard of living and the more specific hygienic measures) and spontaneous decline of infections. But there is reason to believe that an advance in the standard of living, generally agreed to have occurred by the mid-century, contributed substantially to the reduction of mortality from tuberculosis, and that sanitary measures were mainly responsible for the decline of mortality from the bowel infections which coincided with improvements in water supply and sewage disposal. Hence while it is impossible to assess precisely the contribution of spontaneous change in the infectious disease, the evidence that other important influences were at work, and the improbability of a fortuitous explanation for so large a reduction of mortality, appear to justify the main lines of the interpretation. In this communication no attempt will be made to extend it beyond 1900, although elsewhere<sup>13</sup> I have suggested that for the whole period from 1838 until the present day the order in time of the main influences is also the probable order of their importance: a rising standard of living, at least from 1840; improved sanitation from about 1870; and

prevention and treatment of disease in the individual, with the exception of vaccination against smallpox from the second quarter of the twentieth century.

#### IV Population growth before registration

In investigation of reasons for the growth of population in the eighteenth century there are three main causes, or more accurately, classes of causes, to be considered: medical measures of preventing or treating disease in the individual, leading to a decline of mortality; a spontaneous reduction of mortality; and improvements in the environment, whether leading to an increase of the birth rate or decrease of the death rate. It is possible to think of other influences on population growth, for example a reduction of the birth rate such as occurred in France or a spontaneous increase in fertility, but none likely to have contributed significantly to the rise of population in eighteenth-century Britain. In the discussion which follows no assumptions will be made about the levels or trends of birth rate or death rate, and an interpretation will be sought mainly in the light of conclusions from the nineteenth century.

##### Medical measures

If it is accepted that with one interesting but not large exception (vaccination), prevention or treatment of disease in the individual was ineffective in reducing mortality in the late nineteenth century, it would seem to follow that they can have had no significant influence on the trend a century earlier. Indeed there is good reason to believe that some kinds of medical intervention were harmful, for example expansion of hospital care with the attendant risks of the spread of infection. However a little to the surprise of most medical writers the suggestion that inoculation against smallpox made a substantial impact on mortality in the eighteenth century<sup>6</sup> makes it necessary to enquire whether this procedure was a remarkable early exception.

It is unnecessary to review the history and methods of inoculation in Britain which have been discussed extensively in recent years, and it will suffice to note that it was a crude procedure which no one would dare to use today, introduced without knowledge of its mode of action or attendant risks. The difficulties of resolving medical issues by reliance on eighteenth-century evidence are nowhere more apparent than in the wide differences of opinion concerning the frequency of inoculation and its effectiveness in preventing smallpox. It is said that the procedure was common<sup>6</sup> and that it was uncommon;<sup>14</sup> that it afforded substantial protection and that it is likely to have contributed to the spread of the disease.<sup>14</sup> The frequency of inoculation is perhaps a matter for general discussion, but in the absence of firm evidence, assessment of its probable effectiveness should be based on laboratory, clinical and epidemiological experience of the disease. Yet an economic historian has not hesitated to debate this issue with a distinguished virologist.<sup>15</sup>

The conclusion of those who know the disease is that mortality in the eighteenth century was not significantly reduced by inoculation; it is in accord with extensive recent experience of immunization. After nearly a hundred years of investigation there are a number of vaccines which offer substantial protection against some infectious diseases. Had they

been available and used efficiently in the eighteenth century, even in the absence of other influences it is probable that they would have led to a reduction of mortality from the specific infections and one or two, for example measles vaccine, might have had a temporary effect on total mortality. But it is most unlikely that any of them would have had an effect so large and prolonged as to explain the increase of population in the eighteenth century. This conclusion rests on judgement, not of the effectiveness of vaccines, but of the probable contribution of any single infection to total mortality over a considerable period. Hence even if very large assumptions are made about the frequency and effectiveness of inoculation, it cannot account for the rise of population which had occurred before the time of registration, when other influences associated with a rising standard of living were certainly present.

### **A spontaneous decline of mortality**

It is convenient, but somewhat misleading, to describe a decline of mortality as spontaneous if it was not influenced by medical or other measures such as improvements in the environment. The relationship between an ineffective organism and its host is clearly not independent of the environment in which they are placed; nevertheless a distinction should be made between the changes which presumably occurred throughout a man's evolution, leading sometimes to an increase and sometimes to a decrease in mortality, and those which have been associated with the reduction of mortality during the past two centuries. For the latter there must be a more specific explanation.

In the post-registration period it was possible to consider the significance of spontaneous change in the character of the individual diseases which contributed to the total decline of mortality. This procedure cannot be used before 1838 when cause of death is unknown, and we must rely on a judgement of probabilities, assisted by knowledge of the nineteenth century.

The following are among the few undisputed facts relevant to assessment of spontaneous change. A decline of mortality, if it occurred before registration, would have been due to a reduction of infectious causes of death. The relationship between organism and host is variable, but the rate of change is very different for different organisms. Without effective medical or other intervention, over any considerable period some deaths from infections must have increased, some decreased and others remained fairly constant. There is therefore no reason to question that one or more infections may have declined spontaneously in the eighteenth century as did scarlet fever in the nineteenth and other diseases, undoubtedly, in previous centuries.

If it is accepted that medical measures had no significant effect on national mortality trends before registration, without knowledge of cause of death we must ask for how long the rise of population could reasonably be attributed to spontaneous change. While no precise answer can be given it seems hardly credible that this alone can explain the unprecedented increase before registration. Even if some reduction in mortality in the early years of the eighteenth century is analogous to that which occurred in previous centuries, before its end the modern rise of population had begun. Its extent, continuity and coincidence with the Agricultural and Industrial Revolutions were all unique, and it cannot be explained by a decline of mortality which was independent of medical or other measures. We are therefore left with the third interpretation, that the rise of population was

associated with the profound changes in way of life which occurred in the late eighteenth and early nineteenth centuries.

Against this background it will be convenient to refer briefly to the proposal that eighteenth-century population growth can be explained by the disappearance of plague.<sup>1</sup> As in the case of smallpox, the data are quite unreliable, and it needs faith as well as discernment to find regularity in a cycle of mortality whose wavelength was several centuries. On medical grounds it is also difficult to accept that prolonged changes in mortality (from all causes) and population growth can be attributed to the behaviour of a single disease.

But even if plague had the significance suggested, reasons for its decline must be sought under the three headings listed above. It was certainly not due to prevention or treatment of the disease in the individual. If it occurred spontaneously it may have contributed to population growth in the early eighteenth century but cannot be accepted as the main reason for the first phase of the modern increase. And if plague declined because of environmental improvement, the explanation is consistent with the interpretation which follows.

### **Improvement in the environment**

The conclusion that a rising standard of living was the most important reason for the reduction of mortality after registration was suggested by examination of the disease which declined, and was consistent with the fairly uniform opinion of economic historians that by this time conditions had improved. The fact that for several decades after cause of death was first registered, the most notable feature was a decline of mortality from tuberculosis made it possible to go further, and to suggest that the most plausible explanation for its decline was a better diet. This explanation was consistent with what is known about the behaviour of the disease and the consequences of higher employment rates and better wages.

Before registration the grounds for emphasizing improvements in the environment as the probable explanation for a rising population are inevitably somewhat weaker. The conclusion is reached after exclusion of the alternatives (medical measures and fortuitous change) and cannot be supported by examination of individual causes of death. Moreover some economic historians do not agree that on balance living conditions improved in the late eighteenth and early nineteenth centuries and they have reservations about the interpretation on this account.

In a review of the position McKeown and Brown<sup>16</sup> concluded as follows: 'It would probably be unwise for medical writers to attempt to go beyond a general conclusion. It is that in the light of an assessment of the evidence after registration, it seems most reasonable to attribute the rise of population which had occurred before that time to improvement in the environment. For the purposes of a general interpretation it is not necessary, and indeed it may never be possible, to specify the nature of the improvement, or to state a time from which it can confidently be said to have begun. But the fact that the population had trebled in a relatively short period before 1851 leaves little doubt that it was well established before the date when economic historians are agreed that the standard of living had risen.'

There are now reasons for thinking that this conclusion was unnecessarily cautious. Data referred to by Hutchinson<sup>17</sup> in his Presidential Address to the British Association in 1966 suggest

that the explanation for the rising standard of living should be sought in the striking advances in British agriculture. He quotes Ernle:<sup>18</sup> 'In 1811 [the population of England and Wales] had grown to 10 150 615. On these figures the population had doubled itself in 125 years and even if no allowance is made for an improved standard of living, it is probable that England during the same period had doubled her production of food.' Hutchinson states that by the end of the Napoleonic Wars production had outstripped consumption, and it was not until the 1870's that imported food supplies from North America began to make a significant contribution.

This emphasis on the importance of food supplies is not only consistent with the explanation suggested for the decline of mortality in the years after registration; it is also in keeping with more general conclusions concerning the basic requirements for human health.<sup>19</sup> There are four requirements—food, oxygen, warmth (or more accurately, avoidance of excessive heat loss) and water—but only the first has been so deficient as to have a profound impact on human health, numbers and evolution. The position was correctly assessed by Malthus ('The tendency of all animated life is to increase beyond the nourishment prepared for it') and until the eighteenth century any improvements in food supplies were rapidly offset by increasing numbers. The agricultural advances to which Hutchinson and Ernle<sup>17,18</sup> refer were able to support a vastly increased population, which was further expanded by the reduction of mortality consequent upon sanitary reform. But in time, and on an evolutionary scale fairly short time, these advances would again have been overtaken by increasing numbers if the decline of the birth rate from 1870 had not brought population growth under control. Not sufficient control, in Hutchinson's view, to meet the needs of a technically advanced society, but at least enough to maintain a change in health unique in human history.

## V

This interpretation of the modern rise and eventual control of population in Britain puts the emphasis on three influences: improved food supplies from 1770 or earlier; removal of adverse influences in the physical environment by sanitary measures from 1870; and limitation of numbers by a declining birth rate from about the same time. It is not suggested that these advances began precisely in the years mentioned. The improvements in agriculture—enclosure, manuring, wintering of stocks, introduction of root crops, etc.—occurred over a period; there may well have been some advances in hygienic practice, as there undoubtedly were in hygienic teaching, during the eighteenth century; and both French statistics and English literature indicate that contraceptive measures were not used for the first time in the 1870's. Further more there were periods in man's history when other influences may have been temporarily more important than food in restricting numbers, at least of special groups; for example in England for many centuries royal and aristocratic families were presumably adequately, if unhygienically, fed, and their risk of death from violence was probably much greater than from malnutrition. Nevertheless in respect of the population as a whole over any considerable period the Malthusian thesis seems unassailable; and while the three influences—improved diet, sanitation and birth control—were not perhaps unique in kind, they were in

the scientific, educational and political circumstances which led to their introduction and continuity in the eighteenth and nineteenth centuries.

## VI

This interpretation of population growth rests largely on judgement of medical issues: the effectiveness of treatment during the eighteenth and nineteenth centuries; the reasons for the decline of mortality from intestinal infections, scarlet fever and, above all, tuberculosis; the value of inoculation against smallpox; and the likelihood of a sustained reduction of total mortality as a result of 'spontaneous' change in a number of infectious disease or of a single disease such as plague. These issues are brought into focus by investigation of the modern rise of population, a subject which has had the attention of economic historians and demographers, but not, so far to any extent, of medical writers. Medical historians have largely ignored this theme, or have restricted enquiry to individual infections. Yet behind the problem of population growth lies what is among the most important questions in medical history, the reasons for the transformation of man's health during the past two centuries.

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