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Constructing vital statistics:
Thomas Rowe Edmonds and William Farr, 1835–1845

Summary

This paper describes the role of these two English statisticians in establishing mortality measurements as means of assessing the health of human populations. Key to their innovations was the uses for the law of mortality Edmonds claimed to have discovered in 1832. In reality he had merely rediscovered a relationship between aging and mortality first described mathematically by Benjamin Gompertz a decade earlier. During the 1830s Edmonds attempted to interest the medical profession in his discovery and to suggest how his discovery could be used to assess health of large communities and to study case fatality and therapy. Using the rich data of the General Register Office William Farr would develop Edmonds's suggestions to produce some of the most sophisticated uses of vital statistics in the 19th century. In understanding the motivation of these two statisticians, it is essential to recognise their reform sympathies in an age deeply troubled by the human costs of rapid industrialisation and urbanisation. The two set out to reform both their professions and society.

Keywords: History – Vital statistics – Mortality – Epidemiology – William Farr.

The work of two relatively unknown Victorians, Thomas Rowe Edmonds and William Farr, was key to the creation of the modern discipline of vital statistics and of the use of those statistics to assess health and welfare. My thesis is that their contributions originated in their reform aspirations in the politically troubled 1830s and drew heavily on life insurance practices. In 1835 both men were ambitious, young, provincial Englishmen living in Fitzroy Square, London, looking for the places in the professions to which they believed their geniuses entitled them. Edmonds had the advantages a middle class family could provide, including a Cambridge education (Eyler 2002; Driver 1929; Walford 1873). Farr, on the other hand, was born to impoverished farm labourers who abandoned him to the parish. He was able to obtain a piecemeal education and to enter the lowest rung of the medical profession through the largeness of a patron who recognised his intelligence and promise (Eyler 1979; Humphreys 1883). Both Farr and Edmonds tried to make their way with their pens. By 1835 Edmonds had already published three books and had begun the series of articles for the *Lancet* that we will consider below. Frustrated with general practice, Farr turned to medical journalism; he helped edit the *British Medical Almanack*, and co-founded and edited the short-lived *British Annals of Medicine, Pharmacy, Vital Statistics, and General Science*.

Both men considered their professions in desperate need of reform. Farr made his journals a voice for the frustrations and complaints of ordinary practitioners about the privileges and power of the London medical establishment (Anonymous 1837a; Anonymous 1837b; Anonymous 1837c). That establishment, according to its rank-in-file members, neither recognised merit founded on scientific training nor represented the interests of the whole profession. Farr identified himself with a group of radical medical reformers in London that included Thomas Wakely, the editor of the *Lancet*. It is no surprise to find that in these years Wakely gave space in his journal to both Farr and Edmonds. Edmonds had found a place as an actuary. In journals edited by Farr and by Wakely he also took aim at his seniors, subjecting John Rickman, the head of the English census, to scorn for gross errors and for letting great opportunities for gathering invaluable information slip by and accusing John Finlaison, the government's actuary, of costing the nation over £300 000

through poor advice he gave about the government annuity scheme (Edmonds 1835–36a: 369; Edmonds 1835–36c: 357; Edmonds 1835–36d: 692–3; Edmonds 1836–37).

The reform impulse of these two men ran deeper than their professional ambitions. Like the other middle-class professional and business men of radical or Whig sympathies who formed the statistical societies of the 1830s, they were preoccupied by the problems of urban poverty and the condition of the industrial working class, and they believed that these problems could be studied objectively and solved peacefully (Cullen 1975; McGregor 1957; Ashton 1934). Unlike most members of the early statistical societies whose interests proved to be short-lived, Edmonds and Farr found places in the civil service and in the insurance industry where data collection and analysis had become critical functions and where they could function as professional statisticians.

Edmonds's response to the great social problems of his youth was economic and utopian. In 1828, two years out of university, he published his first book, *Practical, moral and political economy: or, the government, religion, and institutions most conducive to individual happiness and to national power* (1828). This book offered a critique of early industrial capitalism in the tradition of Ricardian socialism. Edmonds accepted the labour theory of value and explained British poverty as the result of private property, or the expropriation of the value of the labour of the working class by the unproductive classes (Driver 1929; King 1983; Perelman 1980). Edmonds estimated that one man and one horse could provide the necessities for 15 people. He also calculated that one-third of the population produced all the necessities of life for the entire nation and yet retained only one-third of the product. The remaining two-thirds went to capital and to arbitrary expenditures such as rent. He deplored the utter dependency of wage earners on their masters, observing that there was little difference between slaves and such labourers (1828: 141). It was surplus labour, the excess of labourers over jobs, that drove wages down and made the wage earner's position so uncertain. Such notions anticipated Karl Marx by 15 years. Like Marx, Edmonds also explained capitalism, the "money system" he called it, as a passing stage in human history to be succeeded by a more communal stage he called the "social system." He provided a blue print for radical social reform by describing a utopian, communal society created on an island.

Farr's critique was more limited, and, perhaps because he was a medical man, it was centred on human health. Farr would devote his career to demonstrating that the growth of industrial cities created conditions that caused unnecessary human disease, shortened human life, and cost the nation enormous sums in lost labour (Eyler 1979: 90–6, 123–49).

His reports from the General Register Office over a period of 40 years would do much to sustain interest in the long process of eliminating the worst hazards to human health in the urban environment. But that was in the future. In 1835 Farr was just formulating the ideas and the methods that served him later, and, as I argue below, Edmonds was important to him in this formative process. In 1835 Farr had just begun to publish. His first two articles were lectures on hygiene (1835–36a; 1835–36b). Although these lectures broke no new ground, they mark him as a reformer. He was confident that disease could be prevented and health improved, and he called on his fellow practitioners to put the public interest before professional fees and to support public efforts to prevent disease.

Those who advocated social reform faced a formidable adversary in Thomas Malthus, who had argued that a genuine improvement in the condition of the people was impossible. Population increasing geometrically would always outpace the means of subsistence, which increased arithmetically. Therefore it seemed that laws of nature precluded any genuine improvement in the lot of the mass of the population. Farr and Edmonds felt obliged to respond. Here again Edmonds led in the 1830s. His second book, *An enquiry into the principles of population*, was his answer to Malthusian pessimism (1832a). As we have seen, Edmonds accepted Malthus's analysis, up to a point. The economic condition of workers under capitalism was a reflection of the existence of surplus labour, and he believed that any improvement in the plight of the poor depended on encouraging the working class to forego or to delay marriage, so that its size would grow in proportion to that of the upper classes which provided much of the demand for its labour. But unlike Malthus, he was optimistic that such population restraint was possible. This second book also offered a utopian scheme. This time it was a system to replace the old Poor Law. Edmonds's scheme was vastly different from the system of institutional deterrents to relief that the New Poor Law would soon create. He proposed creating artificial wants and providing a modest improvement in the standard of living to give the working class an incentive to delay marriage. Workers would also be encouraged to become independent craftsmen, and the working class itself would be given a hand in policing abuses in relief.

Edmonds also criticised Malthus's analysis of human misery. His own study of history showed that at every stage of human existence misery depended not on population pressure but on ignorance and bad government. He pointed to examples of an advanced and a "barbarous" people occupying the same land. In every case the knowledge, technology, and institutions of the advanced people supported a large

population with an abundance of food, while the people lacking these blessings of civilisation lived in misery in small numbers (1832: 7–8, 16, 22–4, 33–7). Knowledge, Edmonds concluded, was more important than either capital or natural resources, and human knowledge was boundless. His faith in science and human progress made him confident that Malthus had seriously erred in assuming that the means of subsistence could only grow arithmetically. Edmonds was certain that science was an inexhaustible source of useful discoveries, and that with the application of such useful knowledge, the means of subsistence could grow faster than the population (1832: 57–67).

This objection, that Malthus erred in assuming that the means of subsistence could grow only arithmetically, was raised frequently in these decades (Finer 1952: 23–4). Farr would raise it as well, most often in the 1850s and 1860s, pointing out that the plants and animals on which humans depend also multiply geometrically and that human ingenuity and art amplify this productivity still further (1875: XV–XVI, XX; 1868–69: 210). Farr offered an additional objection, however, by challenging Malthus's assumption that humans, like rabbits, reproduce without regard to the consequences. In the Registrar-General's fourth annual report, which appeared in 1842, Farr used the early results of civil registration to demonstrate not only that was it possible for the mass of the population to limit their reproduction but that in England population growth was already under such human control; thus Malthusian positive checks were not necessary (1842: 133–42 (85–90)). Specifically using the marriage and birth registration for 1839 through 1841, Farr showed that although women were capable of producing children from at least the age of 16 or 17, the average age of first marriage in England was 24 for women and 25 for men. Moreover, the registration records showed that a full 21% of women and 22% of men who reach the mean age of marriage never marry, and that in the years 1839–41 only one in seven women of childbearing age produced a child annually. My claims for Edmonds's seminal influence on vital statistics are based on a book he published in 1832 and on his series of 22 articles that appeared in the *Lancet*, 15 of these between 1835 and 1839. His book, *Life tables founded upon the discovery of a numerical law regulating the existence of every human being* (1832b), demonstrated that according to the best available data human mortality varied in geometrical series in three periods of life which he call infancy; manhood, florescence, or the period of procreative power; and old age or senescence (1834–35a: 6; 1855: 128). In the first period mortality fell each year of life by 32.4%; in the second it increased each year by 2.99%; and in the final period of life it increased annually by 7.97% (1832b: V–VII). Edmonds

held that this was a universal law of human existence. The exact ages dividing the three periods of life and the absolute rate of mortality might vary from people to people or from one historic period to another, but the pattern of change was innate to the human constitution. Edmonds demonstrated how one could use this law of mortality to construct theoretical or model life tables. He assumed a minimum mortality and the age limits of his three periods of life, and computed for each year of life a mortality rate from which he could calculate the number remaining alive at each age. Using this technique he produced three tables, his *Mean, village, and city mortality tables* that agreed quite well with the best available tables compiled from observation (1832b: XVIII–XIX).

Edmonds was certainly not the first to recognise that human mortality varied regularly with age. He mentioned that Richard Price had observed this general pattern. He failed, however, to properly acknowledge that in 1825 Benjamin Gompertz had published a mathematically equivalent law of human mortality in the *Philosophical Transactions* (1825). This overreaching did not go unnoticed, nor was it forgotten. Years later, when Edmonds was proposed for fellowship in the Royal Society of London, his claims for discovery were contested, and his failure to prove that his law was different from Gompertz's in the ensuing dispute cost him a fellowship (De Morgan 1860–61a; De Morgan 1860–61b; De Morgan 1861–62c; Edmonds 1859; Edmonds 1860; Edmonds 1860–61a; Edmonds 1860–61b; Edmonds 1861–62; Sprague 1861–62). The editor of the *Assurance Magazine*, who had presided over this personally bitter controversy probably got it about right, when he observed that Edmonds's law was merely Gompertz's in a slight different form but that Edmonds had applied the law with "great ingenuity, neatness, and effect" (Anonymous 1861).

Edmonds's historic importance does in fact reside in the applications he found for the law of mortality and particularly in the efforts he made to interest the medical profession in the uses of vital statistics. His series of articles in the *Lancet* was occasioned by the publication of the 1831 census. Much to Edmonds's disgust this enumeration did not collect information on the ages of the living, but that information was available from the 1821 census. The enumeration of 1831 did elicit information from the parish registers on the ages of the dying for the years 1813–1830. Now for the first time life tables for the general population of the entire nation or for geographical regions could be computed with the requisite information, the ages of the dying and the number of individuals at risk at each age of life (Edmonds 1835–36a: 365–7, 368–9; Edmonds 1835–36d: 690). Edmonds lost no time in demonstrating that his law of mortality applied to life

tables computed from these national data, and he made the important discovery that infant mortality was actually much lower than had been previously assumed (1834–35b).

In these early articles in the *Lancet* Edmonds presented the law of mortality as a fundamental tool of social and medical analysis. He not only repeated in less technical language the explanations he had offered in his book *Life tables* of how the law could be used to construct accurate life tables, but he argued that the collective vitality these tables reflected was the only accurate measure of public health and medical progress (1834–35a: 5). Age-specific mortality was a test of general health and well-being. To demonstrate he constructed tables using his law of mortality for each county of England and for six large towns and displayed in tables age group mortality rates by gender for each locality (1835–36a). He considered adult female mortality the best sanitary criterion, since it eliminated occupational hazards outside the home. There was great variation in this mortality. Some counties had double the rate experienced by others. When Edmonds arranged the counties of England in groups according to female mortality ages 15 to 30, he found that a line of high mortality extended from Brighton northwest to Liverpool and that the counties with the lowest mortality were furthest from this line (1835–36a: 411). This sort of sanitary topography would be developed much further and with greater emphasis on urban mortality by William Farr at the General Register Office.

Using the very limited data available in the middle 1830s, Edmonds also applied his law to sickness. Using data published by the Highland Society of Scotland on its members and by the Society for the Diffusion of Useful Knowledge on the experience of English mutual benefit societies, Edmonds concluded that the law of mortality applied to human sickness as well (1835–36b). Specifically he found that the number of persons constantly sick in a population changed with age in the same way that mortality did. This fact suggested that there should be a fixed ratio between the morbidity and mortality, so that if one knows the mortality for an area, one should be able to compute the number constantly sick. Edmonds went even further. Employing data Thomas Southwood Smith had published on 6000 cases at the London Fever Hospital between 1824 and 1834 and returns for the London Hospital made to Parliament for 13000 cases during the six years ending in 1833, Edmonds demonstrated that in at least these instances the law of mortality also described case fatality (1835–36b: 857–8; 1835–36e). He was convinced that the law applied to other human disease as well. If this were the case, the methods used to assess the value of therapy must change. Since case fatality varied with age, claims for effectiveness of therapy based on the numbers of

recoveries or deaths without regard to age of patients were invalid (1835–36e: 778). Edmonds challenged medical men to take this investigation further.

Farr was impressed with Edmonds's papers and he made good use of Edmonds's findings. In 1836 and 1837 he published two articles by Edmonds in the *British Medical Almanack*, and in his own chapter in John Ramsay McCulloch's statistical digest of the British Empire, a chapter that appeared in 1837 and helped establish Farr as an authority on vital statistics in his own right, Farr made good use of Edmonds's articles in the *Lancet* (Edmonds 1836; Edmonds 1837; Farr 1837e: 568–72, 585). Farr also took up Edmonds's challenge to study the law of sickness. Using clinical records from the London Smallpox Hospital, Farr published three articles in 1837 and 1838 in the periodicals he edited on the law of sickness in smallpox (1837a; 1837b; 1838). These not only confirmed that the law of mortality described the change in case fatality with age in smallpox as Edmonds had predicted, but they also displayed what Farr called sickness tables for smallpox which showed for an initial group of 100000 cases the number sick, the number recovering, and the number dying in five-day periods during the disease. This sickness or survivorship table was analogous to a life table, and Farr showed how the rates of recovery or dying varied for separate periods of the disease in geometrical series. The exercise provided further demonstration that vital processes were law abiding, and it suggested to Farr that the construction of sickness tables, "nosometry" in his parlance, could be used to judge therapeutic effectiveness (1837a: 73).

Although Farr repeated the latter claim as late as 1862 before the British Medical Association (1962), it was in matters of public health that his debt to Edmonds is most obvious. In this work Farr had great advantages over Edmonds. In 1839 he became compiler of abstracts at the newly-created General Register Office, a minor clerical post that he would turn into a much more important position than its creators could possibly have imagined. He suddenly had at his disposal an unprecedented quantity of vital data in a continuous series for the entire population created by the system of vital registration that had gone into effect in 1837, and he had the unique opportunity of establishing the system in which it would be organised and used.

Edmonds's intellectual legacy can best be seen in three aspects of Farr's work. First and most explicit is Farr's use of life tables. Like Edmonds he constructed life tables for the entire population from public vital data. During his career Farr would compile three national life tables. The first of these is the only one we can consider here. It appeared in the Registrar-General's fifth and sixth annual reports and was based on the deaths registered in 1841 and on 1841 census

(1844; 1839). Farr could have computed the entries for this table at each age directly from census and registration records, but such a procedure would have required enormous labour and been subject to all the inaccuracies and omissions of the raw data at his disposal. He instead used a method of interpolation which he acknowledged was suggested by the law of mortality first described by Gompertz and independently discovered by Edmonds (Farr 1843b: 163 (345–46)). Farr proceeded by calculating mortality at selected ages, and assuming that mortality varied with age in three geometric series as the law of mortality suggested, found the probability of living one more year at each age, and then the number living at each age (Eyler 1979: 77–80). Farr saw the life table as a tool of the widest possible application, and he computed life tables using similar techniques for local areas and for different occupational groups. Life table analysis suggested other techniques to Farr was well: the sickness tables that we have already noticed, a fertility table for English women, a table to describe the life time of English government ministries, and a table to describe promotions in the army and civil service (Eyler 1979: 80–4, 133–5).

The second way in which Farr followed Edmonds was in his use of mortality as a measure of health. Edmonds first measured the healthiness of places by comparing age group mortality rates for entire English counties and began to construct a topography of health for the nation. Over the course of his career, Farr would carry this goal to a high level of development. But let us here consider how he dealt with the problem at the beginning of his career, in his reports to the Registrar-General which appeared between 1839 and 1843 (1839; 1840a; 1841a). Much more than Edmonds, Farr had the particular goal of demonstrating how conditions in large towns undermined human health, and he proposed to do that by comparing the mortality of urban with rural areas. In the first three reports he merely compared total mortality and mortality rates for particular causes of death for two pairs of districts, one composed of urban areas and the other of rural. The districts in each pair had approximately equal population. The comparison demonstrated a dramatic increase in the burden of mortality in towns, and it suggested that the epidemic, endemic, and contagious diseases, the diseases Farr labelled "zymotic", were largely responsible. But this comparison was subject to the objection that the age structures of the urban and rural populations were not the same, and since mortality varied with age, a direct comparison of mortality was subject to error. With the 1841 census enumeration and the preparation of his first national life table Farr was prepared to tackle this problem. He did so in the fifth annual report where he presented not only life tables for the nation, but local tables chosen to represent the

spectrum of national mortality experience: the rural areas of Surrey, the Metropolis, and Liverpool. Using these four life tables he could compare age-specific mortality rates and life expectancies, and he drew survivorship diagrams which dramatically illustrated how a population cohort dwindled with the passage of years in each place (Farr 1843c; Eyler 1979: 131–6). This analysis suggests the direction Farr's investigations would take him. By the middle 1850s Farr had a model healthy population to serve as a standard, his Healthy Districts, the districts having crude annual death rates of 17 per 1000 or fewer. He would eventually publish a life table for the Healthy Districts, but even before he did so, he had begun to compute age-specific mortality rates for the healthy districts and to use those rates to calculate the excess mortality in other districts (1859a; 1859b). Such mortality comparisons form the basis of Farr's famous decennial supplements to the Registrar-General's 25th and 35th annual reports which were published in 1865 and 1875 (1865; 1875). In these magnificent reports he made ample use of life tables for standard populations and of age-standardised mortality rates. The analysis in these reports is a long way from the simple comparisons Edmonds had offered, but the trajectory leading to these sophisticated studies of Farr begins in Edmonds's articles in the *Lancet* in the 1830s.

Third and finally we can find the origins of Farr's idea of a statistical law in these publications of Edmonds. The law of mortality provided confirmation for these two young men that vital phenomena could be described in mathematical terms and that the discovery of mathematical regularities in sickness and death would have great utility. Such a law also defined for Farr the goal of statistical analysis. Farr constantly tried to demonstrate mathematical regularities in the data he collected, and over the course of his career he announced statistical laws of several sorts. Some described the changes in the probability of recovery or death during illness. We have noticed that his first statistical law, the law of recovery and death in smallpox, was of this sort. About the same time he announced another such law for recoveries and deaths among the institutionalised insane (1837c; 1837d; 1841b). Others described the course of an epidemic over time. An early one allowed him to describe and to predict the future course of an epidemic of smallpox in 1840; another in mid-career did the same for the cattle plague in 1866 (1840b; 1866). A third sort of statistical law described how mortality varied under the influence of changing environmental conditions. His elevation law for cholera this volume described in this journal is a good example (Eyler 2001). Others are the two laws relating human mortality to population density that Farr announced, one early in his career and another shortly before he retired (Farr 1843a:

207–10 (419–26); Anonymous 1873; Farr 1878–79; Farr 1878). The longevity of his interest in his density laws and the elaborate efforts he made to save the elevation law for cholera, even after his understanding of the transmission of cholera had changed, speak volumes for his belief in the importance of these statistical laws. For him, as for Edmonds, the laws were simple algebraic expressions that permitted him to generate a series of numbers that agreed with the observed series. As Edmonds had done, he presented them side by side to demonstrate the law. Mathematically simple though they might be, these laws confirmed for Victorian statisticians that vital phenomena were orderly and law abiding and that human health, no less than the subject matter of astronomy or physics as open to mathematical analysis. Such analysis, Farr believed, must precede any effective intervention.

Zusammenfassung

Entwicklung der Bevölkerungsstatistik:
Thomas Rowe Edmonds und William Farr, 1835–1845

Dieser Artikel beschreibt, welche Rolle die beiden Englischen Statistiker Thomas Rowe Edmonds und William Farr bei der Einführung der Mortalitätsstatistik als ein Mittel zur Erfassung des Gesundheitszustandes der Bevölkerung spielten. Basis ihrer Neuerungen war die Verwendung des Gesetzes der Sterblichkeit, welches Edmonds behauptete, 1832 erfunden zu haben. In Wirklichkeit hatte er jedoch nur eine Beziehung zwischen dem Altern und der Sterblichkeit wiederentdeckt, welche von Benjamin Gompertz rein mathematisch ein Jahrzehnt früher bereits beschrieben wurde. Während der 1830er-Jahre versuchte Edmonds medizinische Kreise für seine Entdeckung zu interessieren, indem er ihnen darlegte, wie diese zur Erfassung des Gesundheitszustands grosser Bevölkerungsgruppen und zum Studium der Umstände von Todesfällen und der Wirkung von Therapien verwendet werden könnte. William Farr nutze den grossen Datensatz des „General Register Office", um die Ideen Edmonds weiterzuentwickeln und verwirklichte eine der anspruchsvollsten Anwendungsarten der Bevölkerungsstatistik des 19. Jahrhunderts. Wichtig für das Verständnis der Motivationsgründe dieser beiden Statistiker ist, dass ihr Einsatz für Reformen in ein Zeitalter fiel, das extrem von menschlichen Verlusten im Rahmen der raschen Industrialisierung und Verstädterung betroffen war. Edmonds und Farr traten also für eine Reform ihres Berufsstandes und der Gesellschaft ein.

Résumé

L'élaboration des statistiques sanitaires:
Thomas Rowe Edmonds et William Farr, 1835–1845

Cet article décrit le rôle de deux statisticiens anglais dans l'élaboration de statistiques de mortalité comme moyen d'évaluer l'état de santé de populations humaines. Un aspect clé de cette innovation a été l'utilisation de la loi de mortalité qu'Edmonds prétendait avoir découverte en 1832. En réalité, il avait simplement redécouvert la relation entre vieillissement et mortalité décrite pour la première fois mathématiquement par Benjamin Gompertz 10 ans plus tôt. Pendant les années 1830, Edmonds tenta d'attirer l'attention de la profession médicale sur sa découverte et de suggérer la façon dont celle-ci pourrait être utilisée pour évaluer l'état de santé de grandes populations, pour étudier la létalité et l'effet des traitements. L'application par William Farr des propositions d'Edmonds, à partir de la riche banque de données du Bureau du Registre Général, aboutit aux utilisations les plus sophistiquées des statistiques sanitaires au 19ème siècle. Pour comprendre la motivation de ces deux statisticiens, il est essentiel de réaliser leur sympathie pour des réformes sociales dans une période profondément troublée par les coûts humains de l'industrialisation rapide et de l'urbanisation. Les deux voulaient réformer à la fois leur profession et la société.

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Appendix

A note on sources

Farr's annual letter in the "Annual Report of the Registrar-General of Births, Deaths, and Marriages in England and Wales" is cited as Farr, "Letter, nth A.R.R.G". This important source was reprinted in the British Parliamentary Papers, here abbreviated as "B.P.P." In some years the pagination differed between the separately published version and the version in the Parliamentary Papers. The version in "B.P.P." is cited, but when the pagination differs, the page number in the separately published version is given in parenthesis.