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CHAPTER 1

THE MORTALITY REVOLUTION AND THE TROPICAL WORLD: RELOCATION COSTS IN THE EARLY NINETEENTH CENTURY

Between the seventeenth century and the middle of the twentieth, the Western world passed through a profound demographic change. Earlier patterns of high mortality and high fertility gave way to comparatively lower birth and death rates, like those that prevail today. The crucial change is generally (but not universally) interpreted as a "mortality revolution" – a one-time and dramatic change in death rates that opened the possibility for lower birth rates as well. By the mid twentieth century, the mortality revolution had reached most world societies. Not all of them chose lower fertility, but those that failed to do so experienced runaway population growth, sometimes as high as 4 percent per year.

In the nineteenth century, death rates not only dropped in Europe; they dropped even more dramatically among Europeans who went overseas. The change profoundly altered Europe's epidemiological relationship to the rest of the world. In the eighteenth century and before, death rates of Europeans moving into the tropical world at least doubled and could increase several fold – even for men in the prime of life.[1] When these death rates began to drop, Europeans were free to move into the tropical world at far less risk than ever before.

The Statistical Base

Military doctors have given us our best records of death and disease among mobile populations – and death from disease was far more serious in the nineteenth century than death in battle. Military doctors often treated men recruited in one part of the world and serving in another. From the early nineteenth century, they became especially concerned about recording what they observed. The statistical movement in British and French intellectual life was just then seeking quantitative measures of social phenomena that could be used to guide

[1] Philip D. Curtin, "Epidemiology and the Slave Trade," *Political Science Quarterly*, 83:191–216 (1968).

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public policy in a number of areas, one of which was the health of the army, especially of the army serving overseas. Rising humanitarian sentiments from the late eighteenth century on brought increased sympathy for the common soldier, and practical considerations began to be important; the death of soldiers overseas was a burden to the taxpayer.

Although Britain did not begin to register births and deaths until the late 1830s, military records make it possible to reconstruct some annual mortality rates of British troops serving in India as far back as 1793.[2] These records reflect an even earlier concern for the health of British troops in the West Indies. Medical men and commentators of the early nineteenth century still recalled disease catastrophes of nearly a century earlier.[3] During the English attack on Cartagena on the Caribbean coast of South America in 1742, the English force spent only two months laying siege to the city, but its losses from disease alone were two-thirds to three-quarters of its more than 12,000 men – a big army for the Americas at that time. Even if they had lost only half the force, the annualized loss would come to 3,000 per thousand men.

Losses on a similar scale followed the English attack on Havana in 1762, the English intervention in Saint Domingue in 1793–98, and the French effort to reconquer that colony from rebellious slaves in 1802. In all these cases, fresh, nonimmune troops from the north met epidemic yellow fever. Even in normal times, the high death rate of troops on garrison service was cause for alarm.[4]

Wellington's losses in the peninsular campaign against Napoleonic France was another recent memory of high mortality. Sir James MacGrigor had been chief medical officer during that campaign. He then became director general of the Army Medical Department in the 1830s, where he was instrumental in ordering a retrospective statistical survey based on army medical reports back to 1816.[5]

[2] "Report of a Committee of the Statistical Society of London, Appointed to Collect and Enquire into Vital Statistics, upon the Sickness and Mortality among the European and Native Troops Serving in the Madras Presidency, from the Year 1793 to 1838," JSSL, 3:113–43 (1840).

[3] Moreau de Jonnès, *Essai sur l'hygiène militaire des Antilles* (Paris, 1817); John R. McNeill, "The Ecological Basis of Warfare in the Caribbean, 1700–1804," in *Adapting to Conditions: War and Society in the Eighteenth Century*, ed. Maarten Utlee (Tuscaloosa, 1986), pp. 16–42.

[4] F. Guerra, "The Influence of Disease on Race, Logistics and Colonization in the Antilles," *Journal of Tropical Medicine and Hygiene*, 49:23–35 (1966); David Geggus, *Slavery, War, and Revolution: The British Occupation of Saint Domingue 1793–1798* (Oxford, 1982), pp. 347–72; Nicolas Pierre Gilbert, *Histoire médicale de l'armée française à Saint-Domingue, en l'an dix: ou mémoire sur la fièvre jaune, avec un aperçu de topographie médicale de cette colonie* (Paris, 1803).

[5] James MacGrigor, "Sketch of the Medical History of the British Armies in the Peninsula of Spain and Portugal during the Late Campaigns," *Medical-Chirurgical Transactions*, 6:381–489. For the statistical movement, see Theodore M. Porter, *The Rise of Statistical Thinking* (Princeton, 1986), esp. pp. 23–38; Michael J. Cullen, *The Statistical Movement in Early Victorian Britain* (New York, 1975), esp. pp. 45–52; see also Neil Cantlie, *A History*

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In 1835, a medical crisis at an army hospital in the Bahamas added to the sense of urgency and led to the appointment of a special board of inquiry. Its chairman was Henry Marshall, an army doctor who had served in Ceylon and India and had already published statistical studies of army health. He, in turn, recruited Capt. Alexander M. Tulloch, a former foot officer with a legal background. Marshall was responsible for the overall design of the research that followed, and, when he retired in 1836, T. Graham Balfour took his place. Tulloch did most of the writing and supervised the assemblage of data, while Balfour kept the ensuing series of reports in line with medical knowledge. Together, the three men became the founders of systematic military medical statistics.

The first product of their research appeared in 1838 – the book-length "Statistical Report on Sickness, Invaliding, and Mortality among Troops in the West Indies."[6] Over the next four years the team followed up with equally impressive reports on England, North America, and the Mediterranean (1839); on Africa and the African islands (1840); and on Ceylon and Burma (1842). Each of these covered the two decades between 1817 and 1836 as nearly as possible.[7] Even before the last report had appeared, the British Navy began to produce its own medical statistics, and the United States government ordered a compendium of reports on its own army's health over the period 1819–39.[8] Tulloch and his colleagues began work on a second series covering the decade, 1837–46, but only one full report appeared – on troops in Britain, North America, and the Mediterranean.[9] The Crimean War diverted attention from leisurely retrospective views of army health to the dramatic toll of military deaths from disease in Turkey and the Crimea.

By the end of the 1850s, it was again possible to resume regular reporting – now in the form of annual reports by the Army Medical Department, published as a separate volume each year and also republished in the Parliamentary Sessional Papers. In 1859, the first of the new series summarized the unpublished data for 1837–46 in aggre-

of the Army Medical Department, 2 vols. (London and Edinburgh, 1974), 1:404–41. For its implications for the history of medicine, see James H. Cassedy, *American Medicine and Statistical Thinking, 1800–1860* (Cambridge, 1984) and *Medicine and American Growth 1800–1860* (Madison, 1986).

[6] *British Parliamentary Papers* (cited hereafter as PP), 1837–8, xl (138).

[7] In each case, Alexander M. Tulloch was listed as author, PP, 1839, xvi [C.166]; PP, 1840, xxx [C.228]; PP, 1842, xxvii [C.358].

[8] "Statistical Reports on the Health of the Navy 1830–6, PP, 1840, xxx (163); PP, 1841, Sess. 2, vi (53); United States Army, *Statistical Report on the Sickness and Mortality in the Army of the United States, from January 1819 to January 1839* (Washington, 1839).

[9] Great Britain, Army Medical Department [Alexander M. Tulloch and T. Graham Balfour], *Statistical Reports on the Sickness, Mortality, and Invaliding among the Troops in the United Kingdom, the Mediterranean, and British America* (also published in Parliamentary Papers, 1853).

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gated form, but the decade 1847–58 is still missing from the series. Parliamentary investigations took up the sorry sanitary record of armies in the Crimean War and the loss to disease among troops sent to suppress the Sepoy Mutiny in India in 1857. The government appointed a royal commission to survey the health of the troops in India and prescribe remedies.

When the Royal Commission on India reported in 1863, it found that the recent death rates of British military in India represented the trailing edge of a prolonged plateau of relatively high mortality stretching back still further into the past.[10] Most authorities date the beginnings of the mortality revolution as far back as the late seventeenth or early eighteenth century, and this was no doubt true for civilian populations.[11] The Indian commissioners, however, assessed the plateau rates for enlisted men in India over the whole period from 1800 to 1856 at about 69 per thousand; those for officers were 38 per thousand, and those for European civil servants about 20 per thousand.[12] The low rate for civilians highlights one of the fundamental facts of military medical experience; troops in barracks are much healthier than troops on campaign, even disregarding losses from combat, and military campaigns had been an ever-present reality in India before the 1860s.[13]

That same Royal Commission worked out the cost of Indian operations in pounds, shillings, and pence. It cost £100 to recruit a soldier and maintain him in India. With an army of 70,000 Europeans, 4,830 would die each year, and 5,880 hospital beds would be full at any given moment. Britain was therefore losing £588,000 annually from sickness alone. A similar force might have cost £200,000 in European conditions; the extra £388,000 was a surcharge for tropical service.[14]

[10] Great Britain, Royal Commission on the Sanitary State of the Army in India, *Report of the Commissioners Appointed to Inquire into the Sanitary State of the Army in India*.... 2 vols. (London, 1863), 1:xi. A one-volume version consisting of the commissioners' report and a précis of evidence is printed in PP, 1863, xix [C.3184], but on different size sheets and with different pagination. See also William W. Hodges, "On Mortality Arising from Military Operations," JSSL, 19:219–71 (1856); John Pringle, *Observations on the Diseases of the Army*, 7th ed. (London, 1775), pp. 54, 60; Committee on the Preparation of Army Medical Statistics, PP, 1861, xxxvi (366), p. 44

[11] James C. Riley, "Insects and European Mortality Decline," AHR, 91:833 (1986).

[12] India Royal Commission, *Report*, p. xix. The data for officers and civilians, however, were not calculated over the same period or on the same basis as those for enlisted men, so that they are not strictly comparable. Officers and civilians, for example, had great freedom of choice to be "invalided" home in case of illness. Judging from later evidence, the commissioners' figures were probably too high for enlisted men and perhaps too low for officers. At later periods, death rates for officers and other ranks did not differ very much, and the health of officers was not necessarily better.

[13] This principle was well understood by the early statisticians; see, for example, Statistical Society of London, "Report of the Committee of the Statistical Society of London, Appointed to Enquire into Vital Statistics, upon the Sickness and Mortality among the European and Native Troops Serving in Madras Presidency, from the Year 1793 to 1838," JSSL, 3:113–43 (1840).

[14] India Royal Commission, *Report*, p. xvii ff.

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Equivalent calculations had been published in France. Shortly after 1830, when the French conquest of Algeria began, French authorities became alarmed over the high death rate from disease among its troops in North Africa. In 1847, Jean Boudin, an army doctor who had served in Algeria, pointed to a recent death rate of 64 per thousand for Algerian service, or, with a total force of 100,000 in round numbers, an annual loss of 6,400 men – seven times the death rate in France for men of military age.[15] But the French had already begun to improve their performance, and the death rates dropped steadily from the mid-1830s. The French death rate from disease in the Crimean War, however, was even higher than the British, and the lesson was taken as seriously in France as in Britain. The French credited the British with superiority in military medicine and tried hard to catch up.[16] By 1866, they had succeeded so well in Algeria that the British War Office sent commissioners to investigate, hoping to use the lessons of French experience in India.[17]

The British Royal Commissioners of 1863 set their own goals for the future. They calculated that the "natural" death rate for men of military age in Britain was around 10 per thousand. Twenty per thousand seemed a reasonable short-run goal for India, to be achieved solely by applying known sanitary measures. In the longer run, they hoped to achieve what they called the "natural" rate of "no more than 10 per thousand per year."[18] As it turned out, the British Army in India met the first goal within the decade; it met the second, 10 per thousand, in 1907.

By the 1870s, most European armies and navies published annual reports on the health of the services. Dutch reports are especially important because of their sample size and length of continuous publication. Their forces in the East Indies were the largest in tropical Asia, after India itself, and some data are available as far back as the Dutch reoccupation of the islands at the end of the Napoleonic Wars. At least from 1848, these reports appeared in the annual *Kolonial Verslag*, matching those for the domestic army.[19] Spanish and Portuguese series also began to appear from the 1870s.[20]

Partial French returns had appeared here and there during the first

[15] Jean C. M. F. J. Boudin, "Études sur la mortalité et sur l'acclimatement de la population française en Algérie," AHPML, 37:358–9 (1847).
[16] Alphonse Laveran, *Traité des maladies et épidémies des armées* (Paris, 1875), p. xx.
[17] PP, 1867, xv [Cd.19447], *Report of the Causes of Reduced Mortality in the French Army Serving in Algeria*.
[18] India Royal Commission, *Report*, p. lxxxi.
[19] Netherlands, Department van Kolonien, *Kolonial Verslag* (annual series); Department van Oorlog, Geneeskundig Dienst der Landmacht, *Statistisch overzicht der bij het Nederlandische leger in het year . . . behandelde zieken* (annual series).
[20] Spain, Ministerio de la Guerra, *Resumen de la estadistica sanitaria del ejercito española* (Madrid, 1884+); Portugal, Ministerio de Guerra, *Estatistica geral do servicio de exercito* (Lisboa, 1870–1+).

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half of the century,[21] but the Ministère de la Guerre began its own regular annual series of *Statistiques médicale de l'armée metropolitaine et de l'armée coloniale* beginning in 1862. Volumes for 1869–71 were not published because of the Franco-Prussian War, but otherwise the series continues down to 1913. A French navy series later joined it, but, until the late 1890s, the navy published no regular returns for the *troupes de la marine* (later *troupes coloniales*) who actually did most of the fighting in the nineteenth-century tropics.

The Geography of Relocation Costs

In spite of gaps, the record shows certain major trends for the better part of a century. Table 1.1 provides a point of departure, because it shows the earliest data available for most of the listed territories. The significant data are in three categories: the death rates of soldiers at home, those of soldiers overseas, and the difference between them. This difference (the *relocation cost* in deaths of removing a person to a new setting, different from his childhood disease environment) can be measured absolutely – as so many deaths per thousand – or relatively, as the percentage increase or decrease over the rates prevalent at home. Relocation costs, however, need not be measured in deaths only. They can also be recorded separately for any one of the other health indicators found in the army reports – discharge on grounds of health, repatriation from a foreign station, morbidity measured by hospital entries, or morbidity measured by the mean percentage of the force in hospital at any moment. The most telling of these indicators is death.

Table 1.1 is arranged by region. The variance within some regions is large, although the regional pattern is clear. The temperate countries (Map 1.1) are reasonably homogeneous – showing death rates from 15 per thousand in the northern United States to 20 per thousand in France. Once beyond Europe and North America, the result of movement was generally negative – relocation exacted a *cost*. The one exception is a part of the southern and tropical Pacific, where relocation was a *benefit* to European soldiers.

Relocation Benefits

Epidemiological theory suggests that people moving as adults to a new disease environment will suffer for lack of the immunities they would have acquired in childhood. Nineteenth-century European opinion

[21] Jean Boudin, "Statistique médicale de l'armée anglaise," RMMM, 12(3d ser.): 369–89; 12:1–22 (1864–5); "Statistiques coloniale. Mortalité des troupes," RC, 10(2d ser.):473–81 (1853).

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Table 1.1. *Mortality of European Troops Overseas, 1817–38*

Region	Nationality of Troops	Date of Sample	Deaths per Thousand	Relocation Costs or Benefits (percent)
Pacific Islands				
Tahiti	French	1845–9	9.50	50.01
New Caledonia	French	c. 1848	11.40	21.14
New Zealand	British	1846–55	8.55	44.12
Europe and North America				
France	French	1820–2, 1824–6	20.17	
Great Britain	British	1830–6	15.30	
Northern United States	American	1829–38	15.00	
Canada	British	1817–36	16.10	
Mediterranean climate				
Algeria	French	1831–8	78.20	−287.70
Gibraltar	British	1818–36	21.40	−39.87
Malta	British	1817–36	16.30	−6.54
Ionian Islands	British	1817–36	25.20	−64.71
Cape Colony	British	1818–36	15.50	−1.31
Southern United States and malaria-free islands				
Bermuda	British	1817–36	28.80	−88.24
Southern United States	American	1829–38	34.00	−126.67
Mauritius	British	1818–36	30.50	−99.35
Réunion	French	1819–36	32.12	−59.25

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Table 1.1. *(cont.)*

Region	Nationality of Troops	Date of Sample	Deaths per Thousand	Relocation Costs of Benefits (percent)
Southern Asia				
Bombay	British	1830–8	36.99	−141.76
Bengal	British	1830–8	71.41	−366.73
Madras	British	1829–38	48.63	−217.84
Ceylon	British	1817–36	69.80	−356.21
Coastal Burma	British	1829–38	34.60	−126.14
Straits Settlements	British	1829–38	17.70	−15.69
Dutch East Indies	Dutch	1819–28	170.00	−1,011.11
West Indies				
Jamaica	British	1817–36	130.00	−749.67
Windwards and Leewards	British	1817–36	85.00	−455.56
Guadeloupe	French	1819–36	106.87	−429.85
Martinique	French	1819–36	112.18	−456.17
French Guiana	French	1819–36	32.18	−59.54
Tropical Africa				
Sénégal	French	1819–38	164.66	−716.36
Sierra Leone	British	1819–36	483.00	−3,056.86

Source: British: PP 1837–8. xl (138); 1839, xvi [C.166]; 1840, xxx [C.228]; 1842, xxvii [C.356]. Madras, Coastal Burma, and Straits Settlements: Committee Report on Madras, JSSL, 3:113–43, 4:137–55 (1840–1). All three belonged to the Madras Army, but are here disaggregated. New Zealand: AMSR, 1:114 (1859), relocation calculated on British data for 1830–6. American: Thomas Lawson, *Statistical Report on the Sickness and Mortality in the Army of the United States*, 3 vols. (Washington; D.C. 1840–60). French Interior, Benoitson de Chateauneuf, "Essai sur la mortalité dans l'infantrie française," AHPML, 10:239–316 (1833). The year 1823 is omitted because of French intervention in Spain. Colonies, *Revue coloniale*, 10(2d ser.):473–81 (1853). New Caledonia, Bertillon, "Acclimatment," DESM, 1:43. Tahiti: F. Burot and M. A. Legrand, *Les troupes coloniaux*, 1:66–7. Dutch: *Deutches Kolonialblatt*, 5:116 (1894). Relocation calculated from British home data.

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Table 1.2. *Mortality of European Troops Overseas, 1909–13*

	Nationality of Troops	Dates	Deaths per Thousand	Change from Table 1.1 (percent)	Relocation Costs of Benefits (percent)
Pacific Islands					
Hawaii	American	1909–13	1.30		50.00
Tahiti[a]	French	1903–6	2.30	−24.20	20.14
New Caledonia	French	1909–13	2.33	−79.56	19.10
Europe and North America					
France	French	1909–13	2.88	−85.72	0.00
Great Britain	British	1909–13	2.55	−83.33	0.00
Continental United States	American	1904–13	2.60	−82.67	0.00
Mediterranean					
Algeria and Tunisia	French	1909–13	5.25	−93.29	−82.29
Morocco	French	1909–13	21.99		−663.61
Gibraltar	British	1909–13	2.21	−89.67	13.33
Malta	British	1909–13	2.53	−84.48	0.78
Cyprus	British	1909–13	1.66		34.90
Egypt	British	1909–13	3.97		−55.69
Formerly Malaria-free islands					
Bermuda	British	1909–13	2.21	−92.33	13.33
Mauritius	British	1909–13	4.53	−85.15	−77.65
Southern Asia					
India	British	1909–13	14.08		−452.31
Ceylon	British	1909–13	5.49	−92.13	−115.29
Straits Settlements	British	1909–13	4.75		−86.27
North China	British	1909–13	5.09		−99.61
Philippines	American	1909–13	3.27		−25.77

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Table 1.2. *(cont.)*

	Nationality of Troops	Dates	Deaths per Thousand	Change from Table 1.1 (percent)	Relocation Costs of Benefits (percent)
South China	British	1909–13	3.81		−49.41
Cochinchina	French	1909–13	8.90		−209.03
Annam/Tonkin	French	1909–13	3.57		−23.96
Dutch East Indies	Dutch	1909–13	6.39	−96.24	−150.44
West Indies					
Jamaica	British	1909–13	7.76	−71.91	−204.31
French Antilles	French	1909–13	4.93		−71.11
Cuba and Puerto Rico	American	1904–9	3.59		−38.08
Tropical Africa					
French West Africa	French	1909–13	6.65	−95.96	−131.04
French Equatorial Africa	French	1909–13	5.66		−96.56
Madagascar	French	1909–13	5.67		−96.74
British West Africa	British	1909–13	5.56	−98.85	−118.04
South Africa	British	1909–13	3.84	−75.23	−50.59
Kamerun	German	1901–6	41.12		−1512.63

[a] No troops in Tahiti in 1909–13, but annual average mortality in 1903–6 was 2.3 per thousand.

Source: Netherlands: Central Bureau voor de Satistiek, *Statistisch Overziergt den Behandelde Zieken van het Nederlanisch Lager over het jaar 1913* (The Hague, 1915), p. 28. Kamerun: Germany, Kolonialamt. *Medizinal-Bericht über die Deutschen Schutzggebiete*, 1905–6, pp. 122, 385–9, 393–4, 410–11, 422, 430. Philippines, Cuba/Puerto Rico, Hawaii, and United States: United States; *Report of Surgeon General of the Army*, Annual series. 1904–13. Deaths from disease only. Morocco and Algeria: Ministère de Guerre, *Statistiques médicales*, report for 1913. French Colonies 1909–13: *Statistiques médicale des troupes coloniales*, annual series. Netherlands and Germany: British mortality data used as proxy.