A MATTER OF PRIVILEGE: INFANT MORTALITY IN THE GARRISON TOWN OF GIBRALTAR, 1870-1899

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The British colony of Gibraltar offers an opportunity to compare the infant mortality rates of the civilian and military populations inhabiting a small-scale urban setting from 1870 to 1899. Both groups shared the same poor-quality housing, the same sanitary infrastructure, and the same environmental inseparability. Sufficient water supply, in particular, proved to be a daily struggle for the families living on the Rock. Privilege for the military meant that service families had preferential access to a pure water supply after the installation of a water-condensing plant as well as to a better quality supply of water and milk. The availability of these privileges to one group, and not the other, is associated with a marked decline in infant mortality in the second half of the study period.

One of the most vexing issues in nineteenth-century population studies is the cause of the rapid decline in infant mortality before the advent of twentieth-century medical therapies and services.[1] Concomitant changes in late-nineteenth-century public health initiatives, domestic sanitation, personal hygiene, medical nosology, and improved nutrition have made it difficult for researchers to isolate any single factor from these and other influences. Rarely has history offered an opportunity to study two populations that share the same environment yet differ in fundamental ways that may help to illuminate how access to resources could affect infant health and mortality. The unique conditions required for such a study are present in the British crown colony of Gibraltar, where military and civilian populations lived in close proximity, shared the same urban conditions, and were dependent on the same food supplies and sanitary infra-

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Journal of Family History, Vol. 27 No. 4, October 2002 399-429
DOI: 10.1177/036319902236626

structure. Gibraltar offers the reliable quantitative information needed for comprehensive comparative analyses of the health of the military and civilian populations.

Gibraltar's singular concurrence of geographic, geologic, and political elements makes it a natural laboratory for the study of disease and mortality, albeit at a great cost to the inhabitants.[2] Situated at the southern tip of the Iberian peninsula, Gibraltar is itself a peninsula surrounded by the Mediterranean and attached to Spain by a wide sandy spit (see Figure 1). Measuring only 3.6 square miles, Gibraltar is dominated by a large limestone outcrop covering three-quarters of its land area. It is on the fourth quarter, on the lower inclines of the Rock and on the flat red sands, that the dwellings for the inhabitants were found in the nineteenth century. It should be stressed that Gibraltar was, at best, capable of supporting only light industry at a very modest level. As a result, it can be argued that the overall health of this nineteenth-century urban community was primarily susceptible to high-density living, poor sanitary conditions, and a dependency on scare essential resources and not to general effects of industrialization per se.[3]

Gibraltar's unique geology preempted any possibilities for self-sufficiency in food or even water supplies, and the paucity of natural resources on the Rock required its inhabitants to grapple daily with the scarcity and cost of the essentials of life. Food had to be supplied from neighboring Spain or from nearby Morocco, and water within the town came from only two sources: that which was caught and stored from rainwater or drawn from private wells sunk into the red sands under the dwellings. A third source, from wells sunk into the North Front (or the sandy spit joining Gibraltar to Spain), was frequently contaminated with local pollutants and seawater, yet such was the scarcity of water that the population often had no recourse but to use this brackish water.

CIVILIAN AND MILITARY POPULATIONS CA. 1870-1899

By the mid–nineteenth century, Gibraltar had developed into an important commercial center and international port of call, yet it continued to be first and foremost a fortified garrison post in the British Empire. The population of Gibraltar was strictly segmented, both hierarchically by class and laterally by nationality. Three populations shared the tiny peninsula: the civilians of Gibraltar, the garrison of the British military, and Spanish workers on temporary permits. At the beginning of the study period, in 1870, the Gibraltarians numbered about fifteen thousand, mostly descendants of Spanish, Portuguese, Genoese, and North African immigrants.[4] For the majority of Gibraltarians, Spanish was the language spoken in the home, although English was taught in schools.[5] Life in Gibraltar was essentially a "cradle to grave" prospect for this group, with low levels of emigration from the colony.[6]

In contrast, the second segment, the military, was highly transient. According to the census of 1878, the garrison was composed of some 5,845 soldiers and officers, accompanied by 533 wives and 1,148 children.[7] Almost all were born in Britain or, especially in the case of the children, in other colonial garrisons. Although the military population as a whole was a permanent fixture in Gibraltar, regiments frequently moved; therefore, individuals were in Gibraltar on a temporary basis. On average, an officer or soldier stayed 1.75 years in the garrison before transfer to another post.[8]

As with other regiments stationed in the British colonial empire, only a portion of the men in the Gibraltar regiments (9.1 percent) were married. A troop member required permission to marry, and this was rarely granted to soldiers during their first

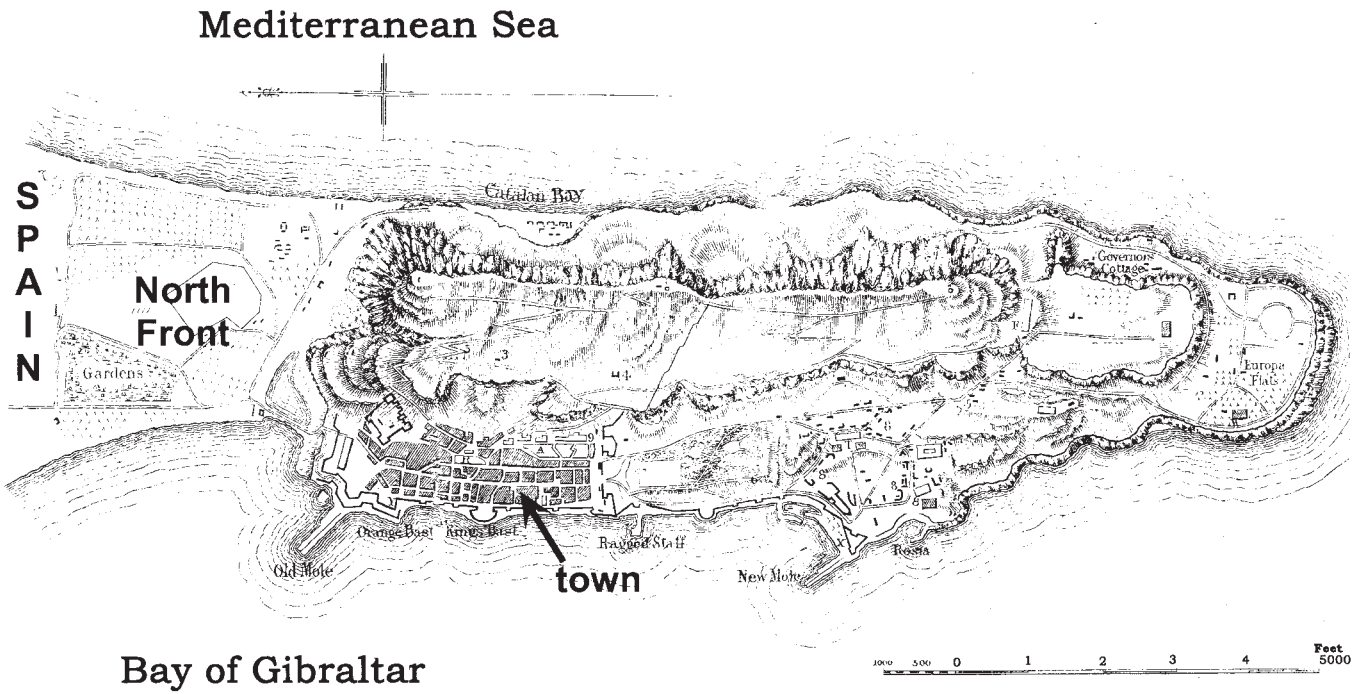

Figure 1. Plan and Location of Gibraltar

term of enlistment. Marriage was a privilege bestowed on only the most deserving of soldiers as an inducement for reenlistment. As Trustram reported,

> From the beginning of the 1860s the possibility of offering greater opportunities to marry as an inducement to men to re-enlist after their initial ten or twelve years of service was discussed. It was not considered a great hardship for men to remain single during the first term of service since most male civilians did not marry before their late twenties anyway.[9]

The percentage of married military men in Gibraltar was on the high end of the scale, given Trustram's finding that "permission to marry was granted to only a small proportion of men . . . generally the same as the proportion allowed to bring their wives into barracks—six per cent—although in some regiments up to ten per cent received permission."[10]

The third segment of the population was also temporary; the Spanish workers had passes that allowed them to come in for the day or perhaps reside for up to three months. Collectively, the temporary workers were known as the "floating" population, and those with limited residency numbered about three thousand in 1870, with another fifteen hundred coming in for the day's work.[11] It was this group that did the work that Gibraltarians had no wish to do: domestic work for the women and scavenging or loading coal for men.[12] A small number of female temporary workers also served as prostitutes for the more than five thousand military men unaccompanied by wives.[13]

The majority of the civilian population lived in the town of Gibraltar, an area bounded on the east side by the steep slopes of the Rock and on the west side by the fortified sea wall and the bay. The north and south ends of the town were (and still are) protected by high, thick walls, built to withstand the pounding of mortar shells during a siege. The town occupied about one hundred acres, and with fifteen thousand or so people residing within these walls, the density was equivalent to seventy thousand people per square mile. Town residents inhabited multiple family dwellings built in the Mediterranean style and commonly called *patios*. Patios were generally crowded, dark, and poorly ventilated. Although efforts were made to keep interior rooms clean, common areas of the patio, including the central courtyard that housed the latrine, were often choked with filth and organic debris.[14]

If the civilian Gibraltarians inhabited unsanitary dwellings, the rank and file of the military did not fare any better. The military barracks were situated in several locations throughout the colony, including the exposed ridge at the southern end of the peninsula and on the north front at the border with Spain, but the largest contingency of rank and file (43.3 percent) was within the town walls.[15] Most barracks were built with thick stone walls to withstand siege, and the buildings were set against the lower slopes of the Rock or buttressed by earth banks. The barracks were very damp, had little ventilation, and there was no provision for fires for the colder winter months. Floors were often unpaved, drainage was poor, and the latrines were open troughs and usually noxious.

By 1870, the primitive sanitary structures built in the 1820s had been overwhelmed by rapid population growth, and no new sewers had been engineered for half a century. Structural improvements in the colony were primarily focused on fortifications, armaments, and batteries, rather than on drains, sewers, and water delivery. For example, in 1857 Gibraltar acquired a gas works facility, yet there was no centralized water plan

for the remainder of the century.[16] Batteries were built wherever a gun logistically could be mounted, yet the soldiers who manned them lived in dark, dank, bomb-proof rooms.[17] The limited space in the colony meant that all residents, whether rich or poor, temporary or permanent, military or civilian, lived in close proximity to each other and shared the same sanitary deficiencies. This resulted in an environmental inseparability of the two groups. As a barracks improvement commission report from 1862 stated,

> The sanitary conditions of the dwellings of the civil population at all the stations [in the Mediterranean] is [*sic*] very bad, and it has been impossible in this inquiry to separate the sanitary condition of the troops from that of the civil population. Much, of course, might be done to render barrack rooms more healthy by themselves, but where a bad, unhealthy system of town drainage is intimately connected with the barrack drainage, and where a defective town water supply is necessarily accompanied by a defective barrack water supply, there is no remedy for either evil, as regards the barracks, but to improve the drainage and water supply as a whole.[18]

Concern over military inadequacies, therefore, also brought attention to the general deficiencies in Gibraltar as a whole.

Although relations between the civilians and the military in Gibraltar always appeared peaceable, there were obvious undercurrents of tension between the two populations. Much of the source of this tension lay in the powerlessness of the civilians in governing their own affairs, as the governor of the colony was appointed by Her Majesty's government and answered only to Whitehall. To the British, Gibraltar was first and foremost a fortress, and civilians were seen as a necessary adjunct to the garrison, as a burden that must be tolerated. Little was done to improve the day-to-day conditions of the civilian lives. But in the 1860s and 1870s, changing attitudes toward sanitation and public health were occurring in England, and some medical men were pointing at the army's neglect of the soldiers and civilians.[19] Defeat on the battlefield made the army look at the wastage attributed to badly conditioned soldiers who had little strength or incentive to fight.[20] Whitehall realized that the cost of caring for ill soldiers and replacing dead ones was far greater than the cost of sanitary and health-promoting measures.[21] Pressure from public opinion[22] and from within the services also caused changes in the military attitude toward the health and well-being of the individual soldier and prompted army reforms beginning in the 1870s. Among these reforms in Gibraltar was the construction of the condensing plant to serve as a badly needed source of pure water.

INFANT MORTALITY MEASURES

Given these considerations and to gauge the overall differences in health between the two populations, this study focuses on infant mortality. As one of the most reliable comparative indicators of health, the infant mortality rate (IMR) is defined as the number of deaths under one year of age per one thousand live births. Infant mortality has "traditionally been used as a proxy measure of the social and sanitary state of a community,"[23] and "there is further evidence to suggest that infant mortality, rather than childhood mortality, is the most sensitive indicator of the effects of malnutrition."[24] Careful study of infant mortality, as opposed to other areas of investigation, offers several advantages. Infant mortality frequently serves as a good predictor of the overall

life expectancy of a population, as well as of the general social well-being.[25] Therefore, not only can real mortality-based differentials in military and civilian health be addressed, but the general living conditions of military and civilian families coexisting in this crowded garrison can also be estimated. An additional advantage in focusing on infant mortality is the fact that its level is calculated independently of the age structure of a population,[26] thereby providing a means to compare communities that have not established a stationary population structure, such as those that are expanding or diminishing. This is particularly important when populations under scrutiny are of a transient nature, such as in the case of Gibraltar's military population.

Previous studies on infant mortality among the civilian population of Gibraltar have shown that lower infant mortality was experienced by the small Jewish population relative to the larger Roman Catholic and Protestant populations and that low infant mortality was associated with higher socioeconomic status, lower parity (number of children born to a woman), and better social support among the Jews.[27] Previous studies have also shown that the most serious threat to life among infants in Gibraltar during the nineteenth century was weanling diarrhea, so-called because it was associated with the transition away from the mother's breast and a major cause of infant death.[28] Therefore, while much is published on civilian infant mortality in nineteenth-century Gibraltar, relatively less is known of the health of infants in the military population.

The materials for this study include vital registration data collected by the colonial government of Gibraltar and housed in the Gibraltar registry office and government archives. Since compulsory birth and death registration began in Gibraltar in 1869, and because of a strict colonial mandate to track the growth of this population, record keeping was of a uniformly high quality. The scope of this study covers the years 1870 to 1899, from the introduction of reliable reporting until the twentieth century, when societal and medical changes began to modernize Gibraltar. Because most medical men, whether military or civilian, were trained in Great Britain, cause-of-death classification is consistent and as reliable as possible by nineteenth-century standards. Since death registrations are cause specific, the role of weanling diarrhea in overall infant mortality can also be assessed.

Results of the infant mortality analyses for all causes of death are presented in Figure 2.[29] While the pattern of IMRs over the study period is complex,[30] it is possible to distinguish two broad phases: Phase I, from 1870 to 1884, and Phase II, from 1885 to 1899. Phase I characterizes a period in which the average IMR for the civilians is 171.6, while slightly lower for the military at 156.5. The differences in the IMR between the military and civilian population at this point are minimal and not statistically significant (Kolmogorov-Smirnov two-sample test [KS] = 0.730, $n = 15$, $p = .66$). In terms of rate of change over time, there is a period of increase followed by a fairly rapid decline in IMR. This secular pattern is shared by both groups ($r_s = .557$, $df = 13$, $p = .031$) and is suggestive of the importance of shared environmental influences on infant mortality among both groups resident in Gibraltar.

During Phase II, beginning in 1885, IMR falls in both groups, although the decline of 32.3 infant deaths per 1,000 live births among military infants is more substantial ($IMR_{civilian} = 160.4$ and $IMR_{military} = 124.2$). Unlike the previous period, the pattern of change in the IMR between the two groups is no longer similar ($r_s = -.207$, $df = 13$, $p = .459$). There are now significant differences in the magnitude of the IMR between the military and civilian communities (KS = 1.461, $n = 15$, $p = .028$), with military infants displaying higher chances of surviving their first year of life.

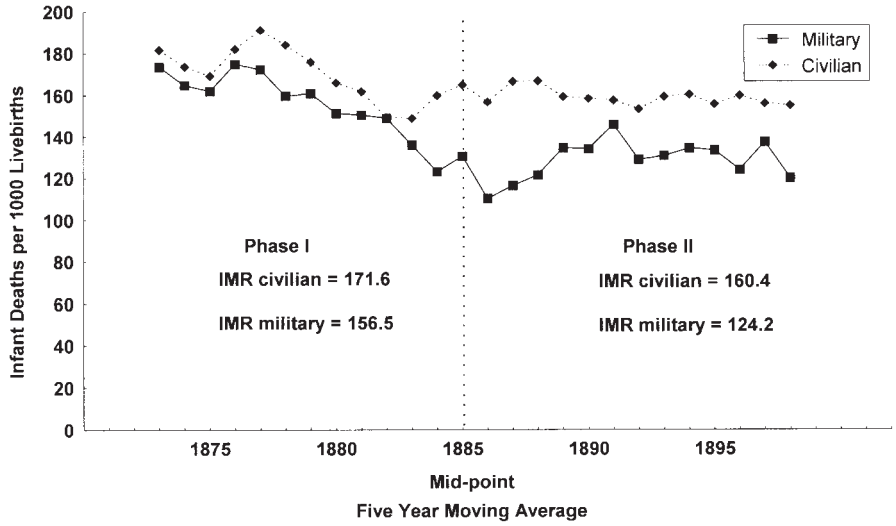

Figure 2. Infant Mortality for Military and Civilian Communities in Gibraltar, 1870-99
Note: IMR = infant mortality rate.

Throughout the study period, weanling diarrhea was the single most important component of overall infant mortality, with an excess of 40 percent of the infant deaths attributable to this etiological complex (see Figure 3). Weanling diarrhea results from a dangerous synergy between enteric infection, malnutrition, unfamiliar microorganisms, and a poor weaning diet. The term is modern, and includes a number of causes of deaths for infants, but the imprecision of the cause-of-death terminology was appreciated even a hundred years ago by the medical officer of health of Gibraltar:

> The terms "Diarrhoea" and "Gastro-enteritis" are very loosely used and it is unsatisfactory to have to return all cases such as these under this heading as it is probable that in the majority of instances they are due to dentition or irregular feeding.[31]

Ironically, "difficult dentition" and "teething" were also considered imprecise a few years later, but at the time in Gibraltar and elsewhere, they were commonplace and recognized as legitimate, certifiable causes of death by physicians. In this analysis, these causes of death are grouped collectively under the heading of weanling diarrhea, which is conceptualized here as a complex of undifferentiated acute diarrheal diseases associated with early childhood.

During Phase I, weaning diarrhea death rates among military and civilian infants averaged 72.7 and 79.6 per 1,000 live births, respectively. Weaning diarrhea death rates among military and civilian infants fell to 51.2 and 68.1 per 1,000 live births, respectively, during the period 1885 to 1899.

The impact of epidemic weanling diarrhea was considerable in nineteenth-century populations, as it continues to be today in developing countries since even those infants who survived an attack would have to recover from a compromised immune system and the opportunities that this, in turn, offered to other infectious diseases. And, according to the medical officer of health, the prevailing Gibraltarian customs for

the treatment of diarrheal diseases only exacerbated the risks to young infants since some community members still believed in the merits of "applying to certain parts of the body the entrails of pigeons, lamb's fat, and similar so-called remedies" for the care of diarrheal diseases.[32] It would not be until the twentieth century that specific bylaws concerning the quality of food, water, and milk were legislated and enforced and, regrettably, infant mortality and weanling diarrhea remained a potent killer in Gibraltar throughout the study period.

AN INSUFFICIENT AND QUESTIONABLE WATER SUPPLY

As the first necessity of life, perhaps the single most important determinant of infant health in nineteenth-century Gibraltar was access to a sufficient and pure source of drinking water. Because Gibraltar has no surface water, acquisition and storage of this first commodity of life occupied an important place in daily routine.[33] Rainwater served as Gibraltar's most important and sometimes elusive resource in the nineteenth century. Not only was there considerable variation in annual levels of rainfall but also, on occasion, marked shortfalls (see Figure 4). During the winter months, Gibraltar typically has ample rainfall, up to six inches per month (see Figure 5). The summer is the dry season, and, on average, less than two inches fall in the months of June, July, and August combined. To meet the necessity of securing year-round access to water, many patios (39.9 percent) had their own cisterns for water storage (see Figure 6). As water was collected from rooftops during the heavy winter rains, it was funneled by long pipes leading down to the cisterns and stored for use during the times of scarcity that typically surfaced in the summer. Gibraltar's primitive, decentralized water supply did have at least one saving grace, in the prevention of extensively distributed water-borne epidemics, particularly during cholera's periodic visitations to the Rock.[34]

The reliance on cisterns did, however, result in numerous difficulties in nineteenth-century Gibraltar. First, they were usually empty by late July and remained so until the rains began in late September. Second, they were often contaminated by dirt and by organic matter washed in from the rooftops and airborne particles that would settle on the water's surface. One of Gibraltar's royal engineers reported that Gibraltarians as late as 1890 were not "alive to the necessity for keeping the roofs of their houses clean, for these places are used for all sorts of improper purposes, such as, for instance, the washing and hanging of clothes, the keeping of poultry, &c."[35] Attempts by the populace to purify the cistern water ran the gamut of practices from the prescient to the pragmatic. The cleansing of roofs, covering of tanks, and boiling of water before use were practiced by some householders, and this improved the potential quality of the water. Other practices included lowering baskets of lime and charcoal into the tanks or placing live eels in the cisterns to feed on any animalcules that had colonized the reservoir (later, the inhabitants would feed on the eels). Gibraltar's medical officer reported cisterns "placed, as I have constantly seen it, with unprotected covering, under dirty bedrooms, greasy kitchens, filthy storerooms, patios, shops and public passages."[36] The actual accessibility of cistern water to patio residents was another issue altogether since there was generally a scale of one bucket full (or three gallons) of water, twice a week, for each dollar of rent paid. That meant, for example, that under ideal circumstances,[37]

> a family occupying rooms which let for four dollars per month, or say 10 pounds per annum, would be allowed from the house cistern twenty-four gallons of water per

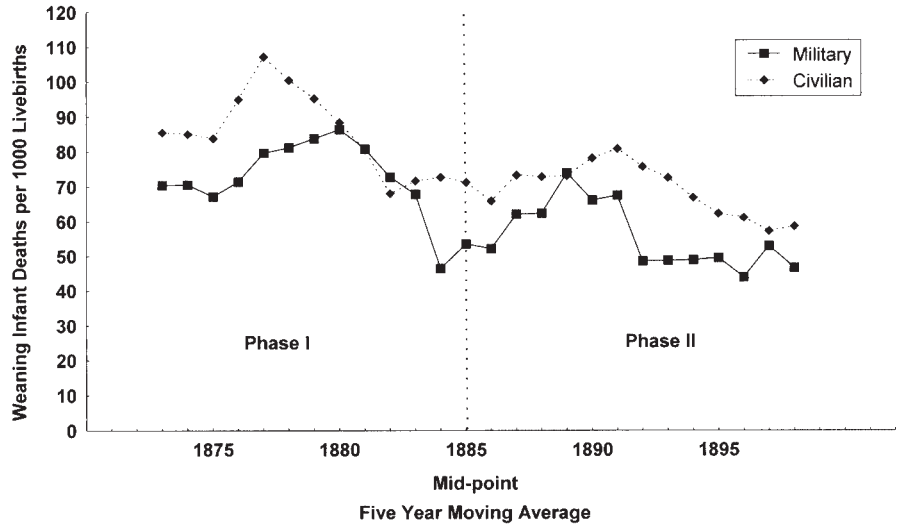

Figure 3. Infant Weaning Diarrhea Death Rates in Gibraltar, 1870-99

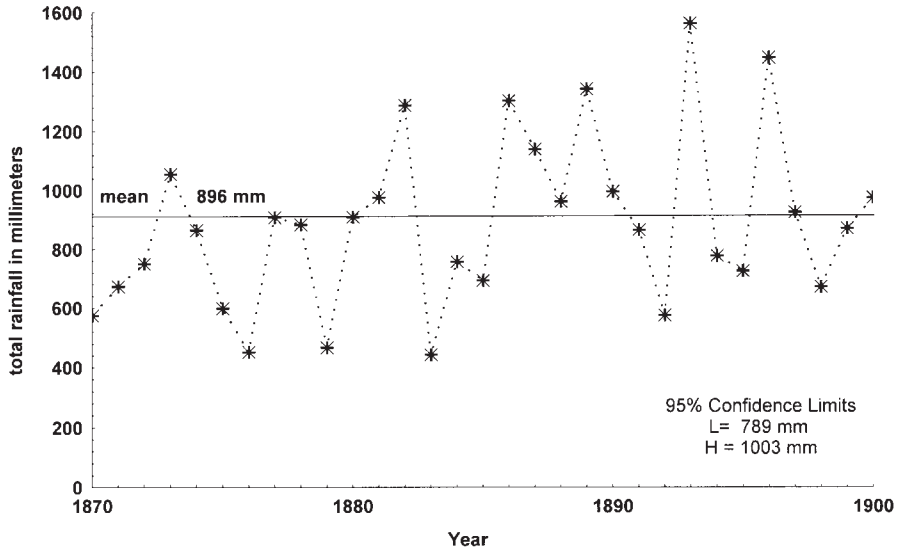

Figure 4. Total Annual Rainfall in Gibraltar, 1870-99

week, or an average of nearly three and a half gallons per day, for the entire household, and so in proportion to rent.[38]

Despite the problems associated with cisterns, they still represented the best source of water in the town.[39] Civilians living in patios that did not have cisterns were more precariously circumstanced since they had to find alternative means to obtain potable water.[40]

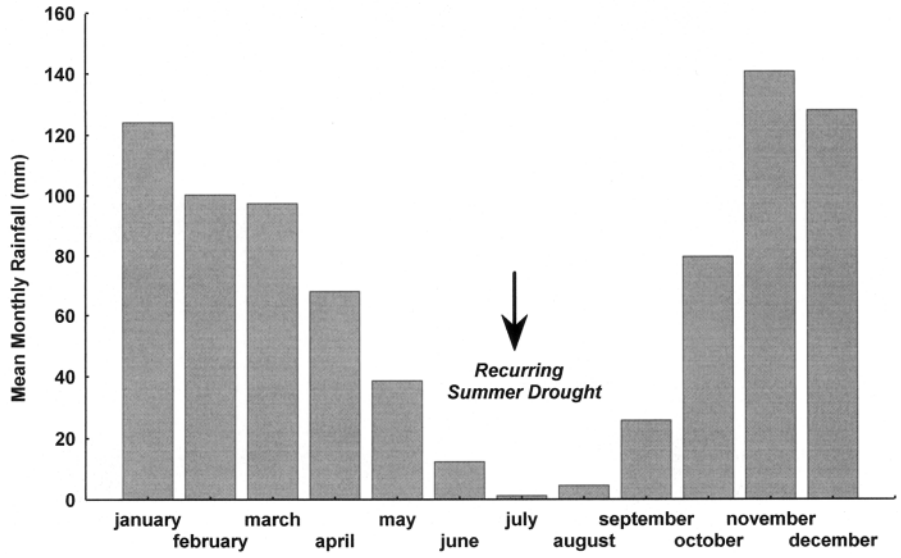

Figure 5. Monthly Average Rainfall in Gibraltar, 1870-99

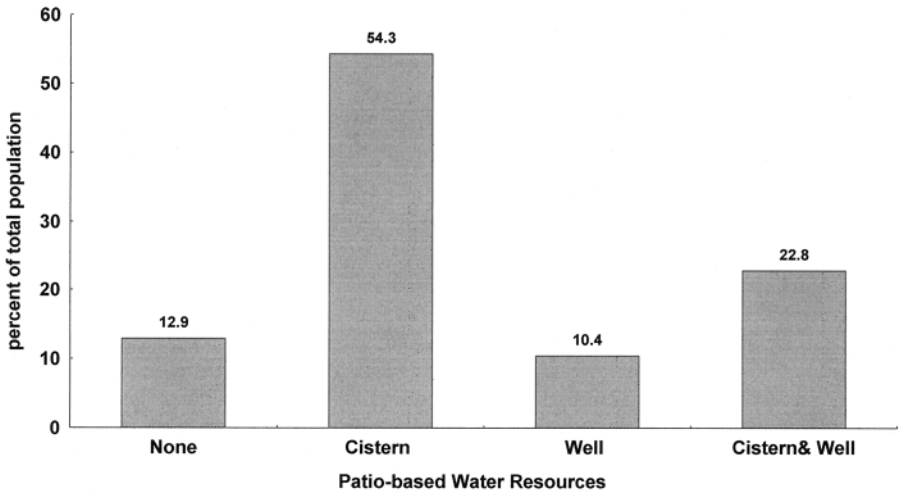

Figure 6. Civilian Housing and Water Facilities in Gibraltar, ca. 1878
Note: Excludes the residents of the south, north front, and Catalan Bay.

Another source of water was private patio wells. Twenty-nine percent of the town dwellings had their own wells, and these were mostly located in the lower part of the town on the flat red sands. Within patios, wells were typically dug in the courtyard, although the water drawn from these sources was not potable. Unfortunately, the building of the sea wall interfered with the Rock's natural water movement and the filtration capabilities of its soil. Further crowding in the town had caused groundwater contami-

nation with effluvia from latrines, drains, and washwater that rendered it unfit for use.[41] Well water was described as "brackish from its mixture with salt water which percolates into the wells from the sea, and it is liable to be polluted with sewage from leaky drains."[42] As a result, well water was dubbed locally as "sanitary water," which was suitable for cleaning, washing, and flushing out latrines but not for drinking purposes. It was estimated that a minimum of ten gallons per head daily of brackish water was necessary to meet flushing and general domestic needs. The annual report for 1893 reported that "in a number of houses the actual supply is very much below this standard" with the important consequence being that "during the dry summer months there is fouling of house drains from insufficient flushing."[43] Laxity of sanitation seemed to go hand-in-hand with an inadequate water supply:

> In many houses cesspools or accumulations of night soil exist, which, through the apathy of the inhabitants and their disregard for stench and filth, remain untouched for years, slow, smoldering hot-beds of disease. When they are emptied, a course resorted to in the summer, when the fetid effluvium overcomes the callous tenant, their contents are carried in open barrels along the streets, spreading their deadly exhalations through the crowded dwellings.[44]

The cost of sanitary water led the poor to use the same water several times over for different purposes.[45] Furthermore, Gibraltar's medical authorities raised concerns that "the temptation to use brackish water for many purposes for which it is manifestly unfit must be so great . . . after a season of deficient rainfall . . . that it must often be yielded to,"[46] suggesting that people may have been tempted to consume sanitary water. Even local breadmakers were known to have adulterated their product with sanitary water during periods of low rainfall, a practice that Gibraltar's medical officer found particularly disconcerting:

> Except in the case of actual difficulty of obtaining sufficient quantity of fresh water, I consider that sanitary water should not be used for this purpose. Although organic matter of a dangerous character is likely to be destroyed during the process of baking, a quantity of salts liable to cause dyspepsia and diarrhea will remain in the bread.[47]

The local practice of distinguishing between potable water and sanitary water eased the demands placed on the provision of pure water but did not diminish the fact that it continued to be a drastically scare resource.

Fully 40 percent of the townspeople had access to neither cistern nor well and were dependent on itinerant water vendors for supply. Most of these dwellings were concentrated on the upper part of the town, on the talus of the slope of the Rock. The vendors, called *borricos*, typically led barrel-laden donkeys through the narrow passageways of the upper Rock, selling buckets of water. For the families of laborers paying dearly for rent and living close to the poverty line, even these few pennies would make a difference. For the most part, the water the borricos sold came from wells on the Spanish side of the border, which was often dangerously polluted. In 1885, fifteen hundred gallons of water in unsterilized barrels were being carted in on the backs of donkeys for sale in Gibraltar each day.[48]

Since water is an important consideration to a military fortress, military needs drew much more attention than the plight of civilians. Almost without question, water

resources had to be made available to the troops and their families.[49] The military and naval populations were perceived as "very much better off, for, although their supply is also derived from the rain caught from the barracks and other buildings, the reservoirs are larger compared with the numbers to be provided for."[50] Military reservoirs could contain 3,500,000 gallons of water and, filled twice yearly, would supply approximately four gallons per head per diem for some five thousand persons a year. Naval reservoirs supplied a further 1,716,768 gallons. Despite the remarkable quantity of water, Tulloch could not guarantee its potability at all times since "the Royal Engineers may keep the roofs as clean as possible, but it is impossible to prevent the winds blowing disease germs and other impurities on to them."[51]

Owing to the scarcity of water in Gibraltar, the military population was, at all times, placed on a water allowance just as if the garrison were in a state of siege. According to military protocol, the amount of potable water was rationed according to rank, age, and gender. Commanding officers received seven gallons of water per day; noncommissioned officers and the rank and file were allotted two-and-a-half gallons per day. As members of the regiment, military wives were also rationed two-and-a-half gallons per day, and military children received one gallon per day. An early account gives indirect support to the perception that the military population was better supplied since civilian water was "so bad, and the scarcity . . . so great, that [the civilians] sometimes pay five reals (near two shillings sterling) for a small keg of better water, which they buy from the soldiers."[52]

INFANT MORTALITY, 1870-1884

The modest decline in infant mortality seen in Phase I (1870-84) is the byproduct of a number of factors and can be attributed, in particular, to improvements in the sewage system. For example, the period 1867 to 1876 is one in which the laying of a new drainage system was undertaken by the government. During these ten years, the medical officer of health, Dr. Stokes, remarked that drains were opened in streets and houses, soil and earth turned up, and large old soil deposits were removed out of town.[53] Such a major sanitation improvement meant that the accumulated filth and rotting organic waste of decades past was removed from beneath the patios and streets. The new sewage system, coupled with a more plentiful supply of sanitary water, allowed for more frequent and efficient flushing of the drains.

Despite the overall downturn in IMRs in Phase I, there was also a period of marked heightened mortality. Interestingly, this deviation from the overall trend coincides with the opening of new wells on the north front, in the area of the wide sandy spit connecting Gibraltar and Spain. These wells were dug in response to a report prepared by Baly and tabled in Parliament in the 1850s.[54] In it, Baly noted that a sufficient quantity of water was needed for the flushing of the streets and sewers and that the clean water needs of both military and civilians were not being met. Despite these endeavors, the new wells were problematic for a number of reasons. The potential for contamination of the north front wells was high because of their close proximity to the cemetery, the kennels of the garrison fox hounds, the wash houses, the cattle sheds, a highly manured market garden, the wooden barracks housing some four hundred men, and the rapidly growing and wholly undrained town of Linea in Spanish territory.[55] Clear distinctions were subsequently made targeting the north front wells as suitable only for sanitary, and not potable, water.

INFANT MORTALITY, 1885-1899

A significant disparity in infant mortality between the civilian and military communities emerged after 1884 as the result of an improved supply of potable water as well as an increased concern for the purity of the drinking water by the military authorities. The initial stimulus for a dependable source of drinking water began in 1882 when Governor Lord Napier of Magdala expressed concern that Gibraltar might be placed under a state of siege by Spain. Cut off from its water supply on the north front, the security of the garrison could be jeopardized. Accordingly, he instructed that two of Normany's patent condensers from Egypt should be brought to Gibraltar.[56] This initiative received further support when it became apparent that there would be an insufficient supply of drinking water arising from the lack of sufficient winter rains. Concern for the security of the fortress and the safety of the soldiers prompted colonial authorities to act quickly:

> Owing to the present unsatisfactory state of the water supply of the Fortress, and having regard to the exceptional drought with which the locality is being visited, the General Officer Commanding has considered it necessary in view of the very limited supply of drinking water now available for the use of the garrison to order that two of the condensers recently landed from Egypt shall be put up with the least possible delay, so as to insure a supply of fresh water, which may become an urgent necessity within a very short period.[57]

Further motivation for a regular and pure source of drinking water came from the all too frequent occurrence of sickness and deaths arising from enteric fever among the soldiers in the garrison. By the mid-1880s, military authorities began to examine systematically the purity of their water tanks.[58] Increased vigilance over the water tanks offered military personnel potentially lower risks of water-borne infections:

> Tank water is supplied for drinking, and is generally good, though sometimes it is discovered to contain some organic matter, probably from the catchment areas. Many samples of drinking water were analysed, mostly with satisfactory results; in about a fourth of the instances, the water was found impure, when the tanks were at once emptied, examined, and cleaned out and repaired if necessary.[59]

The systematic inspection of the sanitary state of water tanks by the military stood in marked contrast to a laissez faire approach by the civilians, where concern for the potable water supply varied from household to household and from patio to patio.

With outbreaks of cholera in neighboring Spanish towns in the summer of 1884 and 1885, and growing knowledge of the link of cholera to water, surveys of well water from Spain were also initiated. A report on samples drawn from four wells located on the Spanish lines, which provided water for sale in Gibraltar, revealed alarming results:

> No. 1. A well near San Pedro Alcantara shows considerable pollution. It contains an amount of organic matter—Chlorine—highly dangerous to public health.
>
> No. 2. This came from a well near the cemetery. It is still more polluted than No. 1. In addition to excess of organic matter it contains very numerous living animals, also pieces of hair, woolen fibers, particles of epithelium from the human skin indicating pollution from household refuse.

> No. 3. From Tarifeno Well. This is very fair water. It shows no sign of pollution. It contains fine sand. Small pieces of decayed vegetable matter apparently the result of carelessness in the collection on transit. With ordinary care with filtration it might be used with safety.
>
> No. 4. From a well near the "Bull Ring." This is the most polluted of all the specimens. It contains ten (10) times more organic matter than ought to be in good water. It contains a large quantity of matter in suspension, hair, bits of wool dried, bits of mucus—indicating great pollution from excrete of men or animals.[60]

Governor Adye ordered that all water from Spain could no longer be introduced in the garrison. To make up for this shortfall in potable water, Adye stipulated that distilled water from the newly erected condensers would be available to military and civilian alike during the hot dry summer months. However, it is important to note that while distilled water was available free of charge only to the military and their families, civilians had to pay for this new, pure water. Although the water was pegged at a reasonable sum of six gallons for a penny, an observer at the time remarked,

> The water to replenish these jars costs, it is true, only a halfpenny a bucket, but sometimes even this small sum is a consideration. The temptation to drink polluted well-water or to use the salt water provided for flushing drains must occasionally get the better of the prudence of the poor.[61]

Despite local attempts to overcome Gibraltar's water problem, it was clear, in a report from 1890, that civilian needs continued to fall far from being met: "the total quantity of sweet water available to the inhabitants, both from public and private sources, amounts to not even 2½ gallons per head per diem."[62]

With independence from a highly suspect Spanish supply, frequent inspections of the water tanks, and greater access to a pure source of drinking water, the military inhabitants began to enjoy albeit a slight, but nonetheless significantly higher, state of infant survivorship that arose as a matter of privilege.

REFLECTIONS ON WOMEN'S HEALTH

On another level, the observed infant mortality differentials could be attributed to wider ranging disparities in the general health and well-being of military and civilian women. Aside from access to water, there were certainly other aspects of the daily lives of women and children that weighed heavily on health and mortality. Pregnancy, parturition, and the rearing of infants occurred within a system, and to ignore these other aspects would be detrimental to any comprehensive study of infant mortality. While these issues are critical to understanding the generally high level of infant mortality in the garrison, however, their similarities in cross-cutting the lives of military and civilian women render them less adequate explanations for the differentials in infant mortality.

The Home as the Primary Environment of Mothers and Infants

To put the infant mortality results in perspective, it is important to delineate the similarities and the differences in the daily lives of the mothers and their infants in the two

populations. As the primary environment of infants, the nature of home life is important to consider when discussing variations in infant mortality. Descriptions of civilian dwellings and the military married quarters illuminate military life in a late nineteenth-century garrison and illustrate that neither civilians nor the military enjoyed an advantage in this respect.

Civilians typically lived in one of the eight hundred patios that could be found within the town walls. A patio was usually about forty feet square, three or four stories high, and was built around a small central courtyard of perhaps ten feet in width. Each patio was bounded on three sides by other patios and was open to the street by only a narrow passageway. Windows and doors of the patio rooms were found only on the interior, overlooking the narrow courtyard. Because of this architecture, ventilation within the interior was exceedingly poor, and conditions were made worse by the fact that the courtyard was also the location of the latrine. The sanitary condition of some courtyards was appalling, with filth-choked drains leading to sewers that were nothing more than cesspits.[63] Substandard living conditions abounded as one ventured further up the Rock and away from the central part of town. In 1866, a surveyor for Gibraltar's sanitary commissioners provided a detailed description of living conditions in one patio up the talus of the Rock:

> There are three cesspools to this House all full of sewage and soil, and in two cases running over. . . . The privy is in a dilapidated and filthy condition, and is used by a large number of persons, there being but three privies for 76 inhabitants who occupy the house. . . . This house, No. 10, is like a small walled village. . . . All the houses are bad, and several totally unfit for human dwellings, the walls and floors being very damp, and the roofs in very many places admitting rain; they have no chimneys, and no ventilation except what is afforded by the door and windows which are almost invariably on one side, and are of course closed at night. There is one large tank upon the premises, apparently in good condition, capable of holding 41,000 gallons of water, but it is never filled.[64]

Census returns for the year 1868 reveal that twenty separate households occupied this particular patio.

Patio dwellings were designed to accommodate twenty or so people but frequently housed many more, as many as a hundred. An analysis of patio composition in the 1878 census reveals that the average patio housed some twenty-five individuals living in five apartments. An analysis of the structure of 3,901 households in the 1878 census also reveals that single-family households (married couples with or without children and widow[er]s with children) predominated, accounting for some 54 percent of Gibraltarian households. An additional 17 percent of households were extended in nature, including either or both horizontally and laterally related family members.

Rents were exorbitant, even higher than in the crowded cities of Victorian Britain.[65] The result was widespread subletting and dangerous overcrowding, and entire families sought to live in single rooms to offset this expense.[66] Because property "ownership" was on a lease-based system, landlords had little incentive to maintain or to repair their buildings, even despite the high return on their initial investment. Even less motivation existed to introduce new sanitary facilities. Private property was considered inviolable, and the local authorities had no power to enter the courtyards and remove the accumulated filth.[67] New building was almost impossible. Even if the land was available,

military regulations governed the size, placement, and the height of dwellings, further limiting the housing supply.[68]

Military families had equally poor, and perhaps worse, living conditions. In the early 1870s, the wives and children of married soldiers were seen as a liability to the British army, and little was done to house them.[69] In Gibraltar, separate accommodations were arranged for married soldiers and their families, rather than the communal barracks accommodation given to wives and children in the home stations in Britain.[70] But with the exceptions of the families of the Royal Engineers and the Royal Artillery, the accommodations were as bad or worse than that of the bachelor soldiers. The artillery gunners, their wives, and their children lived in separate cottages that were "tolerably clean and convenient."[71] The families of the Royal Engineers also had acceptable lodgings, but the remainder of the married quarters left much to be desired. A report from 1863 describes them as follows:

> We have hardly ever seen human dwellings so bad as some of the wooden huts on the Neutral Ground and at Windmill Hill. They are ruinous, not water-tight, in such a condition that it is impossible to preserve either cleanliness or decency in them, and the poor women and children are worse off in this respect than the lowest class of the Spanish population about them.[72]

Recollections of a minister called to the King's Bastion to perform a baptism for a military infant describes the deplorable living conditions of military families housed in these barracks in 1864:

> The casements are bomb-proof, and contain quarters for 800 men, with kitchens and ovens for cooking. . . . The entrance to the different apartments is from a large court, about ten to twelve feet below the level of the ground. I was conducted there by a soldier of the Royals, who had applied to me to baptize his newly-born and dying child. His wife had been confined at seven months. At the end of a long subterranean apartment, with no other opening to admit air or light but at the entrance, and occupied by several other families, I found the poor mother and her infant.[73]

Service families occupied workshops, storerooms, kitchens, schoolrooms, and guardrooms.[74] In 1863, only 26.2 percent of married families occupied tolerably acceptable lodgings, with the remaining men, women, and children housed in inadequate makeshift rooms (see Figure 7).

The similarity in housing issues is perhaps best illustrated by the fact that buildings could change hands between the military and civilian populations according to local necessity. Civilians, for example, were turned out of their houses in the Danino and Levy patios to make way for the families of married soldiers, only to be returned to the civilian housing stock once these buildings became too run down for military purposes.[75] This is despite the fact that, in 1875, it was recommended that since Danino's patio, then in military possession, was "a source of disease among the occupants," it "should be condemned as unfit for occupation and replaced by new quarters."[76]

During the late 1880s and 1890s, improvements were undertaken by the British administration in an effort to improve the health and efficiency of the Gibraltar garrison, and this had an effect on married quarters. Still, progress was slow:

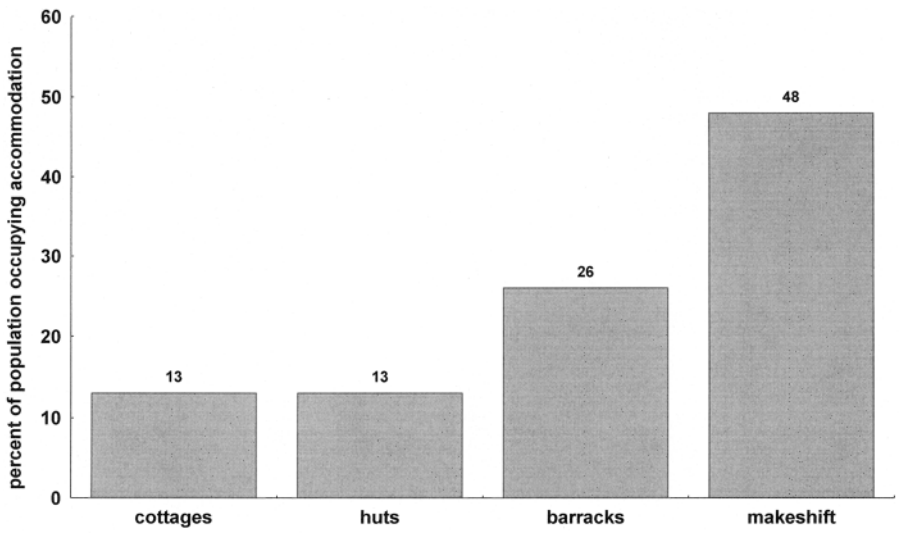

Figure 7. Types of Accommodations of Military Families in Gibraltar, 1863

> The Casemates Barracks, whose sanitary reputation has not been good, have been made by recent improvements comparatively healthy dwellings, except a certain portion of King's Bastion, occupied by families, which is not so good; there is, however, no other accommodation available.[77]

Clearly, both military and civilian mothers were severely challenged to provide a good home environment for newly born infants.

Social Support for Women

With the uncertainties facing life in late nineteenth-century Gibraltar, social support for a mother could make the difference between life and death for her infant. Social support can be kin based or community based and can take forms of charity, sharing or allocation of tasks, or perhaps the pooling and sharing of knowledge. Examining infant health in Gibraltar offers an opportunity to compare the support systems available to civilian and military women, an important issue given that prior to the twentieth century, there was no system of poor relief in Gibraltar.

Most civilian women were native Gibraltarians and benefited from a strong local tradition of extensive kin-based support networks. In addition, membership in a patio figured prominently in the provision of support, outside of financial aid, which could be found in civilian life. In Gibraltar, the patio effectively became the extended family of civilian women, embedding them within a diverse support network, and, according to Sawchuk, "the close proximity and long-term residence in a patio could foster friendship, group identification and the development of strong bonds between its residents that cut across both religious and socio-economic lines."[78] As available avenues

for support expanded outside of the immediate domestic family unit, so too did the lives of civilian women and children become more resistant to the stresses of daily life.

The level of support available within the patio and the communal approach to issues of daily life extended to experiences with illness. One description of a typical patio at the turn of the century is telling in this respect:

> On entering one of these Patios you will probably find a medley of people squatting in the courtyard round an itinerant vendor of goods, all chattering away at the tops of their voices. . . . Ascend the narrow wooden steps and you may pass a room in which lay a sick person who will be attended and half-suffocated by a large number of men, women, and children who are crouching round the bed with sympathetic motives.[79]

Despite the poverty found within many of the local patios, the ingrained local custom of visiting the sick ensured that the burdens of illness would not be left to the individual.

Issues of support were even more important for military wives as they faced a number of heightened biological risks inherent in the transient nature of military life. These risks were particularly visible in the nineteenth-century era of infectious diseases. In examining the higher susceptibility of military infants among regiments stationed in India, Guha characterizes them as part of

> a population with a continually changing composition which would imply that disease-host interactions would be unstable, with the continual arrival of new, unexposed human material, whether adult or infant. Many infants would be born to newly-arrived mothers, and thus would not possess some of the passive immunities that would be expected in a resident population.[80]

Unlike the highly stable lives of the civilians, military wives had to accept "a more or less nomadic existence," and each time they were re-stationed they had to leave behind their safety nets of "kinship ties and local connections which might well have seen them through times of stress and difficulty."[81] Military women typically traveled greater distances from the place of their birth and faced long-term separations from their extended families. Destitution was a constant possibility, particularly if the spouse of a military wife died; rapid remarriage was often the only choice.[82] Even with healthy husbands, military women were subject to the same poverty-related stresses that were characteristic of lower-class women. Soldiers' wives had to cope with their ambiguous position within the military and the unique demands of a military lifestyle.[83]

Recent work on infant mortality among army and civilian babies in a UK garrison town indicates that a lack of maternal social support may be an important factor explaining elevated mortality among army babies.[84] The findings "suggest that army mothers were less likely to receive support from their mothers and the wider family" and that "regimental transfers probably reduced the chances of establishing relationships with local services and continuity of care and support."[85]

To offset these assaults on family stability, Trustram has described the important role of regimental philanthropy "which sprang from within the army [and] was very much part of the tradition of benevolence and paternalism which was so central to its structure."[86] Furthermore,

> the threat posed by family ties to a man's military efficiency could be minimised by placing the whole family under army discipline and making it indebted to the benevolence of the officers. The family's allegiance then lay with the regiment rather than with itself as a self-contained domestic unit. From the 1850s onwards families on the strength were able to look towards the army as a provider of their basic maintenance, but at the same time they became increasingly dependent on subject to military discipline.[87]

In turn, the small minority of military wives typically played an important role in supporting the regiments since "in keeping with the notion of the regiment as a family, wives worked for the regiment instead of just for their own husband and children."[88]

Moreover, the general military population in the nineteenth century was, for the most part, not a wealthy population. Soldiers with families were forced to stretch their pay to support all individuals in the household, a difficult undertaking since, according to Trustram, "a soldier's pay was for himself and himself alone and its purpose was to keep the soldier fed and housed so that he could remain an efficient fighting member of the army."[89] And food was an expensive commodity in Gibraltar. As an isolated garrison town inhospitable to agriculture or animal farming, the necessity of importing most foodstuffs from Spain and Morocco rendered the price of food rather dear.[90] Unable to travel the large distances necessary to secure reasonably priced provisions, Gibraltar's inhabitants had to shop in the local markets, and mothers were left to provide for their families by navigating the vagaries of the huckster's economics.

Most soldiers' wives needed to supplement their husbands' pay, something that they did by performing essential work in the regiment, including washing, cleaning, sewing, or nursing.[91] Such labor was often very demanding. Gibraltar's military washhouses were located on the north front, beside the cemetery, the cricket ground, and the rifle practice range. These buildings were used primarily for washing the bedding of the troops. The huts were described as filthy upon inspection and, structurally, "of comparatively large dimensions, constructed of wood, and apparently old."[92] During the 1865 cholera epidemic, three fatal cases were linked to the washhouses, principally, it was believed, because of the large pools of stagnant water that always collected around the washhouses. By the washhouses also lay a large "cesspit about 50 feet long by 5 feet wide and 3 1/2 feet deep, just inside the boundary wall of the Cemetery, where it produces an intolerable nuisance, and creates most pernicious malaria."[93] Clearly, working conditions for military wives could be hazardous.

Antenatal and Postnatal care in Nineteenth-Century Gibraltar

The experience of women over the course of their pregnancies and at the time of parturition can have important implications for both the immediate and longer term health of their children. Problems associated with pregnancy and parturition may reveal themselves in an infant's failure to thrive and, ultimately, in heightened infant mortality. Since contemporary studies point to the important role of antenatal and postnatal care in the development and survival of infants, conditions among military and civilian women would have shaped their experiences during pregnancy, parturition, and early childcare.

A letter from a Gibraltar surgeon described the overall dismal experience of childbirth in the overcrowded garrison:

> The poorer classes are confined in small and crowded rooms without any sort of convenience whatever—frequently, as is the case in the Patio Corridor in a one-room apartment—the kitchen, bedroom and sitting room being one and the same room about the size of our Secretary's office—consequently, there is neither cleanliness nor care at the times of childbirth and you frequently find the mother up and about in 3 or 4 days after the confinement, a thing which is the direct cause of so much of the Uterine disease, a malady which is, nowadays, nothing more or less than a curse among the humbler classes.[94]

At the beginning of the 1890s, suggestions were raised for establishing a maternity department in the Colonial Hospital for military women.[95] The need for such a facility was further outlined by the acting surgeon at the Colonial Hospital:

> The wives of soldiers . . . are, I believe (as is also the case with the poorer portion of the Civilian population), mainly attended by Midwives who may or may not have any teaching in their profession, I have always looked upon the want of a Lying-In Department as the one great want of the people in Gibraltar.[96]

It is clear, therefore, that both military wives and poor civilian women were being singled out as the groups most likely to be in need of assistance.

The unfilled needs of women in Gibraltar were clearly understood. Hospital care would benefit local women by the simple removal of the new mother from her household:

> Naturally a woman confined in the Hospital would remain from 9 days and upward, and would be spared the worry of having to live in a small room, surrounded by all her other children who probably, along with her husband, have to share her bed with her.[97]

One of the district medical officers further commented that

> I have seen many cases where patients would have done well, had they been removed from their overcrowded and insanitary houses. It is no unusual occurrence among the poorer classes to find a woman being confined in a room where her husband and several children sleep, and which serves at the same time, as kitchen and the temporary water-closet for the mother.[98]

According to Trustram, in the home stations, women "living in barracks were entitled to admission to the garrison hospital for childbirth unless they occupied two rooms or one room without children."[99] It has been reported that in Gibraltar, with the development of a true maternity department pending, allowance was made in 1880 for the wives of noncommissioned officers and soldiers to be admitted into the naval hospital for their first confinement, so long as accommodation was available. In the interests of decency, "they would also be entitled to admission in subsequent cases of confinement, a) when occupying a wooden hut, or b) when occupying one room in quarters or barracks."[100]

But despite these indications that women in Gibraltar had some access to hospital lying-in, records show that military women did not make use of the hospital. Sick

infants were rarely removed from the military barracks; over the thirty-year period, less than 2.5 percent of military infant deaths occurred in the colony's three hospitals. If the women were not using the hospital in the case of difficult confinements or severe infant illness, it is unlikely that they were using it for routine births. During this period in Gibraltar, confinement, birth, and infant death occurred overwhelmingly in the dwelling, not the existing hospitals.

Reproductive and Maternal Health

Both the maternal mortality rate and the stillbirth rate represent two indirect means of assessing women's reproductive health in the nineteenth century. The maternal mortality rate is calculated by dividing the total number of women who died within forty-two days of giving birth by the total number of births and standardizing to 1,000. A study of civilian women from 1874 to 1878 estimated maternal mortality rates at 4.93 maternal deaths per 1,000 live-born infants and 18.52 deaths per 1,000 stillborn infants. Combining live births and stillbirths, Gibraltar's civilian maternal mortality rate is estimated at 5.62 deaths per 1,000 total births. The same calculations yielded almost identical results for military women. Between 1874 and 1878, the maternal mortality rate stood at 5.64 deaths per 1,000 births among the military wives. Louden's estimates for maternal mortality in England and Wales are 5.4 (1871-75) and 3.9 (1876-80) maternal deaths per 1,000 total births.[101] Despite the abysmal lack of facilities in Gibraltar, the reproductive health of civil women in this garrison town was on par with that of women in late nineteenth-century England and Wales.

In combination with maternal mortality, an analysis of "prenatal" mortality is also warranted since, according to Hart, "stillbirth is . . . a valuable health status indicator. A high stillbirth rate implicates maternal health and physique as a primary factor in mortality."[102] Any infant deaths that occurred in utero, either during pregnancy or during parturition, are included in the stillbirth classification. The underlying causes of stillbirths are complex and often correlated with an array of biological factors (sex, age and parity of the mother, birth spacing, father's age, multiple births, Rh incompatibility), social factors (socioeconomic status, nutrition), and environmental factors.[103] In general, stillbirths become another proxy measure for women's underlying physiological constitution.

With the existence of a cemetery register of stillbirths in Gibraltar dating back to 1869, it was possible to analyze the scope of prenatal mortality in late-nineteenth-century Gibraltar.[104] Between 1870 and 1884, the stillbirth rate among civilian women was high, at approximately 68.85 deaths per 1,000 births. Stillbirths were notably lower for military women, at an estimated 41.88 per 1,000 births.

Reasons for this important difference in stillbirth rates are varied and could range from better midwifery to improved nutrition among military wives. Yet the results of the stillbirth analysis are surprising, considering the high rates of venereal disease that prevailed among British troops.[105] Many venereal diseases, particularly syphilis, are known to have adverse effects on pregnancy outcome among infected mothers, leading to an increased risk for stillbirths, low birth weight, and neonatal infection.[106] Serving their first term of military service as single men, the opportunities for venereal diseases to present themselves would have been manifest. In Gibraltar, for example, there was always a number of Spanish prostitutes, women known to be "mostly imported by regular native dealers . . . associated with or owners of wine shops frequented by sol-

diers,"[107] and the sanitary control of these women became an important issue in the late nineteenth century.[108] According to one report, venereal disease was more common among officers than regular soldiers, with an overall excess of venereal morbidity in Gibraltar relative to other Mediterranean stations in Malta and the Ionian Islands.[109] Since officers, rather than regular soldiers, were more often permitted to marry,[110] this is an important observation. Further information on a comparative level of venereal disease in military and civilian men would be necessary to understand how this affected the absolute level of the reproductive health of their wives.

Infant Feeding Practices and the Milk Supply

Breast-feeding in the nineteenth century was particularly important for infant health since it generally bolsters immune efficiency, minimizes exposure to contaminated food and liquids, and promotes mucosal renewal and recovery following enteric infection.[111] Accordingly, it is important to address the possibility that the frequency and duration of breast-feeding might also contribute to the observed disparity in infant mortality among infants born to civilian and military mothers.

While there is no direct evidence on infant-feeding practices in nineteenth-century Gibraltar, insight into the pattern of infant feeding can be gained using Bourgeois-Pichat's biometric technique,[112] coupled with the findings of Knodel and Kintner,[113] who applied this method to populations with known patterns of various infant-feeding practices.[114] Based on this approach, Knodel and Kintner found that the ratio of the slope of cumulative mortality between one and six months of age to that of six and twelve months of age is typically above unity in populations where breast-feeding predominates. Ratios of less than one suggest populations where breast-feeding was less common, with a high percentage of infants fed by other means. The basis of this argument is grounded in the observation that when infants are not mainly breast-fed, the mortality slope is steeper in the first half of the first year of life relative to the latter half. The excess of mortality in early infancy is attributed to the absence of passive immunity and nutritional benefits conferred by breast milk, coupled with early exposure to poor sanitary conditions surrounding artificial feeding. Calculation of this ratio for the military and civilian populations of Gibraltar yields values of 1.73 and 1.52, respectively, indicating that breast-feeding was commonplace among both groups of women.

Further scrutiny of the plotted infant mortality values (according to age) in Figure 8 allows for some insight, albeit crude, into the timing of weaning.[115] A sharp change in the slope of cumulative mortality is commonly viewed as a general indicator point at which weaning occurred. The Gibraltar results reveal that shifts in the slope of mortality at about three months of age among the military and civilian infants may signal the beginning of the weaning process in both of these groups. This suggests that, at least for the first three months of their lives, infants were largely buffered from the food- and water-borne contaminants prevailing in the colony. As infants were weaned, they would likely come into contact with contaminated matter, either by direct contact, usually through unclean hands, or indirect contact through tainted milk, water, or food, which can lead to weanling diarrhea.

In Gibraltar, cow's milk and, more frequently, goat's milk were available for infants upon weaning. The milk may have been produced locally in Gibraltar, but usually it was imported from Spain. It was clear to Gibraltar's local authorities that milk from

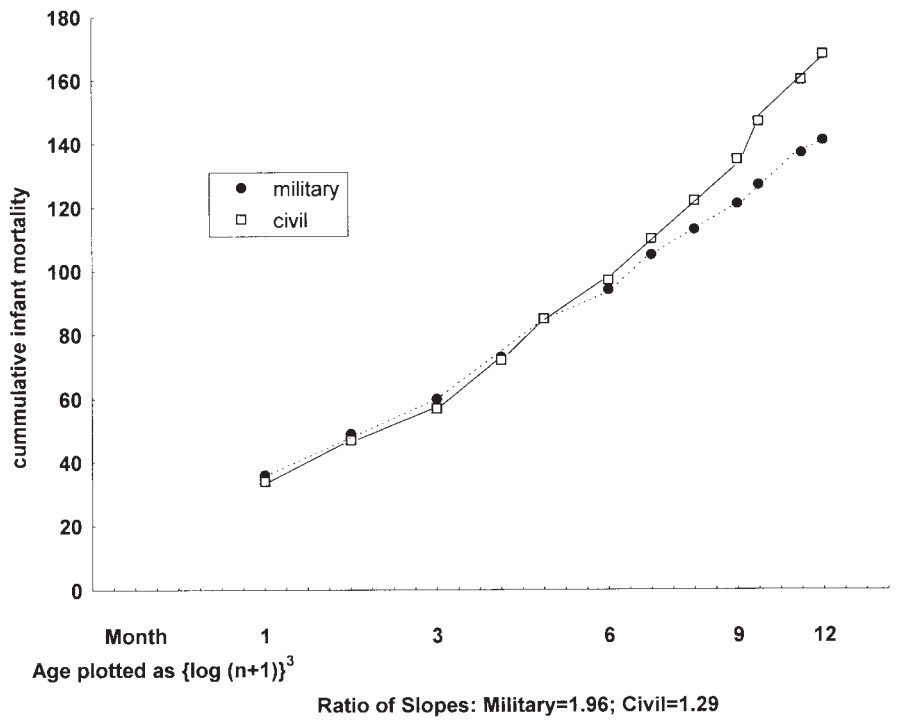

Figure 8. Biometric Model: Infant Mortality in Gibraltar (1870-99) in Military and Civilian Communities

Spain had a very high probability of being adulterated with water, most often impure water.[116] The evidence is limited as to whether the observed mortality differentials between the two groups could have arisen from differences in the supply of milk. One observation from the medical officer of health among the military provides little support for such a possibility when he states that "the milk supply is . . . very unsatisfactory, and exposes both the troops and the civil population to the risk of any diseases that may be prevalent in Spanish territory."[117] The scope of the problem was aptly captured by Dr. MacPherson, Gibraltar's health officer:

> I beg to report that a sample of goats milk was obtained by me today from a milk vendor, Nicholas Sanchez, bringing the milk direct from Spain; and that it contained about 45% of added water. For every 10 gallons of milk so adulterated about 5 gallons of water from an unknown source are introduced into the garrison, and I would draw the attention of the commissioners to this probable source of such diseases as enteric fever, &c.[118]

Control over the quality of the Spanish milk supply was further complicated by "the fact that the majority of the street vendors were young boys aged 12-15 who were less liable to be convicted if caught."[119] Problems also stemmed from the fact that Gibraltar's sanitary authorities could not control the manner in which milk was produced and handled in Spain:

> The sanitary condition of the cowsheds is usually grossly defective and the cleansing of the milker's hands and cow's and goat's utters is practically unknown. The milk is not cooled to retard bacterial growth and arrangements for washing cans and storing the milk are often primitive in the extreme.[120]

As late as 1914, it was estimated that "if during the summer months we attempted to prevent dirty milk from entering the Garrison we should practically have to stop 2/3 of the whole supply."[121]

The question that emerges, of course, is why did Gibraltar continue to rely on Spain to deliver this very dangerous commodity? While the Gibraltar garrison and some civilians did keep livestock, particularly goats, on the Rock, the terrain and lack of space made any large-scale animal farming impossible. Goats were left to graze on the upper portions of the Rock, then herded through the steep passages and alleyways of the town to be milked on demand at the doorsteps of the patios.[122] But this was not enough; Gibraltar still had to rely on Spain for an estimated 50 percent of cow's milk and 90 percent of goat's milk.[123]

While we have argued that it was likely that both groups drew from a suspect milk supply, there may have been additional risks to civilian infant mortality relating more directly to the generally poorer economic well-being of civilian families. Milk sellers in Gibraltar were known to have offered two different types of milk for sale—"pure" milk and a "watered down" version:

> Two kinds of milk are sold; the *leche pura*, at 3d. or 4d. a pint, and the *leche con agua*, at 2d. and 2 1/2d. a pint. The latter frequently contains 60 percent of added water, which may come from a surface well in Linea for all this is known to the contrary![124]

It is likely that poor families would have knowingly purchased the watered-down milk because it was cheaper, but most likely did not know that its adulteration with impure water meant serious potential health risks to their infants. Beginning only in the 1890s, health officials advised people to boil milk before consumption.[125] Even then, it is likely that the poor, who made up a large proportion of the civilian population, were at a disadvantage since they could not afford the cost of fuel. Even with respect to the milk supplied to infants, therefore, it is likely that economic differences rooted in matters of military privilege also contributed to the observed infant mortality differentials distinguishing the two communities.

Further problems facing local infants in their consumption of milk relates to the medical officer of health's observation that "in [local] dairies, it is not uncommon to find milk stored and boiled in dirty rooms and patios and in the proximity of water closets."[126] It was only in 1893 that a comprehensive listing of milk bylaws was introduced to the garrison,[127] clearly attesting to the risks that dairy products posed to Gibraltar's infants during the study period.[128] Other efforts to improve the quality of milk before the end of the century included the purchase of a milk sterilizer for use by the station hospital and the provision of a bacteriology laboratory in 1897.[129] Despite these laudable efforts, the quality of milk in Gibraltar remained suspect until after the turn of the century.

CONCLUSION

Interspersed with each other and crowded onto a small peninsula, the military and civilian populations of late-nineteenth-century Gibraltar endured an environmental inseparability that allows comparison of health parameters. Their close proximity to each other meant that they shared the same pathogens, the same sanitary defects, and the same squalid urban conditions typical of the late nineteenth century. In the town, civilian patios were pressed up against military barracks and billets, and both groups suffered from inhabiting dwellings that were badly built and poorly maintained. For the first half of the study period, from 1870 to 1884, the perennial Gibraltarian problem of poor-quality water and supply dogged both groups, although the military men, families, and even horses were always allotted larger quantities than the civilians were. The IMRs for both populations were experiencing a modest decline and are statistically the same until 1884.

In the second half of the study period, the IMRs of the two populations diverged, and the military families enjoyed a distinct and measurable advantage over the civilians. Such a divergence in an important health indicator requires the close scrutiny of all aspects of community and domestic life that can affect the survival of a group of infants. Measured by maternal mortality, nutritional and overall maternal health was similar in both groups. The Bourgeois-Pichat biometric model shows that both groups of infants were breast-fed, removing infant-feeding practices as a reason for differential mortality. Although antenatal care, improved midwifery, or hospital-based care may have improved the experiences of Gibraltar's mothers and infants, both military and civil alike, the important distinction here is that neither group had access to these improvements to any large extent. Differences in pregnancy and parturition, therefore, would not be expected to account for a significant portion of the variation in IMRs. Rather than a lingering aspect of past pregnancy experiences, it is more likely that infant mortality was reacting to immediate ecological pressures exerted in the time after birth.

Weaning marks a critical time of infant susceptibility to infection from environmental sources, particularly contaminated water and milk. While both groups depended on a highly suspect milk supply from Spain for weaning foods, military families, being less economically constrained, may have enjoyed an advantage in terms of the quality of the milk they could afford. While it is tempting to couch the observed infant mortality differentials in the two communities in economic explanations, it could be argued that such economically grounded benefits became appreciable only when a safe and plentiful supply of water was available. Furthermore, the timing of the marked decline in IMR among the military, which was well in advance of any improvements in the milk supply, suggests that access to larger amounts of pure water relative to the civilians was the main factor contributing to the mortality differentials. Although civilians could access this commodity, they were restricted to smaller quantities of this precious resource and had to pay for the privilege that the military was granted free of charge. That fresh, pure, and safe water is critical for weaning infants is, today, universally accepted. The inability of part of the population to access clean, potable water during the weaning period is, we believe, the main underlying factor that led to military/civil differences in infant mortality.

NOTES

1. See Thomas McKeown, *The Modern Rise of Population*, (New York, 1977); Simon Szreter, "The Importance of Social Intervention in Britain's Mortality Decline c. 1850-1914: A Reinterpretation of the Role of Public Health, *Social History of Medicine* 1 (1988): 1-37; Sumit Guha, "The Importance of Social Intervention in England's Mortality Decline: The Evidence Reviewed," *Social History of Medicine* 7, no. 1 (1994): 89-113; M. Lewis, "Sanitation, Intestinal Infections and Infant Mortality in Late Victorian Sydney," *Medical History* 23 (1979): 325-38.

2. Gibraltar's position as a natural laboratory was appreciated even in the nineteenth century. In 1828, Chervin went to Gibraltar to study an outbreak of yellow fever. In 1866, von Pettenkofer went to study the conditions for cholera. Louis T. Chervin and D. Barry, *Documens de la Commission Medicale Francais Envoyée á Gibraltar pour Observer l'Epidemie de 1828* (Paris, 1830); Max von Pettenkofer, "Die Choleraepidemie des Jahres 1865 in Gibraltar," *Zeitschrifte für Biologie* 6 (1870): 95-110.

3. See, for example, R. A. Wrigley, *Population and History* (New York, 1969); R. Woods , "The Structure of Mortality in Mid-Nineteenth Century England and Wales," *Journal of Historical Geography* 8 (1982): 373-94; D. Friedlander et al., "Socio-economic Characteristics and Life Expectancies in Nineteenth-Century England: A District Analysis," *Population Studies* 39 (1985): 137-51.

4. L. A. Sawchuk, *Deadly Visitations in Dark Times* (Gibraltar, 2001).

5. Johannes Kramer, *English and Spanish in Gibraltar* (Hamburg, Germany, 1986).

6. See Lawrence A. Sawchuk and Stacie D. A. Burke, "Gibraltar's 1804 Yellow Fever Scourge: The Search for Scapegoats," *Journal of History of Medicine and Allied Sciences* 53 (1998): 3-42, at 3.

7. Census of Gibraltar (1878).

8. This is based on the period of residence within the colony at the time of death from 1869 to 1899 (military men, fifteen years of age and older).

9. Myna Trustram, *Women of the Regiment: Marriage and the Victorian Army* (Cambridge, 1984), 41.

10. Ibid., 41.

11. The number of coal heavers entering Gibraltar by day. From a letter by William Seed, chief of police, to the colonial secretary, January 18, 1889. Gibraltar Government Archives.

12. W. G. F. Jackson, *The Rock of the Gibraltarians: A History of Gibraltar* (Northants, 1990).

13. L. A. Sawchuk and J. Padiak, "Public Visitors, Hygiene and Human Rights: Issues in Prostitution in 19th Century Gibraltar" (paper presented at the Canadian Association of Physical Anthropologists in Fredericton, New Brunswick, 1999).

14. L. A. Sawchuk, "Rainfall, Patio Living, and Crisis Mortality in a Small-Scale Society: The Benefits of a Tradition of Scarcity?" *Current Anthropology* 37 (1996): 863-67.

15. L. A. Sawchuk, *Deadly Visitations in Dark Times* (Gibraltar, 2001).

16. W. G. F. Jackson, *The Rock of the Gibraltarians* (Toronto, Canada, 1987).

17. Ibid. Army Medical Report 1860, vol. 37 of *Parliamentary Papers*.

18. Report on the Barrack and Hospital Improvement Commission on the Sanitary Condition of the Mediterranean Stations (hereafter Barrack Improvement Commission, 1863), vol. 13 of *Parliamentary Papers*, 1.

19. J. Sutherland, *Report on the Sanitary Condition of Gibraltar with Reference to the Epidemic Cholera in the Year 1865* (London, 1867); Dr. Baly, *Quarantine* (Gibraltar, 1855).

20. W. S. Hamer, *Civil-Military Relations in Victorian Britain* (Oxford, 1970).

21. Ibid.

22. It is important to note that much of the qualitative information presented here is derived from authors who were not without vested interests. Some sought improved sanitation, lying-in

hospitals, and so forth, while others were more concerned with the cost of such reforms. Furthermore, it is important to recognize that Gibraltar had no free press during the study period, and opinions expressed by locals were often subject to censorship by the colonial authorities. Each statement should accordingly be weighed carefully as many of the sources quoted here were not without bias nor constraints.

23. S. Scott, S. R. Duncan, and C. J. Duncan, "Infant Mortality and Famine: A Study in Historical Epidemiology in Northern England," *Journal of Epidemiology and Community Health* 49 (1995): 245-52.

24. Ibid., 248.

25. Ibid.

26. R. Pressat, *Demographic Analysis* (Chicago, 1972).

27. In the temporal period from 1870 to 1899, the Jews numbered 733 out of a population average of 15,159. See L. A. Sawchuk, D. A. Herring, and L. R. Waks, "Evidence of a Jewish Advantage: A Study of Infant Mortality in Gibraltar, 1870-1959," *American Anthropologist* 87 (1985): 616-25.

28. For civilian infants and children, see Sawchuk, "Rainfall, Patio Living and Crisis Mortality in a Small-Scale Society," note 7; L. A. Sawchuk, "Societal and Ecological Determinants of Urban Health—A Case Study of Pre-reproductive Mortality in 19th-Century Gibraltar," *Social Science and Medicine* 36 (1993): 875-92; Sawchuk, Herring, and Waks, "Evidence of a Jewish Advantage," note 27; L. A. Sawchuk and L. Flanagan, "Infant Mortality among the Jews of Gibraltar, 1869 to 1977," *Canadian Review of Physical Anthropology* 1 (1979): 63-72.

29. It is important to note that Figure 2 displays a five-year moving average temporal perspective of declining rates of infant mortality. In Phase I, there were 373 infant military deaths among 2,379 births, while there were 1,144 infant civilian deaths among 6,717 births. In Phase II, there were 212 infant military deaths among 1,737 births, while there were 1,216 infant civilian deaths among 7,579 births.

30. The infant mortality rate (IMR) of Gibraltar's civilians is somewhat higher than that of England and Wales from 1880 to 1899, which ranges between 139 and 156 infant deaths per 1,000 births. The military IMR, however, is somewhat lower. The English data cover a large population and a variety of ecological and sanitary situations. With its smaller populations and specific circumstances, the Gibraltar groups flank the English averages, providing a measure of the type of variation that could occur within a single urban center. Data are from William A. Brend, "The Relative Importance of Pre-natal and Post-natal Conditions as Causes of Infant Mortality," in *Health and the State* (London: Constable and Company, 1916): 27.

31. H. P. Elkington, *Annual Report on the Public Health of Gibraltar for the Year 1900* (Gibraltar, 1901), 8.

32. R. MacPherson, *Annual Report on the Health of Gibraltar 1892* (Gibraltar, 1893), 8.

33. See Sawchuk, "Rainfall, Patio Living, and Crisis Mortality in a Small-Scale Society," note 15; Sawchuk, "Societal and Ecological Determinants of Urban Health," note 28.

34. Sawchuk, *Deadly Visitations*.

35. H. Tulloch, *Report on the Water Supply and Sewage System of Gibraltar* (London, 1890), 16.

36. R. MacPherson, *Annual Report on the Health of Gibraltar 1890* (Gibraltar, 1891), 21.

37. The estimates provided here are regarded as ideal under normal rainfall conditions as well as the intelligent use and monitoring of the cistern tank.

38. G. Alton, *Remarks on the Water Supply for Gibraltar* (Gibraltar, 1870), 15.

39. Barrack Improvement Commission, note 19.

40. Despite these difficulties, recent work by Sawchuk suggests that children in households lacking access to cistern water may actually have fared better when faced with periods of high ecological stress in the form of low rainfall; see Sawchuk, "Rainfall, Patio Living and Crisis Mortality in a Small-Scale Society," note 15.

41. Barrack Improvement Commission, note 19; Sawchuk, *Deadly Visitations*.

42. Tulloch, *Report on the Water Supply*, note 35, at 16.

43. R. MacPherson, *Annual Report on the Health of Gibraltar 1893* (Gibraltar, 1984), note 31, at 12.

44. Frederick Sayer, *The History of Gibraltar and of Its Political Relations to Events in Europe* (London, 1865), 475.

45. Sutherland, *Report on the Sanitary Condition of Gibraltar*, note 20.

46. Tulloch, *Report on the Water Supply*, note 35, at 13.

47. W. G. MacPherson, *Annual Report on the Health of Gibraltar 1891* (Gibraltar, 1892). Baked bread was problematic for reasons other than bad water. Sawchuk, "Societal and Ecological Determinants of Urban Health," notes that "many of the bakeries, devoid of any regulation or licensing, were in a disgraceful and filthy state. The use of mules in the kneading of the dough was often cited as a major contributing factor in this regard" (p. 48). The sanitary inspector, in cooperation with the district medical officers, endeavored to condemn the sale of any food deemed unwholesome. Their undertakings were somewhat hampered, however, "owing to a reluctance on the part of the public to give information, which may affect the interests of retailers," and unwholesome food continued to be imported and consumed by the public. H. Stokes, Appendix IV, *Report of the Officer of Health of the Sanitary Commissioners of Gibraltar for the Year 1866* (Gibraltar, 1867).

48. Sawchuk, *Deadly Visitations*.

49. Even the garrison horses were included in water-provisioning estimates.

50. Tulloch, *Report on the Water Supply*, note 35, at 16.

51. Ibid., 16.

52. Thomas Walsh, *Journal in the Late Campaign in Egypt, Including Descriptions of That Country and of Gibraltar, Minorca, Malta, and Macri* (London: T. Cadell and W. Davies in the Strand, 1803), note 33, at 7.

53. H. Stokes, Memorandum contained in the Report of an Inquiry into the Working and Administration of the Gibraltar Sanitary Commission, J. Ponsonby Cox, Royal Engineers, 1877.

54. Baly, *Quarantine*, note 20.

55. J. Ponsonby Cox, Report of an Inquiry into the Working and Administration of the Gibraltar Sanitary Commission, November 12, 1877, Gibraltar Government Archives.

56. Collectively, these condensers would be capable of distilling about eight thousand gallons a day. Sir J. Adye, *Recollections of a Military Life* (London, 1895).

57. Treasury 1/14774, War Office, report by Arthur D. Hayter, December 7, 1882.

58. It was not until a decade later, in 1891, that a systematic inspection of civilian water tanks was initiated.

59. Army Medical Report, vol. 49 of *Parliamentary Papers* (1889), 62.

60. R. Collins, *Annual Report of the Public Health of Gibraltar for the Year 1885* (Gibraltar, 1886).

61. Anonymous, November 12, 1885, *Times*.

62. Tulloch, *Report on the Water Supply*, note 35, at 16; Edward Roberts, *Report of a Proposed Scheme for a Supply of Fresh Water to the Town and Garrison of Gibraltar* (Gibraltar, 1870), pegs the average daily allowance of water to each member of the civilian population as less than two gallons per day.

63. Barrack Improvement Commission, note 19, at 26.

64. Edward Roberts, Selections from Reports of E. Roberts, Esq., Surveyor to the Sanitary Commissioners, March 31, 1866, in *Report of the Proceedings of the Sanitary Commissioners of Gibraltar for the Year 1866* (Gibraltar, 1867).

65. Barrack Improvement Commission, note 19, at 27.

66. Sawchuk, *Deadly Visitations*.

67. Ibid.

68. Ibid.

69. Trustram, *Women of the Regiment*, note 10.

70. Ibid.

71. Barrack Improvement Commission, note 19, at 45.

72. Ibid., 45.

73. W. J. Barlette, *Gleanings on the Overland Route* (London, 1864), 143.

74. Barrack Improvement Commission, note 19.

75. John Bishop Antini, Correspondence to Colonel R. S. Baynes, April 4, 1874. CO 91/331 Public Record Office (hereafter PRO).

76. Army Medical Report (1875), vol. 61 of *Parliamentary Papers 1876*.

77. Army Medical Report (1891), vol. 52 of *Parliamentary Papers 1892*.

78. Sawchuk, "Societal and Ecological Determinants of Urban Health," note 28, at 881.

79. R. G. Thomsett, *A Record Voyage in H.M.S. Malabar and Reminiscences of the Rock* (London, 1902), 156-58.

80. S. Guha, "Nutrition, Sanitation, Hygiene, and the Likelihood of Death: The British Army in India c. 1870-1920," *Population Studies* 47 (1993): 385-401, at 387.

81. Trustram, *Women of the Regiment*, note 10, at 141.

82. See, for example, the description in Derek J. Oddy, "Gone for a Soldier," *Journal of Family History* 25 (2000): 39-62.

83. Trustram, *Women of the Regiment*, note 10, at 139.

84. M. Rao, D. Benton, and S. Bremberg, "A Comparative Study of Army and Civilian Babies in a UK Garrison Town," *Public Health* 111 (1997): 317-19.

85. Ibid., 319.

86. Trustram, *Women of the Regiment*, note 10, at 165.

87. Ibid., 190.

88. Ibid., 106.

89. Ibid., 55.

90. Reports from 1877 indicate that Spanish fruit and vegetables were relatively abundant and that the garrison was well supplied with fish. While poultry and eggs were brought in from Morocco, fresh meat was more difficult to come by. This reliance on foreign sources to provision the garrison led to one of England's greatest weaknesses in maintaining as isolated territory such as Gibraltar. Walsh noted,

> In the event of war on the one side [with Spain], and pestilence on the other [the coast of Barbary], it often happens, as was case when I was there, that the garrison is compelled to live entirely on salt provision; not having even the advantage or comfort of vegetables, which are scarce, and very dear. (Walsh, *Journal in the Late Campaign in Egypt*, 9)

According to Hennen, poor Gibraltarians largely relied on "fish, especially salted and dried, pork in its fresh and salted state, macaroni, rice, oil, bread and a large proportion of the leguminous and other vegetables" as the staples to their diet. J. Hennen, *Sketches of the Medical Topography of the Mediterranean Comprising an Account of Gibraltar, the Ionian Islands, and Malta; to Which is Prefixed, a Sketch of a Plan for Memoirs on Medical Topography (London: Thomas and George Underwood, 1830).*

91. Trustram, *Women of the Regiment*, note 10, at 105-6.

92. Geo. Bent, Colonel Royal Engineers, et al., Report and Recommendations of Special Board of Inspection on the North Front, April 1866, May 23. In *Report of the Proceedings of the Sanitary Commissioners of Gibraltar for the Year 1866* (Gibraltar, 1866), 52.

93. Ibid., 54.

94. J. Errington Ker, letter to the subcommittee appointed to investigate the question of a lying in hospital for the wives of soldiers in connection with the Colonial Hospital, December 23, 1893. Gibraltar Government Archives.

95. Firm divisions between the care of military and civilian women at childbirth persisted well into the twentieth century with the provision of strictly defined practicing midwives. A. W. Fawkes, Letter of December 29, 1893, Gibraltar Government Archives.

96. J. Errington Ker, letter to the subcommittee, note 89.

97. Ibid.

98. District Medical Officer [name illegible], letter to the subcommittee on the proposed maternity hospital, December 24, 1893, Gibraltar Government Archives.

99. Trustram, *Women of the Regiment*, note 10, at 84.

100. Christine Lawrance, *The History of the Old Naval Hospital Gibraltar 1741 to 1922* (Hampshire, 1994), 81.

101. I. Louden, "Deaths in Childbed from the Eighteenth Century to 1935," *Medical History* 30 (1986): 1-41.

102. Nicky Hart, "Beyond Infant Mortality: Gender and Stillbirth in Reproductive Mortality before the Twentieth Century," *Population Studies* 52 (1998): 215-29.

103. See I. Zusman and A. Ornoy, "Embryonic Resistance to Chemical and Physical Factors: Manifestation, Mechanism, Role in Reproduction and Adaptation to Ecology," *Biological Review* 65 (1990): 1-18; P. Gruenwald, "Stillbirth and Early Neonatal Death," in *Perinatal Problems: The Second Report of the 1958 British Perinatal Mortality Survey*, ed. N. R. Butler and E. D. Alberman (Edinburgh/London, 1969).

104. A nominal charge of one-tenth of the regular fee that was charged for digging and interment was imposed on any child under ten years of age; this reduced fee amounted to one dollar.

105. Linda Bryder, "Sex, Race, and Colonialism: An Historiographical Review," *International History Review* 20 (1998): 806-22; Philippa Levine, "Rereading the 1890s: Venereal Disease as 'Constitutional Crisis' in Britain and British India," *Journal of Asian Studies* 55 (1996): 585-612; Douglas M. Peers, "Privates off Parade: Regimenting Sexuality in the Nineteenth-Century Indian Empire," *International History Review* 20 (1998): 823-54.

106. See, for example, A. Conde-Agudelo, J. M. Belizan, and J. L. Diaz-Rossello, "Epidemiology of Fetal Death in Latin America," *Acta Obstetricia et Gynecologica Scandinavica* 79 (2000): 371-78; A. De Schryver and A. Meheus, "Epidemiology of Sexually Transmitted Diseases: The Global Picture," *Bulletin of the World Health Organization* 68 (1990): 639-54; M. Genc and W. J. Ledger, "Syphilis in Pregnancy," *Sexually Transmitted Infections* 76 (2000): 73-79; M. Koskiniemi et al., "Stillbirths and Maternal Antibodies to Chlamydia Trachomatis: A New EIA Test for Serology," *Acta Obstetricia et Gynecologica Scandinavica* 75 (1996): 657-61; M. Temmerman et al., "Effect of a Syphilis Control Programme on Pregnancy Outcome in Nairobi, Kenya," *Sexually Transmitted Infections* 76 (2000): 117-21.

107. F. Solly Flood, correspondence to Freeling, colonial secretary, August 25, 1866, CO 91/285 PRO.

108. For a more detailed examination of this issue, see Sawchuk, "Public Visitors," note 14.

109. Statistical Report on the Sickness, Mortality, and Invaliding among Troops in the Mediterranean, vol. 59 of *Parliamentary Papers 1853*, 129.

110. Trustram, *Women of the Regiment*, note 10, at 46.

111. N. M. Mirza et al., "Risk Factors for Diarrheal Duration," *American Journal of Epidemiology* 146 (1997): 776-85.

112. Jean Bourgeois-Pichat, "De la mésure de la mortalité infantile," *Population* 1 (1946): 53-68; idem, "Analyse de la mortalité infantile," *Revue de l'Institut International de Statistiques* 18 (1950): 45-68; idem, "La mésure de la mortalité infantile. I. Principles et méthodes," *Population* 6 (1951): 223-48; idem, "La mésure de la mortalité infantile. II. Les causes de décès," *Population* 6 (1951): 459-80; idem, "Essai sur la mortalité 'biologique' de l'homme," *Population* 7 (1952): 381-94; idem, "An Analysis of Infant Mortality," *Population Bulletin of the United Nations* 2 (1952): 1-14.

113. J. Knodel and H. Kintner, "The Impact of Breast Feeding Patterns on the Biometric Analysis of Infant Mortality," *Demography* 14 (1977): 391-409.

114. For other examples of the application of this technique, see D. Ann Herring, S. R. Saunders, and M. A. Katzenberg, "Investigating the Weaning Process in Past Populations," *American Journal of Physical Anthropology* 105 (1998): 425-39; Larry A. Sawchuk and Stacie D. A. Burke, "Mortality in an Early Ontario Community: Belleville 1876-1885," *Urban History Review/Revue d'histoire urbaine* 29 (2000): 33-47; S. Scott, S. R. Duncan, and C. J. Duncan, "Malnutrition, Pregnancy, and Infant Mortality: A Biometric Model," *Journal of Interdisciplinary History* 30 (1999): 37-60.

115. See also Herring, Saunders, and Katzenberg, "Investigating the Weaning Process in Past Populations," note 109.

116. Bacteriological contamination and the adulteration of milk were also commonplace in many other European countries. P. J. Atkins, "White Poison? The Social Consequences of Milk Consumption, 1850-1930," *Social History of Medicine* 5 (1992): 207-26; B. Moring, "Motherhood, Milk, and Money," *Social History of Medicine* 11 (1998): 177-96; D. Dwork, "The Milk Option: An Aspect of the History of the Infant Welfare Movement in England, 1898-1908," *Medical History* 31 (1987): 51-69; M. W. Beaver, "Population, Infant Mortality and Milk," *Population Studies* 27 (1973): 243-54.

117. Army Medical Report (1892), vol. 53 of *Parliamentary Papers 1894*, 39.

118. W. MacPherson, health officer, memorandum to the sanitary commissioner's office, October 13, 1891, Gibraltar Government Archives.

119. Sawchuk, "Societal and Ecological Determinants of Urban Heath," note 28.

120. *Gibraltar 1914 Annual Report on the Public Health of Gibraltar* (Gibraltar, 1915).

121. Ibid.

122. Sawchuk, *Deadly Visitations*.

123. *Gibraltar 1916 Annual Report on the Public Health of Gibraltar* (Gibraltar, 1917).

124. MacPherson, *Annual Report on the Public Health of Gibraltar (1892)*, note 31, at 21.

125. It was not until 1907 that the boiling of milk became a bylaw in Gibraltar.

126. MacPherson, *Annual Report on the Public Health of Gibraltar (1892)*.

127. MacPherson, *Annual Report on the Public Health of Gibraltar (1893)*.

128. The regulations are as follows: (1) people can only sell milk that is absolutely pure and free from extraneous matter or adulteration of any kind whatsoever, and carried in clean vessels; (2) premises for the sale of milk must be certified in writing by sanitary commissioners as fit and proper premises for milk shops; (3) sanitary commissioners require premises of sale of milk to be kept clean and lime-washed; (4) places where milk is sold must not be used for any other purposes; (5) vessels and receptacles must be kept scrupulously clean with water from a pure source; (6) disease among animals that supply milk must be immediately reported to the sanitary commission; (7) for any person duly authorized, the power to enter and inspect rooms or other places where milk is kept for sale to assess sanitary conditions, condition of milk, and vessel conditions; and (8) the officer of health has the power to examine and take samples for analysis from all milk kept for sale in any place, including street vendors.

129. Bacteriological testing was first reported in Gibraltar in 1897. Army Medical Report 1897, vol. 54 of *Parliamentary Papers 1898*, 625.