Cholera Epidemic in Bologna, 1855:

Canal Networks and Women's Working Conditions

Francesco Scalone and Cristina Munno

Alma Mater Studiorum – University of Bologna

Abstract

This paper investigates the gender disparities in the 1855 cholera epidemic in Bologna, Italy. The presence of a network of canals and distinct occupational roles for women are considered as contributing factors. Cholera, a waterborne disease, thrives in contaminated water sources. In Bologna, the canal system likely affected the spread of the disease. We analyze data from the city's Burial Registers during the epidemic, which included 1,165 male and 1,825 female cases, reflecting a sex ratio of 0.638. Our analysis shows that age, rather than gender, was a significant predictor of mortality due to cholera. The risk of infection was only slightly elevated for women compared to men, and there was no evidence of a more severe outcome in women once infected. We argue that gender played a role in infection rates, but other factors, including age and neighbourhood, influenced cholera outcomes.

Keywords: cholera, gender disparities, epidemic, Bologna, canals

Introduction

There has been a resurgence of interest in mortality crises, especially those caused by epidemics. This paper examines the particularly severe cholera epidemic in Bologna in 1855, offering several intriguing study aspects. Notably, a network of canals ran through the city at the time, and there was a gender disparity in the disease's impact. Women were more frequently afflicted and had higher mortality rates than men.

Cholera, caused by the Vibrio Cholera bacterium, spreads mainly through contaminated water and food, highlighting sanitation and hygiene issues in affected cities. Factors like population density, poor water supply, and inadequate sewage systems influence its transmission. Individual resistance to the disease varies based on age, malnutrition, socioeconomic conditions, and residence. Access to clean water and proper sanitation are crucial for controlling cholera, especially in overcrowded, impoverished areas. The disease can cause rapid dehydration due to diarrhoea and vomiting, leading to death in unsanitary conditions.

Initially confined to Asia, cholera reached Europe in 1817, with Italy experiencing its first epidemic in 1835 via France. The 1854-1855 epidemic followed a similar west-to-east trend. Despite limited knowledge about cholera, health authorities implemented control, prevention, and care measures. However, contemporary treatments, primarily saline to counter dehydration, were largely ineffective (Cosmacini, 2005).

In 19th-century Italy, the prevalence of gastrointestinal infections and cholera outbreaks stemming from contaminated food and drinks underscored the country's underdeveloped water and sanitation infrastructure and pointed to broader housing issues. A survey of Italian municipalities in 1885-86 revealed widespread sanitary deficiencies. Most municipalities needed proper sewage systems and water supply, with many needing more waste removal. Even those with a water supply often had poor-quality or insufficient water, resulting in nearly 22 million Italians relying on potentially unsafe water sources such as wells, springs, and rivers (Della Peruta, 1980).

During cholera outbreaks in 19th-century Italy, governments imposed strict containment measures like land and maritime cordons, quarantines, and isolating infected areas, as the medical community lacked understanding and effective treatments for the disease (Tognotti, 2021). Italian doctors were ill-equipped to combat this affliction (e.g. Vaglia, 2013).

The aim of this paper is to analyze the reasons for the gender-related disadvantage observed during the 1855 cholera epidemic in Bologna and provide an explanation considering the city's environmental and economic characteristics at that time.

Waterborne Transmission: The Role of Contaminated Water in Cholera Outbreaks

Understanding the spread of cholera in places like Bologna, with its complex network of canals, required a deeper investigation into the environmental factors at play. German chemist Max von Pettenkofer established a connection between infected individuals' spread of cholera and polluted water and faecal matter. Further studies by English physician John Snow, who linked a cholera outbreak to a single water source, emphasized the importance of personal and public hygiene. Snow's work highlighted the critical role of clean water and sanitation systems in preventing cholera

outbreaks and refuted the notion of airborne transmission and blood poisoning. His contributions to understanding cholera transmission in Great Britain remain influential today (Newsom, 2005; Underwood, 1948).

The importance of water in cholera's spread, a waterborne disease caused by the bacterium Vibrio cholerae, is fundamental. Thriving in contaminated water sources, the bacterium, when ingested, leads to severe diarrhoea and dehydration, which can prove fatal without prompt treatment. Poor sewage systems and polluted water exacerbate the proliferation of cholera. The 19th century witnessed a growing awareness of the link between contaminated water and cholera outbreaks, emphasising the significance of clean water and proper sanitation in disease prevention. For example, in Naples, issues with hydraulic infrastructure likely contributed to the spread of cholera (Tagarelli et al., 2000). As cholera bacteria flourish in water tainted with faecal matter, access to clean water and adequate sanitation is vital for cholera prevention.

Bologna was not alone in facing hygiene issues; many other urban areas encountered similar challenges. Research shows consistent problems across cities and towns of all sizes, including inadequate or absent sewage systems, restricted access to clean water, streets strewn with household waste, and unsanitary housing. Consequently, cholera and other contagious diseases spread rapidly, especially within certain neighbourhoods, met by uncoordinated and ineffective responses. Notably, the situation in Bologna was further compounded by the presence of canal networks, which provided a conducive environment for the spread of diseases such as cholera (Sabbatani et al., 1997; Sabbatani & Piro, 1998).

Gender and Cholera: Bologna's 1855 Epidemic Revisited

There is a renewed interest in mortality crises, especially those triggered by epidemics. Recent research, largely microdemographic, focuses on small areas or individual communities and estimates of cholera-related deaths in Italy's six epidemics from 1835 to 1893 (Alfani, 2014). Numerous studies on cholera have highlighted the role of social inequalities in both the spread of the disease and the resulting fatalities, identifying specific areas particularly vulnerable to outbreaks. In these discussions, however, the examination of gender differences has often been overlooked, despite its potential importance in understanding the impact and management of epidemics. Indeed, few studies address gender differences, but some confirm higher cholera risks for women, often due to these role disparities (Agtini et al. 2005; Scallan et al. 2005; Archer et al. 2009).

The case of Bologna in 1855, characterized by its network of canals and specific working conditions for women, presents a unique opportunity to explore the gendered implications of a cholera outbreak. At the time, Bologna's extensive canal system served multiple purposes, including providing water and powering industrial activities. Unfortunately, these canals were also prone to contamination, making them potential sources of waterborne diseases such as cholera.

Simultaneously, the working conditions for women in Bologna were distinct, often involving specific roles within the local industries. These factors might have influenced their exposure to cholera, increasing or decreasing their susceptibility compared to their male counterparts. Moreover, once infected with cholera, the severity of the disease and the lack of effective treatment at the time

could have significantly elevated the risk of mortality among these individuals, regardless of their occupation or social status.

Building on these observations, our research addresses the following question: How did the interplay between the canal network and the unique working conditions for women in Bologna in 1855 contribute to gender differences in the spread of the cholera outbreak and in the death risk? Answering this question will deepen our understanding of the 1855 cholera epidemic in Bologna and provide insights into the role of gender in shaping the outcomes of public health crises.

Cholera Epidemic of 1855 in Bologna: Outbreak, Response, and Documentation

The cholera epidemic of 1855 arrived in the Bologna area, first affecting the towns of Molinella, Baricella, and Pianoro. Rapidly, the disease spread and reached Bologna on May 29th. In response, Bologna activated the San Lodovico Lazzaretto to manage the epidemic but quickly became overwhelmed. To coordinate the response, the Provincial Health Commission enlisted military forces to enforce health cordons and established health presidencies in the city's districts, complete with medical staff and local pharmacies. As cases surged, additional facilities were opened. By the fall, cholera cases began to decrease, and the epidemic officially ended on December 1st, with a toll of 4905 infections and 3649 deaths in the municipality, 3700 infections and 2759 deaths within the city walls. The impact varied by district, with infection rates ranging from 3.5% to 6.7%.

During this devastating epidemic, authorities convened a health committee, cleaned public spaces, disinfected affected homes, and isolated the sick, sometimes in quarantine facilities. In response to the fear of contagion, the city also introduced new health regulations and policing measures. However, these efforts had limited success due to the constrained medical knowledge at the time (Alaimo, 1990).

Several key studies documented the outbreak during the 1855 epidemic. Ferdinando Verardini (Verardini, 1856) published an analysis, while Enrico Bottrigari (1962) provided an account of events in his "Cronaca di Bologna." Notably, Paolo Predieri (Predieri, 1857), leading a comprehensive study by the city's health department, meticulously documented the epidemic's progress, preventive measures, and outcomes in a 440-page report, providing valuable insights into the cholera outbreak in the Bologna province. Subsequent research has cited this report, including works by Forti Messina (1984), and public health scholars like Sabbatani, Pirro and Giusberti (1997).

Medical reports from the time reveal that contemporary physicians were still grappling with understanding the disease's spread. Data was correlated with climatic conditions, population malnutrition, and the patient's gender. Territorial aspects such as overpopulation and demographic density were considered. However, there was limited exploration of sewage systems, the presence of canals in the city, and the quality of water systems. Significantly, the main public washhouses were situated along the canal that used to run through the city, now buried beneath Via Riva di Reno. The evidence and insights led to undoubtedly effective prophylaxis measures, such as isolations and protocols requiring the burning of straw bedding used by patients after recovery.

Gender Differences in Cholera Incidence and Mortality Across Italian Contexts

Previous studies have not provided a consistent picture regarding gender differences regarding the contagiousness and lethality of the disease, likely because cholera could affect sociodemographic groups and population segments in ways that varied depending on environmental characteristics, urban configuration, and the social classes inhabiting the area. Here, we provide examples of how the disease incidence by sex could vary across Italian contexts.

In some areas, gender differences in cholera incidence and mortality were not evident. For instance, during the 1855 outbreak in the Umbrian provinces of Perugia, Spoleto, and Orvieto, older people were disproportionately affected, but no significant gender disparities were observed (Bussino, 2014). Similarly, in the 1854-55 outbreak in Casalguidi, central Italy, those aged 5-54 were primarily affected, and gender differences in mortality were minimal, with a mortality sex-ratio of around 0.96-0.97 (Manfredini, 2003). In Istria, a region near the Italian border, the 1855 cholera epidemic affected 9.87% of the population, causing 6,727 deaths. The disease's distribution was fairly even between genders, with roughly 42% of males and females contracting cholera and around 33% dying from it (Cigui, 2008).

Conversely, there are also situations where women were more affected. In Colorno, Duchy of Parma, women were more likely to be affected by cholera, with an Odds Ratio 1.5 times higher than for men. This disparity was probably due to women's roles in family care, health maintenance, and cleaning high-risk areas such as latrines, which increased their risk of infection (Mazzoni, 2014).

However, there is also evidence that supports the opposite trend. During the 1865-66 cholera epidemic in Italy, gender differences in case numbers and deaths were observed. Among 1.87 million males, 12,143 cases were reported with a 55.7% death rate, while among 1.81 million females, 11,434 cases occurred with a 53.6% death rate. The data suggests that males were slightly more affected by cholera than females regarding both cases and mortality (Tagarelli et al., 2000).

Canals and Cholera: The Changing Role of Waterways in 19th Century Bologna

In Bologna, a network of canals once served as vital hubs of social and economic activity, particularly for dyers, weavers, and laundresses. These canals, intertwined with the city's daily life and culture, were essential for the livelihoods of these workers and also played a role in local celebrations and rituals. However, as the understanding of hygiene and sanitation evolved, the waters of these canals, once viewed as a symbol of prosperity and community, were increasingly seen as health hazards (Callari Galli, 2007). This was particularly evident during the cholera epidemics of the 19th century.

In the 19th century, many Italian cities, including Bologna, were plagued by cholera epidemics. In these cities, the poor sanitary conditions and the contamination of water sources played a pivotal role in spreading the disease. In Bologna, the canals were frequently polluted with sewage and waste, making them ideal breeding grounds for cholera. People often drank from the same contaminated water sources, so the risk of contracting the disease was significantly heightened (Sabbatani, 2002).

According to Sergio Sabbatani (1997; Sabbatani, 2002; 1998), the spread of cholera varied across neighbourhoods, with differences influenced by factors such as urban layout, population density, and the presence of canals. Areas affected by the disease were typically those traversed by canals, including the Canale delle Moline, Savena, Aposa stream, and especially the Navile canal, which connects Bologna to the Adriatic Sea. These open-air canals in Bologna's industrial belt have long been associated with commercial activities like silk mills. During the 18th century, the water from the canals powered a burgeoning proto-industry, including silk production and leather tanneries, that was renowned throughout Europe. However, this industry struggled to keep pace with the advancements of the first Industrial Revolution. As a result, the decline of these factories and manufacturers had a knock-on effect on the maintenance of the canals, which, by the mid-19th century, had fallen into a state of disrepair.

Particularly concerning during the 1855 epidemic was the open sewer system, the discharge of latrines through the Grada (Reno canal), and the use of city canals for activities such as washing laundry or boiling legumes. Efforts to reorganize the urban infrastructure, to improve hygiene and sanitation conditions began in the 1860s. As early as 1840, a section of the Savena canal, now known as Via Rialto, was covered in response to public health concerns. Similarly, following a cholera outbreak in 1865, a significant stretch of the Aposa canal was enclosed. However, despite these measures, the unpleasant odour of the water, the risk of flooding during heavy rainfall, industrial noise from nearby mills and factories, and even official prohibitions, many people continued to bathe in the city's waters throughout the 19th century (Orlandi, 2007).

The challenges posed by water management were not exclusive to Bologna. For instance, in the northeastern region of Italy, Udine faced similar documented issues during the 1836 cholera outbreak. In both Udine and Bologna, the spread of cholera was linked to poor sewage systems and contaminated water (Breschi & Fornasin, 1999; Fornasin et al., 2011).

Cholera in 1855 Bologna: Historical Records and Data

Various sources available for studying the 1855 cholera epidemic in Bologna, including cholera case records and burial records, provide detailed insights into the epidemic, context, and affected individuals. These sources enable analysis of disparities in disease spread and risk exposure among inhabitants. The quality and detail of the information, thanks to the careful data collection by health authorities and preventive measures of the time, support a comprehensive analysis of this epidemic. This section examines the available sources for the 1855 cholera epidemic in Bologna and its characteristics.

The Burial Registers

The Bologna municipal archives hold burial registers as primary sources detailing the burial permissions granted. The Certosa cemetery, established in 1803, consolidated over fifty smaller cemeteries to resolve issues related to their scattered locations. After funeral services in parish churches, bodies were transported to the mortuary, where a numbered medallion corresponding to their grave was placed around their neck.

These individual records contain information such as date, deceased's name, parentage, age, birthplace, social and civil status, address, parish, cause of death with date and time, the declaring physician, and burial location. These detailed records provide valuable insights into the deceased individuals.

The Register of Cholera Cases

The records of cholera cases that occurred in the city between May 29 and November 16, 1855 are of particular interest. Only three of the four registers in the city are currently available in the municipal archive.

The register for San Giovanni in Monte in the southeast of Bologna is missing, and the data from this area are not reported or transcribed in the other volumes. The relief office for this area was located in the eponymous parish. In the northeast of the city, the health office for the San Giacomo district was located on Borgo Paglia Street on the ground floor next to the Ferrarini Pharmacy. In Facchini Street, pallbearers and gravediggers were on standby to transport the sick, reaching up to sixteen in number on some days. In the northwest, the Santa Maria Maggiore district was located on the ground floor of the Fibbia Palace on Galliera Street. The office had "a proportionate number of pallbearers and gravediggers, reaching up to twelve on some days." Additionally, the office was equipped with "three small cots for the sick and two for the deceased, placed in the parish mortuary". In the southwest, the administrative office for the San Francesco district was located on the ground floor of the former Zambeccari Palace. Pallbearers and guards, numbering up to eighteen, were based in the shop of the former Sant'Agostino Convent. Regarding the Appodiati, the territorial fractions outside the city of Bologna, the Alemanni, San Giuseppe, and Bertalia registers are available. However, the Arcoveggio, S. Egidio, and S. Rufillo registers are missing.

Table 1 shows summary information on data availability for the districts and Appodiati of Bologna, derived from the health office registers or health reports. Table 1 also shows the presence of health offices in Bologna during the cholera epidemic of 1855.

In summary, the registers offer the following pieces of information: date of onset of illness or admission, time of registration, last name, first name, father's name, mother's information (first and last name), age, birthplace/city of origin, marital status, social status/profession, district, house number, place of care (home or hospital), outcome of the disease (recovery or death), date of outcome of the disease, Physician/priest who recorded the information.

Results

The data used in this analysis is sourced from the Burial Registers of Bologna, which provide a comprehensive record of individuals who were infected with cholera during the epidemic of 1855. Each observation in the dataset represents one case or individual, and it includes information about the date the observation started and ended, the outcome of the infection (whether the person recovered or died), and other relevant details such as age, civil status, and occupation.

The dataset spans from the beginning of the epidemic to its conclusion, with the first observation recorded on [insert date of first observation] and the last observation on [insert date of last observation].

Analyzing the cholera case registry for three neighborhoods in Bologna in 1855, we find a total of 1,165 male cases and 1,825 female cases, yielding a sex ratio of 0.638. At first glance, this might suggest that women were more susceptible to infection, possibly due to professional roles that required contact with water or care of the sick. However, when interpreting these figures, it's essential to account for the demographic composition of the neighborhoods under study.

According to census data from 1845, the population consisted of 33,975 males and 37,625 females, resulting in a population sex ratio of 0.902 (Bellettini, 1961). In this context, it becomes evident that while there were more female cases of cholera, there were also proportionally more women in the population, which could account for the disparity in case numbers. Further evidence of the gender imbalance in the population comes from the 1871 census, which recorded a male population of 49.61% and a female population of 50.39%, registering a sex ratio equal to 0.984. This continued disparity in population numbers likely influenced the gender distribution of cholera cases in subsequent outbreaks.

However, it is important to note that the sex ratio for cholera cases is lower at 0.638 than the population sex ratio of 0.902 in 1845 or 0.984 in 1871. This discrepancy suggests that, although the higher number of female cases might be partly due to the greater proportion of women in the population, there does seem to be a slightly elevated risk of infection for women compared to men.

The total number of individuals in the dataset who were infected with cholera in Bologna in 1855 is 2,998. Of these, 777 individuals recovered from the infection, while 2,221 individuals succumbed to the disease. The odds of death for the total cases are approximately 2.86, meaning that for every person who survived, approximately 2.86 people died.

When examining the odds of death by sex, we find that the odds of death for males are approximately 2.75, indicating that for every male who survived, approximately 2.75 males died. In contrast, the odds of death for females are slightly higher, at approximately 2.92. This suggests that the course of the disease might be slightly more severe for women than for men.

Sex ratio and Odds Ratio by age groups

Figure 1 illustrates the distribution of cholera cases in Bologna in 1855, broken down by sex and age group. This data is drawn from the neighborhoods of San Giacomo, Santa Maria Maggiore, and San Francesco, as the records for the San Giovanni in Monte neighborhood are not available. Notably, male infections are more prevalent in age groups under 20, while women aged 20 and above show a higher number of infections.

Figure 1 - Here

Table 1 and Figure 2 corroborate the patterns observed in Figure 1, displaying the sex ratios of cholera cases by age classes (M/F). In younger age groups (0-9 and 10-19), the ratios are above 1, showing slightly more male infections. However, for working-age groups (20-29 to 60-69), the ratios are below 1, with as low as 0.47 and 0.55 for the 20-29 and 30-39 groups. For older groups (70-79 to 80+), the ratios increase to 0.61 and 0.67, reflecting a relative balance between male and female cases.

Table 1 and Figure 2 – Here

Table 2 and Figure 3, the odds ratio, a common metric in epidemiological studies, was used to compare the odds of death among males to that of females across age groups. An odds ratio of 1 implies equal odds of death for both sexes, whereas an odds ratio greater than 1 indicates higher odds of death for males, and an odds ratio less than 1 suggests lower odds for males.

The odds ratios across age groups vary, indicating that the relative risk of death from cholera for males and females is inconsistent across ages. For example, males aged 10-19 and 40-49 had slightly higher odds of death than females, while those in other age groups had lower odds.

The variation in the odds ratios across age groups indicates that neither sex seems more susceptible to death once infected with cholera. In our analysis, while it appears that women may have been slightly more exposed and infected with cholera, the progression of the disease was similar for both sexes, with no evidence of a more severe outcome in women compared to men.

Table 2 and Figure 3 – Here

Sex ratio and Odds Ratio by occupation groups

This section compares the sex and odds ratios among various socio-professional categories. We begin by using a macro-professional aggregation previously proposed by other authors for the Bologna context (Bellettini, 1961; Sabbatani et al., 1997). While this classification has limitations, such as not clearly identifying a gradient among socio-professional classes or providing a status measure, it is sufficient for our current study's purposes. Our primary interest lies in examining the macro-sectors of economic activity rather than the hierarchy of professions, as different economic sectors may be associated with varying modes of transmission and lethality of the disease.

The table 3.1 shows that for certain typically male-dominated professional categories, the sex ratios are greater than one, such as for artisans and merchants. This is most notably seen in the category of professions, where the ratio is as high as 7.375, likely due to the exclusion of women from many professions at the time. On the other hand, for other occupational categories, the sex ratio is less than one, such as in manufacturing, where women were employed as weavers or in silk production and might have been exposed to water.

Table 3.1 – Here

3.2, listing the specific occupational titles recorded in the Cholera Cases Register. This table includes the first 29 occupations that employed more than 1500 women. However, it is essential to note that some of these occupations correspond to a small number of cases and, thus, may not hold statistical significance.

Notably, domestic work, where women were often in contact with water and potentially exposed to cholera, has a sex ratio of only 0.024. Similarly, spinners and weavers, who were also exposed to water, have low sex ratios of 0.024 and 0.085, respectively. In contrast, shoemakers and labourers, typically male-dominated fields, have higher sex ratios of 9.000 and 6.000, respectively.

Women were employed in occupations with a higher likelihood of exposure to water, such as washerwomen, reelers, and sewists. Other female occupations related to handling food, such as vegetable and fruit sellers.

Table 3.2 – Here

Table 4 presents cholera outcomes by occupation group and sex and the odds of death for males and females in each occupation group in Bologna in 1855. The odds ratio indicates the relative odds of death for males compared to females in each occupation.

At first glance, it is difficult to discern a specific pattern as some professions have a gender imbalance in cases, thus influencing the odds ratio more due to small sample sizes than a real tendency to die once infected with cholera in one professional category compared to another.

For example, there are many female cases in the Domestic Work category compared to male cases. The odds of death for males are considerably higher at 12.000 compared to 3.044 for females, resulting in an odds ratio of 3.942. This high odds ratio may reflect the gender imbalance in this category rather than a real increased risk of death for male domestic workers.

In contrast, the Professions category shows a lower odds ratio of 0.505, indicating that males in this category had relatively lower odds of death than females. However, this finding may be influenced by the small number of female cases in this category.

Overall, the odds ratio has no clear pattern across different occupation groups. This suggests that other factors, such as age, overall health, or living conditions, might be more significant in determining cholera outcomes than occupation alone. Furthermore, the influence of small sample sizes in certain categories and gender imbalances should be considered when interpreting the odds ratios presented in this table. It is important to conduct more in-depth analyses to understand better the factors contributing to cholera outcomes in this population.

Table 4 – Here

Cholera Outcomes in Bologna, 1855: Risk Factors from Logistic Regression Analysis

The presented logistic regression analysis in Table 5 assesses the mortality risk factors for cholera outcomes based on several variables such as sex, age group, occupation group, neighbourhood, and civil status. It is essential to note that, unfortunately, we do not have all the necessary information in our data to control for all potential confounding factors. However, we have tried to set up a logistic regression using the variables related to the main control factors.

The results show that the fatality of the course of cholera did not vary much depending on sex or occupational sector, confirming the severity of the disease. Specifically, the odds ratio (OR) for females compared to males (reference group) is 1.053, which is not significantly different from 1. This suggests that the odds of death were roughly equal between males and females.

Age is a significant predictor of cholera outcomes. The odds of death increased with age, as indicated by the progressively higher odds ratios in the older age groups compared to the 30-39 age group (reference group).

The occupation group did not show significant differences in the odds of death from cholera, although some categories had elevated odds ratios, such as Clergy and Landowners. However, these results should be interpreted cautiously due to the small sample size in some categories.

Those for whom civil status was not registered appear to have a lower propensity for death, with an odds ratio of 0.499, though this finding is more challenging to interpret. In contrast, an interesting lower risk is recorded in the San Francesco neighbourhood, where the city hospital was located. This may indicate that access to medical care played a role in reducing the odds of death from cholera.

It is crucial to remember that the logistic regression model's results should be interpreted with caution due to potential confounding factors not accounted for in the analysis. In addition, the number of events and exposures can influence the stability and reliability of the model's estimates.

Table 4 – Here

Conclusions

Our analysis of cholera cases in Bologna during the 1855 outbreak, based on data from the Burial Registers, reveals important insights into the spread and outcomes of the disease among various population groups. Although a higher number of females were infected, which may be attributed to the greater proportion of women in the population, the risk of infection was only slightly elevated for women compared to men. Additionally, our analysis shows no evidence of a more severe outcome in women than men once infected with cholera.

Several factors influenced the odds of death due to cholera. Age emerged as a significant predictor of outcomes, with older age groups showing higher odds of death. While the occupation group did not show significant differences in odds of death, some categories with small sample sizes

exhibited elevated odds ratios. Other factors, such as civil status and neighbourhood, also appear to have played a role in cholera outcomes.

However, our findings should be interpreted with caution due to potential confounding factors and the influence of small sample sizes in some categories. Further research is needed to understand better the factors contributing to cholera outcomes in this population and their implications for public health strategies.

Our analysis of cholera cases in Bologna in 1855 reveals a discrepancy between the sex ratio in the general population and among the infected. The general population in 1845 had a sex ratio of 0.902, while the infected had a sex ratio of 0.638. It is possible that the greater proportion of women in the baseline population contributed to the higher number of infected women. However, the sex ratio among the infected is significantly lower than that of the general population, suggesting that other factors may have influenced infection risk. The main limitation of this analysis is the absence of data on those at risk of infection, making it difficult to ascertain the reasons for the discrepancy between the sex ratios. Nonetheless, it is unlikely that the sex ratio in the population would have matched that of the infected, suggesting that differences in infection risk may be due to factors beyond demographic composition.

Possible refinements to this analysis involve the application of survival analysis models, a more detailed spatial assessment using georeferencing of the infected individuals' addresses, and alternative occupational classification.

Table 1: Cholera Cases by Age Group and Sex with Sex Ratios in Bologna, 1855 (San Giacomo, Santa Maria Maggiore, San Francesco)

	Male	Female	Sex Ratio (M/F)
0-9	119	115	1.035
10-19	136	123	1.106
20-29	94	200	0.470
30-39	130	238	0.546
40-49	176	301	0.585
50-59	190	260	0.731
60-69	182	364	0.500
70-79	116	191	0.607
80+	22	33	0.667
Total	1165	1825	0.638

Source: Register of Cholera Cases

Table 2: Cholera Outcomes by Age Group and Sex with Odds of Death in Bologna, 1855 (San Giacomo, Santa Maria Maggiore, San Francesco)

	Male Deaths	Male Survivors	Female Deaths	Female Survivors	Male Odds	Female Odds	Odds Ratio
0-9	87	32	90	25	2.719	3.600	0.755
10-19	80	56	69	54	1.429	1.278	1.118
20-29	52	42	115	85	1.238	1.353	0.915
30-39	83	47	162	76	1.766	2.132	0.828
40-49	130	46	213	88	2.826	2.420	1.168
50-59	147	43	203	57	3.419	3.561	0.960
60-69	155	27	307	57	5.741	5.386	1.066
70-79	98	18	167	24	5.444	6.958	0.782
80+	22	0	33	0	-	-	-
Total	854	311	1359	466	2.746	2.916	0.942

Source: Register of Cholera Cases

Tab 3.1: Cholera Cases by Occupation Group and Sex with Sex Ratios in Bologna, 1855 (San Giacomo, Santa Maria Maggiore, San Francesco)

	Male	Female	Sex Ratio (M/F)
Craftsman	249	147	1.694
Merchant	93	79	1.177
Clergy	7	10	0.700
Servants and Workers	260	240	1.083
Education	8	15	0.533
Domestic Work	13	554	0.023
Manufacturing	109	316	0.345
Subsidized Beggars	32	100	0.320
Military	6	0	-
Unknown	5	20	0.250
Landowners	31	57	0.544
Professions	58	9	7.375
Various	39	40	0.975
Total	910	1587	0.574

Nota: The data presented refers only to the population aged 20 years or older.

Source: Register of Cholera Cases

Table 3.2: Occupational Distribution of Cholera Cases by Sex and Sex Ratio in Bologna, 1855 (San Giacomo, Santa Maria Maggiore, San Francesco)

	Male	Female	Sex Ratio
domestic work	14	579	0.024
spinner	4	164	0.024
servant	18	148	0.122
beggar	33	105	0.314
tailor	18	64	0.281
weaver	5	59	0.085
landowner	26	57	0.456
washerwoman	13	56	0.232
seamstress	2	35	0.057
reeler	3	23	0.130
cigar maker	0	22	0.000
vegetable seller	8	19	0.421
tinker	3	16	0.188
ironer	0	15	0.000
shopkeeper	0	14	0.000
retiree	3	14	0.214
schoolteacher	7	13	0.538
greengrocer	6	13	0.462
fringe maker	2	12	0.167
embroiderer	0	10	0.000
student	13	10	1.300
fruit seller	6	8	0.750
pot seller	6	8	0.750
dressmaker	0	8	0.000
shoemaker	63	7	9.000
hat maker	1	7	0.143
ribbon maker	0	7	0.000
laborer	30	5	6.000
wool worker	8	5	1.600
other occupations	734	174	4.218
Total	1165	1825	0.638

Nota: The data presented refers only to the population aged 20 years or older.

Source: Register of Cholera Cases

Tab 4: Cholera Outcomes by Occupation Group and Sex with Odds of Death in Bologna, 1855 (San Giacomo, Santa Maria Maggiore, San Francesco)

	Male Survivors	Male Deaths	Female Survivors	Female Deaths	Male Odds	Female Odds	Odds Ratio
Clergy	1	6	1	9	6.000	9.000	0.667
Craftsman	68	181	42	105	2.662	2.500	1.065
Domestic Work	1	12	137	417	12.000	3.044	3.942
Education	1	7	4	11	7.000	2.750	2.545
Landowners	4	27	10	47	6.750	4.700	1.436
Manufacturing	36	73	87	229	2.028	2.632	0.770
Merchant	24	69	17	62	2.875	3.647	0.788
Military	1	5	0	0	5.000	-	-
Professions	13	45	1	8	3.538	7.000	0.505
Servants and Workers	55	205	62	178	3.727	2.871	1.298
Subsidized Beggars	5	27	16	84	5.400	5.250	1.029
Unknown	3	2	4	16	0.667	4.000	0.167
Various	11	28	6	34	2.545	5.667	0.449
Total	223	687	387	1200	3.081	3.101	0.994

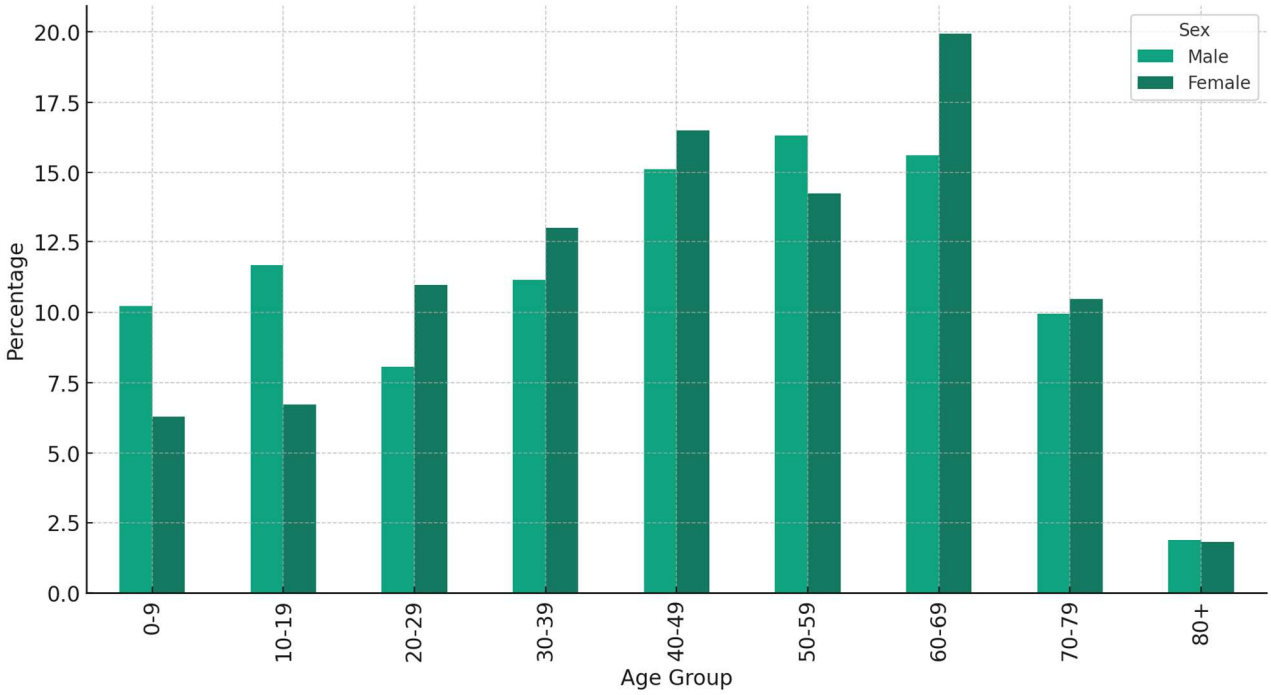
Nota: The data presented refers only to the population aged 20 years or older.

Source: Register of Cholera Cases

Table 5: Logistic Regression Analysis of Cholera Outcomes: Multivariable Assessment of Risk Factors

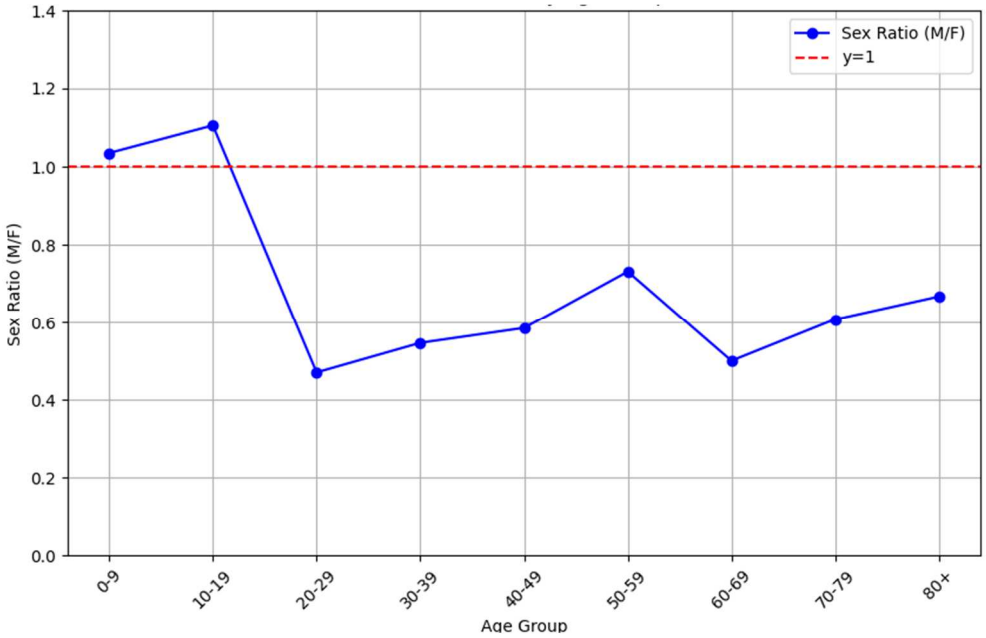
	OR	beta	P>z	[95% conf.	interval]
Sex					
Male [Ref.]	1.000	0.000	-	-	-
Female	1.053	0.051	0.661	-0.178	0.281
Age Group					
20-29	0.701	-0.355	0.026	-0.667	-0.042
30-39 [Ref.]	1.000	0.000	-	-	-
40-49	1.445	0.368	0.015	0.070	0.666
50-59	1.741	0.555	0.001	0.241	0.869
60-69	2.824	1.038	0.000	0.701	1.375
70-70	5.401	1.687	0.000	1.200	2.173
Occupation Group					
Craftsman	1.296	0.259	0.122	-0.069	0.588
Merchant	1.369	0.314	0.152	-0.116	0.744
Clergy	3.637	1.291	0.102	-0.254	2.836
Servants and Workers	1.410	0.343	0.032	0.029	0.657
Education	1.704	0.533	0.321	-0.519	1.586
Domestic Work	1.236	0.212	0.169	-0.090	0.513
Manufacturing [Ref.]	1.000	0.000	-	-	-
Subsidized Beggars	1.630	0.489	0.070	-0.041	1.018
Unknown	1.265	0.235	0.626	-0.710	1.179
Landowners	2.146	0.764	0.017	0.134	1.394
Professions	1.732	0.549	0.103	-0.112	1.210
Various	1.438	0.363	0.234	-0.234	0.960
Neighborhood					
San Giacomo [Ref.]	1.000	0.000	-	-	-
Santa Maria Maggiore	0.873	-0.136	0.264	-0.375	0.103
San Francesco	0.807	-0.215	0.074	-0.450	0.021
Civil Status	1.000				
Not registered	0.499	-0.696	0.000	-0.956	-0.436
Not Married	0.877	-0.131	0.387	-0.430	0.167
Married [Ref.]	1.000	0.000	-	-	-
Widower	0.850	-0.163	0.261	-0.447	0.121
Const	2.025	0.705	0.000	0.324	1.086
Number of Events		1893			
Number of Exposures		2497			
Log-Likelihood		-1294.9			

Figure 1: Percentage Distribution of Cholera Cases by Sex and Age Group. Bologna, 1855 (San Giacomo, Santa Maria Maggiore, San Francesco)



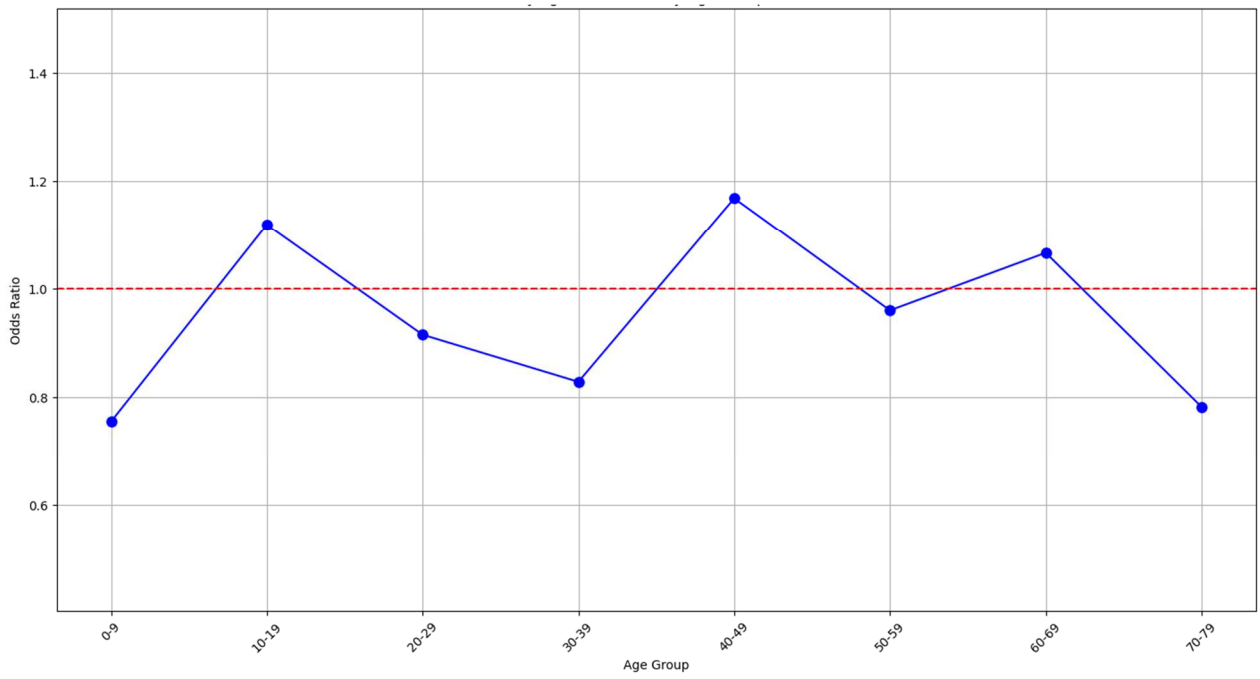
Source: Register of Cholera Cases

Figure 2: Sex ratio of cholera cases. Bologna, 1855 (San Giacomo, Santa Maria Maggiore, San Francesco)



Source: Register of Cholera Cases

Figure 3: Odds Ratios by Dying from Cholera Mortality by Age Group in Bologna, 1855 (San Giacomo, Santa Maria Maggiore, San Francesco)



Source: Register of Cholera Cases

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