The Role of Occupations in the Decline of Pulmonary Tuberculosis. Insights From Amsterdam's Jewish Neighbourhoods, 1856–1909

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The Role of Occupations in the Decline of Pulmonary Tuberculosis

Insights From Amsterdam's Jewish Neighbourhoods, 1856–1909

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ABSTRACT

The decline of pulmonary tuberculosis in the second half of the 19th century was instrumental in shaping long-term shifts in historical mortality patterns and life expectancy. Despite its significance, the underlying determinants of this decline remain a subject of ongoing debate. This study contributes to the discussions about the role of standards of living by examining the impact of occupation on the decline of pulmonary tuberculosis mortality in Amsterdam between 1856 and 1909. It does so through the lens of the city's Jewish neighbourhoods, that, despite facing poverty and overcrowding, exhibited substantially lower tuberculosis mortality rates than the rest of the city, but also experienced a slower decline over time. Using individual-level mortality data from the Amsterdam Causes-of-Death Database and occupational data from marriage certificates, we analyse how shifts in occupational structures following industrialization influenced these trends. Our findings highlight the significant role of labour conditions in shaping historical health disparities and suggest that work environments, alongside nutrition and public health measures, played a pivotal role in shaping and exacerbating intra-urban health disparities.

Keywords: Tuberculosis, Amsterdam, Jewish, Mortality decline, Historical occupation data

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1 INTRODUCTION

Amsterdam underwent a remarkable transformation during the second half of the 19th century. The capital's population doubled, its stagnating economy rebounded, industrialisation went full steam ahead, and mortality dropped dramatically. Economic changes caused overall wellbeing to rise dramatically, reflected in indicators such as stature (Tassenaar, 2019) and real wages (de Zwart, 2023; van Zanden & van Riel, 2004), which rose more sharply in Amsterdam than in the rest of the country. Concurrently, the disease burden of pulmonary tuberculosis and other nutrition-related diseases started falling (Jansen & de Meere, 1982; Lammertink, 2023). Since pulmonary tuberculosis constituted the main cause of death among the adult population (Hardy, 1993), its decline had a significant impact on overall mortality patterns, not only in the Netherlands but across the Western hemisphere (Condran & Cheney, 1982; Mercer, 2014; Puranen, 1991; Rothman, 1994; Zürcher et al., 2016). This trend is particularly striking given that extensive public health interventions — let alone the discovery of truly effective treatments — would not emerge until after the turn of the century, by which time the decline in tuberculosis was already well underway (Hueting & Dressing, 1993).

While this "early decline" in pulmonary tuberculosis mortality has sparked considerable debate, its determinants remain poorly understood. Since the introduction of McKeown's controversial nutritional thesis in 1976, discussions have primarily focused on whether living standards, particularly in terms of diet, played a more significant role in the reduction (or absence thereof) of tuberculosis mortality, or whether medical and public health interventions were the key factors instead (Mackenbach, 2020; Szreter, 1988). More recently, attention has been given to the influence of a combination of factors, including better nutrition, as well as other aspects relating to standards of living such as occupational conditions (Devos, 1996; Greenlees, 2005; Reid & Garrett, 2018). Workplace environments provided plausible settings for increased exposure and maximised opportunities for transmission, particularly if they were crowded and when high levels of dust and humidity provided additional risk factors (Murkens, 2023; van Rossem et al., 2017).

In this study, we shed further light on the possible contribution of occupational composition and labour conditions to patterns of mortality from pulmonary tuberculosis through the lens of Amsterdam's Jewish neighbourhoods between 1856 and 1909. Amsterdam witnessed a substantial reduction in tuberculosis mortality during this period, but this decline did not occur uniformly across the population and was instead marked by significant socioeconomic differences between poorer and wealthier neighbourhoods (Muurling et al., 2026). Moreover, notable variation was observed between the small but important Jewish enclave, comprising roughly 10% of the city's population, and Gentiles: (i) pulmonary tuberculosis rates in Jewish neighbourhoods were much lower but also (ii) saw a slower decline when tuberculosis mortality dropped rapidly among other social groups in Amsterdam. To what extent can the divergent occupational structures of Amsterdam's Jews help explain these peculiar characteristics of their pulmonary tuberculosis mortality? And what are the implications for our understanding of declines in tuberculosis mortality more broadly speaking?

To scrutinise the roles of occupational exposure in shaping observed pulmonary tuberculosis mortality patterns, we will first discuss how, from a historiographical perspective, the case-study of the Amsterdam Jews complicates any attempts to establish a singular explanation for the decline in tuberculosis mortality and a need to consider factors beyond nutrition. Following a section about the sources and methods that we employ, we examine the developments in tuberculosis mortality rates and explore its possible connections with the occupational structures of Jews and Gentiles during the 19th and early 20th centuries. By doing so, we provide further evidence for the role of work environments in shaping the course of the historical decline of pulmonary tuberculosis.

2 TUBERCULOSIS MORTALITY IN AMSTERDAM

In the 19th century, tuberculosis was the main cause of death for the European workforce. Nearly half of all young adult deaths were attributable to tuberculosis. Despite this numeric importance, the historical decline in tuberculosis mortality from the second half of the 19th century onwards remains poorly understood. Most notedly, McKeown (1976) used the process of elimination to contend that falling tuberculosis mortality was explained by increasing wellbeing and improved nutrition. He claimed

that the drop occurred prior to the introduction of vaccinations and other preventive measures. Others have argued for a greater importance of investments in public infrastructure (Mitchell, 1990; Szreter, 1988), the isolation of sick individuals (Fairchild & Oppenheimer, 1998; Wilson, 1990), or a conscious effort to reduce overcrowding (McFarlane, 1989; Zürcher et al., 2016).

In Amsterdam tuberculosis mortality started falling in the final three decades of the 19th century. In line with McKeown's reasoning, tuberculosis declined prior to key medical advancements such as the BCG-vaccination, preventative institutions like sanitoriums, or societies aimed at fighting tuberculosis established after the turn of the century (van der Korst, 1988). In fact, contemporary medical professionals in the Netherlands were still unsure whether tuberculosis was communicable or not in the 1870s (Betz, 1878). At the time tuberculosis mortality started falling, population densities in Amsterdam were on the rise. Since 1870, Amsterdam was characterised by a rapid inflow of domestic immigrants attracted by economic recovery. With delays in the expansion of the city's housing stock, the number of families and persons per house increased significantlyin Amsterdam's inner city between 1869 and 1899 (Laloli, 2007). Declines in overcrowding can therefore hardly explain the fall in tuberculosis mortality in Amsterdam. Meanwhile, the decline of tuberculosis occurred concurrently with significant improvements in wages and male stature (de Zwart, 2023; Tassenaar, 2019), common proxies for nutrition. However, tuberculosis mortality started falling earlier and faster for women, raising doubts about the universality of improving nutrition (Muurling et al., 2026).

An additional counterpoint against nutrition is offered by Amsterdam's Jewish community. As was the case in other cities, Amsterdam Jews had lower mortality rates than non-Jewish Amsterdam residents. This was true for virtually all age groups and for a wide range of diseases (Riswick et al., 2022) including tuberculosis (Boekman, 1936; Sanders, 1918), and was already observed by 19th-century contemporaries (Coronel, 1864a). Although it has been clear that fewer Jews died from tuberculosis — as well as from other causes — throughout 19th-century Europe and the United States (Sawchuk & Herring, 1984), a clear consensus regarding the determinants remains absent. It also appears paradoxical given that Jews in mid-19th-century Amsterdam were generally poorer than the average Amsterdam resident (Wallet, 2017), experienced higher population densities, and worse housing conditions — all believed to worsen tuberculosis mortality. Jews' below-average economic standing problematises attributing their health advantages related to tuberculosis to better nutrition (see also Muurling & Ekamper, 2024, p. 20). Several other commonly cited potential explanations for the overall lower mortality rates among Jews, such as differences in breastfeeding patterns (Israëls, 1862), specific hygienic rituals (Pinkhof, 1908), and more trust and use of medical professionals (Blom & Cahen, 2017; Zaidman-Mauer, 2022), do not seem plausible in the context of pulmonary tuberculosis. Meanwhile, less alcohol abuse (Stephan, 1904) and particularly an occupational structure with less health-affecting careers (Sawchuk et al., 2013) are more worthy of consideration.

Most of the aforementioned factors, including nutritional intake, also fall short when we try to explain the much slower reduction in tuberculosis mortality among Jews. Between 1870 and 1920, the time during which tuberculosis mortality fell the hardest, Jews' gains in socioeconomic resources were larger than among other social groups in the city (Kok, 2025a). They also experienced the starkest improvements in their living conditions, moving from the cramped Jewish Quarter, with the highest population densities in the Dutch capital, to more sanitary newly-built neighbourhoods in Amsterdam East and South (Tammes, 2011). We therefore need to find another factor to explain Jewish-Gentile differences in tuberculosis mortality. To identify this reason, we will focus on conditions of and developments in occupational structures.

3 DATA AND METHODS

To investigate whether occupational structures might have impacted tuberculosis mortality rates we use detailed information on occupations and deaths in Amsterdam. Mortality data for the years 1856–1909 is derived from the Amsterdam Causes-of-death Database (ACD) (Janssens et al., 2023) based on the cause-of-death registers initiated by the city authorities in the early 1850s (Neurdenburg, 1929). In addition to the cause of death, the registers record the residential address of the deceased, the date of death, age, sex, marital status and occupation. The causes of death are coded according to the ICD10h; a joint coding scheme constructed by the SHiP+ network to study mortality dynamics using

individual cause-of-death-data across Europe between 1850 and 1950 in a systematic way (Janssens, 2021; Reid et al. 2024). We focus on respiratory tuberculosis (all codes starting with A16 in the ICD10h). Since the ACD has no direct measure to identify Jews and Gentiles, we use a neighbourhood proxy instead. All deaths occurring to individuals who lived in the Jewish Quarter — comprising the old Jewish Quarter with districts C, P, Q, R, and S, as well as newer districts V and W — are considered Jewish (Bregstein & Bloemgarten, 1978; Kok, 2025a).[1] To standardise comparisons across time, we limit the comparison group to the remaining 43 districts of inner-city Amsterdam, that is, all districts that existed in Amsterdam in 1850 and excluding the city's expansions since 1896. While the mortality rates are calculated based on the total male neighbourhood populations, our further analyses are based on a sample limited to adult men. Roughly 80% of men between the ages of 20 and 60 were recorded with an occupation in the ACD. The high frequency of listed occupations and constancy across age groups and time suggests that the undercounting of male occupations was negligible.

To measure changes in the male occupational structure in Amsterdam, we turn to the LINKS database containing all marriage certificates in Amsterdam from 1811 up to 1932 (Mandemakers et al., 2023). Following Kok (2025b), we adopt a name-based approach to identify Jewish and non-Jewish families on the certificates. This enables us to compare the differential trends in occupational changes between Jewish and Gentile men. To limit second-order marriages, we limit the sample to all men who married between the ages of 18 and 40. We also filter out marriages before 1830 due to greater frequencies of misleading occupational titles. Note that the marriage certificates do not directly tell us the relative size of an industry, but offer a proxy for the relative attractiveness of sectors for young entrants.

In both the ACD and the marriage certificates, each occupational title is given a HISCO-code (van Leeuwen et al., 2002). Additionally, we code each occupation with whether it was performed indoors or outdoors following Rijpma and colleagues (2022). We make this distinction between indoor and outdoor occupations due to assumptions in scholarly literature about its potential effects on exposure and transmission, as well as the mentions of the breathing in of high levels of dust particles in enclosed environments as an important additional risk factor (Greenlees, 2005; Murkens, 2023; Reid & Garrett, 2018).

4 THE LOW BURDEN OF TUBERCULOSIS MORTALITY

For a long time, the endemic nature of tuberculosis did not cause vast, occasional mortality spikes, but instead resulted in a steady death toll that for a long time seemingly raised little public health concern. The development of pulmonary tuberculosis mortality in Amsterdam in census years is presented in Figure 1. It demonstrates the high mortality rates discussed earlier, as well as its decline over time for Amsterdam's entire population. Moreover, the figure reveals the stark differences between the mortality rates from pulmonary tuberculosis in the Jewish Quarter relative to the rest of Amsterdam's historical inner city.[2] First, it shows the lower levels of tuberculosis mortality rates in the Jewish Quarter throughout the second half of 19th century. Especially prior to the 1870s, mortality rates for men in Jewish neighbourhoods were substantially reduced compared to their Gentile counterparts. The dip in 1869 can likely be explained by excess mortality during the 1866 cholera epidemic. Second, it makes apparent that the Jewish neighbourhoods experienced a less steep decline during and following industrialisation. Thus, while Jews died less frequently from tuberculosis in mid-19th-century Amsterdam, their advantage dissipated in the final decades of the century.

There are good reasons to believe that tuberculosis mortality is associated with a locality's occupational distribution. Both industrial production and agricultural work are believed to be strongly correlated to tuberculosis mortality (Devos, 1996; Janssens, 2016; Janssens & van Dongen, 2018; Murkens, 2023; Reid & Garrett, 2018). For men, several occupational groups have been linked to high rates of tuberculosis mortality (Greenlees, 2005). These occupations required workers to spend prolonged periods of time

1 This is the area that in the 19th century was considered 'Jewish' (Bregstein & Bloemgarten, 1978). A discussion of changing Jewish settlement patterns in the late 19th and early 20th century can be found in Chapter 7 of Kok's dissertation (Kok, 2025a).

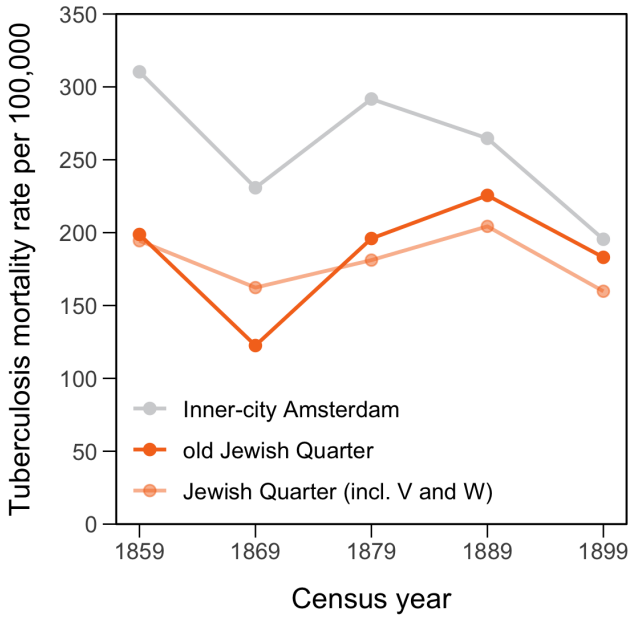
2 Since neighbourhoods V and W had a distinct age structure owing to the presence of multiple *oude-liedenhuizen* (old people's homes), we have chosen to show the Jewish Quarter with and without these neighbourhoods separately.

in areas with increased particle densities in the air and poor ventilation. Think, for instance, of textile workers, but also miners, those involved in leather and tobacco production, ceramic workers, stone masons, metal workers, diamond workers, and typesetters (Bavinck, 1897). In short, industrial labour performed indoors with high densities and lacking air quality. The workplace environment may have also been important among men working in clerical occupations, probably as a result of a combination of increased exposure and greater opportunities for transmission (McIvor, 2012).

Jews in Amsterdam were characterised by an occupational profile that was distinctly different from their Gentile peers. Eighteenth-century guild interference excluded Jews from the guild system and, in turn, closed possibilities to learn skilled trades (Lucassen, 1994). Consequently, few Jews worked in industry even after the guild system was abolished at the end of the 18th century. Important exceptions included the occupational niches in the diamond industry, where both employers and employees were virtually all Jewish by the mid-19th century (Heertje 1936), and a strong Jewish presence in the tobacco industry (Knotter, 1991). In contrast, Jews were heavily overrepresented in all strata of trade, including as peddlers, and frequently employed as unskilled labourers (Tammes, 2012), primarily in the transportation of goods (Kok, 2025a). Until Amsterdam started industrialising in the 1870s, causing the occupational structure of Jews to transform dramatically, Jewish men's occupations can be characterised as generally favourable compared to the rest of the Amsterdam population in terms of tuberculosis mortality hazards.

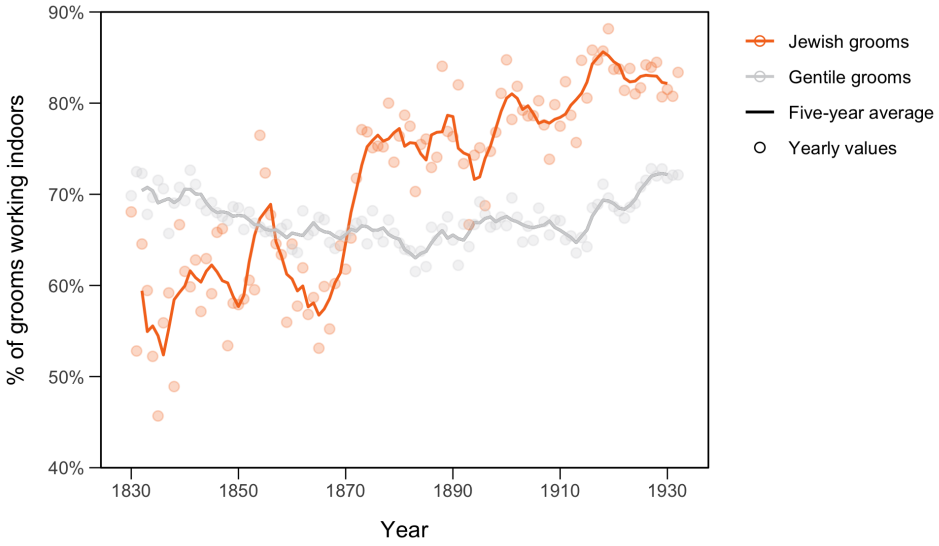
The marital certificates of men who married between the ages of 18 and 40 support this characterisation of the Jewish occupational structure as comparably favourable. As Figure 2 shows, Jews more frequently worked outdoors compared to their non-Jewish counterparts up to 1870. This is explained by much higher rates of unskilled labour, the primary group that worked outside. Moreover, within the category of unskilled labourers, Jews were also more likely to work outside. Unskilled Jews most frequently worked as peddlers, porters, and carters, all occupations that took place in the open air. Between 1850 and 1870, less than 4% of Jewish grooms with unskilled occupations worked in occupational groups that generally laboured inside, compared with 36% of Gentile workers. While these percentages grew more similar during industrialisation, it showcases the potential for better health in the Jewish area due to working in the open air (Stokvis, 1869).

Figure 1 *Total male tuberculosis mortality in the Jewish Quarter and the rest of Amsterdam, 1859–1899*



Note: Since ACD data is incomplete for 1899, deaths are taken from 1898. Mortality rates are lower in 1869 presumably due to an aftershock from excess cholera mortality in 1866. The mortality rates for inner-city Amsterdam exclude the Jewish Quarters.

Figure 2 *Share of Jewish and Gentile grooms working in 'Indoor' occupational groups, Amsterdam 1830–1932*



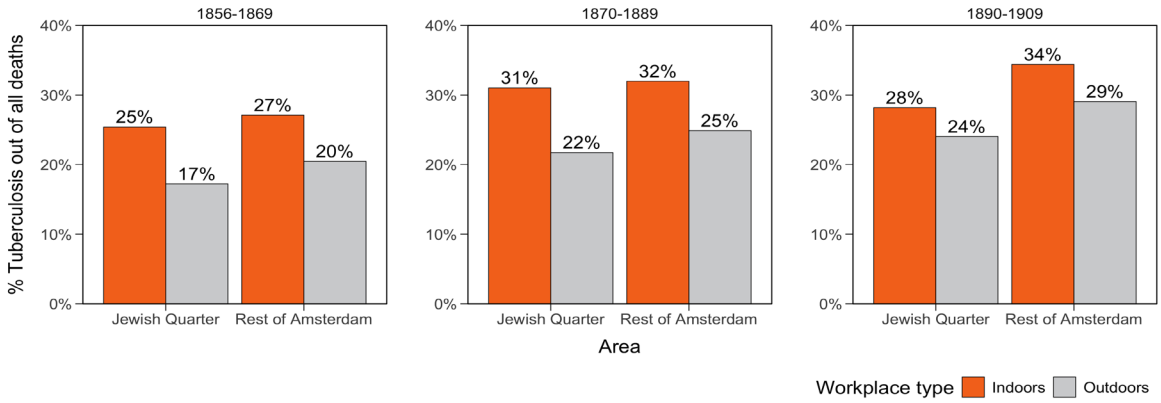
5 THE SLOWER DECLINE OF TUBERCULOSIS MORTALITY

Jews' occupational structure changed completely during Amsterdam's industrialisation. Key in this transformation is the rapid expansion of the diamond industry. Between 1870 and 1890, the diamond industry expanded from 1,500 to 10,000 workers, nearly three-quarters of whom were Jewish (van Tijn, 1976). By the early 20th century, roughly 30% of all working Jewish men were employed in the diamond industry, compared with 2% of non-Jewish men (van Zanten, 1926). Jews who would a decade earlier have started their working lives as carters or porters in the open air now started as diamond polishers and setters in congested factories with subpar ventilation and filled with coal vapour and dust particles from polishing. Tuberculosis was rampant in this industry and the trade was commonly mentioned as one of the worst offenders (e.g. Bavinck, 1897). Louis Heijermans, who spent time as a health inspector in the diamond workers' union and published one of the first books on occupational diseases in the Netherlands (Heijermans, 1908), pointed to the sedentary nature of the work in an enclosed space as particularly fruitful for tuberculosis (Heertje, 1936, pp. 251–252).

During industrialisation, the expansion of unhealthy industries, such as the diamond industry (Coronel, 1864b), became more common, especially among Jews. The transition from unskilled labour in the open air to skilled work in factories and offices likely hampered the decline of Jewish men's tuberculosis mortality relative to that of Gentile men. This is reflected in Figure 2, which shows that Jews underwent more drastic changes in their occupational structure than the non-Jewish population at the same time as industrialisation accelerated. From 1870 onwards, Jews were much more likely to work inside. High wages paid to diamond workers in an industry where Jews had the upper hand was a massive pull for the sons and daughters of unskilled workers (Kok, 2025a). The contents of the labour created adverse conditions for respiratory diseases such as tuberculosis.

The impact of working indoors can clearly be seen in the ACD. Figure 3 contrasts the share of all deaths attributable to respiratory tuberculosis by workplace type for three periods — roughly comprising before, during, and after industrialisation. In each period, and in both the Jewish Quarter and the rest of Amsterdam, individuals working indoors had higher percentages of tuberculosis mortality. During the period of industrialisation — when mortality rates decreased across the entire population but comparatively less so for the Jewish neighbourhoods — the percentage of deaths attributable to pulmonary tuberculosis rose among Jews with "indoor" occupations by 5%. The rest of Amsterdam's population experienced a roughly similar increase in pulmonary tuberculosis deaths, but due to the growing proportion of Jews employed in factories and offices, the impact of this rise in the second period (1870–1889) may have been more pronounced for the Jewish population. It seems plausible that at least part of the slower relative decline of pulmonary tuberculosis mortality during the last decades of the 19th century can be attributed to deteriorating working environments for Jewish men.

Figure 3 *Tuberculosis as percentage of all deaths among men aged 20–59 in- and outside of the Jewish Quarter, Amsterdam 1856–1909*



Note: 1892–1894 and 1899 are excluded due to incomplete data in the ACD.

The relationship between labour conditions and tuberculosis mortality is further underscored by developments in the third period, i.e. between 1890 and 1909. Looking at the development of tuberculosis death shares across the three periods, its overall gradual increase among both workplace types might be construed as indicative of a general change in the epidemiological profile of the city rather than a change in work environments. After all, if fewer people died from now treatable infectious diseases, chances of dying from degenerative and (at that time) non-curable diseases like tuberculosis would theoretically rise. However, the data provides little support for any straightforward "exchange" with pulmonary tuberculosis. As expected based on existing literature (e.g. Lammertink, 2023), a comparison of the compositions of different groups of causes of death in Amsterdam over time (not shown here) reveals a consistent decline in the share of infectious diseases and a corresponding rise in the share of degenerative diseases, with little distinction between indoor and outdoor workers. The pattern for tuberculosis, on the other hand, is more complex. While its share among causes of death increased during the period of industrialisation, it declined among male Jewish indoor workers in the subsequent period (see Panel 3). As a result, mortality differences between indoor and outdoor workers in the Jewish Quarters largely disappeared. The timing of these changes aligns with the introduction of new labour regulation and collective action, such as the Labour Law of 1889 (Swuste et al., 2019), which introduced the Labour Inspection in 1890, and the formation of the diamond workers' union in 1894 (Hofmeester, 2020). Conditions in the factories, especially in the diamond industry, would soon improve through lowered densities, improved ventilation, and the reduction of work hours.

6 CONCLUSION

In this paper we investigated the differential trends in pulmonary tuberculosis mortality in the Jewish and non-Jewish communities of Amsterdam during the mortality transition: (i) the low overall pulmonary tuberculosis mortality rates of the Jewish neighbourhoods compared to the rest of Amsterdam and (ii) the slower reduction in tuberculosis mortality among Jews. Explaining these differences is helpful in solving the larger tuberculosis puzzle, in particular in regard to the larger debates about the impact of different facets of standards of living on the historical tuberculosis decline.

Given the initially backward socioeconomic position of Amsterdam Jews, generally poorer and living in more deprived and dense areas of the city, we focused on their distinct occupational profile and its development over time. Using detailed spatial mortality information on Amsterdam, our results potentially support the hypothesis that differences in tuberculosis mortality between Jews and Gentiles were driven by (a) initial differences in occupations and (b) changing occupational structures during the period of industrialisation. Prior to industrialisation, Jews were much more prone to working outside. When the diamond industry — the premier occupational niche of Amsterdam Jews — expanded during industrialisation, thousands of Jewish workers instead started working in congested and unhealthy factories. Consequently, this transition slowed down their decline in tuberculosis mortality. The fact that Jewish women did not see such a comparative slowdown (not reported here) supports this finding.

The results of this short paper have implications for more general studies of tuberculosis and overall mortality. For one, distinguishing relevant characteristics of occupations — such as working in- or outdoors — can provide key new interpretations regarding mortality differences by social classes. While occupational differences have often been used to argue for mortality differences between urban and rural areas, newly-digitised individual-level mortality data enable further study of these differences within important, large urban localities.

Moreover, differences between Jews and Gentiles merit further studies too. So far, the main focus has been on infant and child mortality and emphasis has been put on Jewish mothers' greater propensities to breastfeed as a key determinant in Jewish children's health advantages. Studying ethno-religious differences in adult mortality, however, can additionally provide a better understanding of which determinants impacted the survival chances of the majority of the (European) workforce. While we by no means contest that nutrition constituted a key driver in the historical decline of tuberculosis mortality, we argue that the modifying effects of other socioeconomic factors, such as labour conditions, should not be overlooked. By advancing the positions of some and hampering the conditions of others, work environments and labour conditions played a pivotal role in shaping and exacerbating intra-urban health disparities.

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