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A Decomposition Approach to Cause-Specific Mortality in the Port City of Antwerp in the Early 20th Century

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ABSTRACT

Building on Janssens' work, which highlights the distinct epidemiological profiles of port cities, this study explores cause-specific mortality in early 20th-century Antwerp, Belgium's largest city and a major international port. Using Arriaga's decomposition method, we compare life expectancy and mortality by cause of death in Antwerp with those in Brussels, Ghent, and Liège, the country's next three largest cities. Despite its status as a bustling port city, Antwerp showed a relative health advantage. However, this advantage masked gender- and age-specific risks. Young adult men experienced elevated mortality from accidents, largely due to hazardous port labor, while women faced excess mortality from childbirth, likely linked to socioeconomic vulnerabilities among working-class and immigrant women. Notably, child mortality from infectious diseases was higher in Antwerp than in the other three cities, reflecting particular public health challenges. These findings highlight the importance of individual-level data to better understand localized mortality and cause-of-death patterns. They also underscore the need for further comparative research within the frameworks of the SHiP and Great Leap networks.

Keywords: Mortality, Historical causes of death, Decomposition method, Port cities, SHiP network, Aggregated data, 20th Century, Belgium

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1 INTRODUCTION

This article builds upon the foundational reflections presented in *Gateways of Disease?* by Angélique Janssens and Evelien Walhout, which explored the distinctive mortality and epidemiological patterns of port cities within the broader context of the SHiP (Studying the History of Health in Port Cities) network (Janssens & Walhout, 2018). Their chapter highlighted how 19th- and early 20th-century European port cities served as dynamic laboratories for demographic and health transitions. These urban centers, characterised by high levels of mobility, global commercial ties, and intense socio-economic transformations, were not only hubs of trade and migration but also centers of disease transmission (Hein & Schubert, 2021; Vögele & Umehara, 2015). The study of Janssens and Walhout showed that in the late 19th century, the two major seaport cities in the Netherlands, Amsterdam and Rotterdam, had the highest rates of infectious diseases among children, but not among adolescents and adults, despite being large and rapidly growing port cities. While adult men in these cities faced a high risk of death from infectious diseases, other cities like Maastricht and 's-Hertogenbosch had even more lethal conditions. Port cities facilitated the spread of disease through high traffic, but nearby inland cities also suffered from similar conditions due to crowding and migration. The western Netherlands, where these two port cities were located, saw earlier declines in mortality rates, linked to better living conditions and the spread of medical knowledge.

Inspired by this conceptual framework and the Dutch results, the present study explores mortality patterns and causes of death in the port city of Antwerp in Belgium in the early 20th century. Antwerp's rapid expansion as a major international seaport and commercial gateway during this period makes it an ideal case to further interrogate the assumptions proposed by Janssens and the SHiP network. By examining aggregated cause-of-death series and employing Arriaga's decomposition method, we aim to delineate the disease environment of Antwerp, Belgium's largest city, and assess the extent to which its mortality and cause-of-death patterns aligned with or diverged from those of the next three largest cities: Brussels, Ghent, and Liège. We pay special attention to gender differences, which is a key focus in Janssens' work (Janssens, 2014; Janssens & Pelzer, 2012). Through the Antwerp case study, we also aim to critically reflect on the methodological challenges and potential of historical individual-level cause-of-death data, a concern raised in the SHiP network's research agenda (Janssens, 2021) and now a central element of the ongoing COST Action Program, The Great Leap.

The article starts with a brief overview of the socioeconomic context of Antwerp and the other three cities. In Section 2, we address our sources, while Section 3 delves into the urban health penalty, analysing life expectancies and age-specific mortality risks for men and women across these cities. We then present, based on Arriaga's decomposition, the findings on the causes of death for men and women, with a particular focus on the patterns unique to the port city of Antwerp. We conclude with some final remarks and suggestions for future research.

2 ANTWERP AT THE TURN OF THE 20TH CENTURY

Antwerp's trajectory during the 19th and early 20th centuries was closely linked to its port. From the 1830s, Antwerp evolved from a modest textile hub to a major international seaport and commercial center, driven by Belgium's industrialisation, advances in shipping technology, and improved transport links. The city's transformation was striking, with its population rising from 50,000 in the early 1800s to 301,766 by 1910, making it Belgium's largest city, largely surpassing Brussels (177,078), Ghent (166,445), and Liège (167,521) (Ghent University Quetelet Center, n.d.). Roughly 10% consisted of international migrants (Puschmann, 2015). By 1850, it was one of north-western Europe's most connected inland ports, strategically serving Belgium, the German Rhineland, the southern Netherlands, and northern France. Regular shipping routes to Rotterdam, London, Hull, and Le Havre supported trade with Britain, France, and the Netherlands, while intercontinental links extended to Rio de Janeiro, New York, Singapore, and other ports. This expansion fostered export industries and local shipbuilding such as the Cockerill shipyard, while the city became a key departure point for emigrants, particularly with the rise of the Red Star Line company which ferried nearly two million emigrants from Antwerp to the United States (Winter, 2009).

The transport and trade sectors thrived in Antwerp, supported by shipbuilding companies, commercial agencies, import and export firms, banks, insurance companies, and transport enterprises, along with cafés and restaurants. The 1910 industrial and trade census reveals that ca. 30% of the male workforce was employed in transport-related jobs (see Table 1). Many men also worked in sales (ca. 16%), while women, though facing more limited employment opportunities, were active in sales and catering (ca. 58%) (see Table 2). Clothing was another large sector for women. Similar patterns were observed in Liège and Brussels, while in Ghent women predominantly worked in the mechanised cotton industry (Van Rossem, 2018). In Liège, men found work in coal mining, steel, and machine-building, while Brussels, where technical innovation was largely absent and industry was smaller-scale, offered jobs in construction, furniture, printing, and the production of luxury and consumer goods. Many also worked in finance and government due to the city's capital status (Ghent University Quetelet Center, n.d.).

This economic boom brought significant social challenges. Antwerp's labour market was polarised, with skilled merchants, international merchants, and specialised artisans alongside unskilled dockers and manual labourers (Greefs & Winter, 2016). Living conditions for the working class had deteriorated throughout the 19th century, characterised by widespread poverty, overcrowding, and inadequate housing (Lis, 1986). According to the special census of habitations in 1910, 10% of households in Antwerp had more than two people per room. Similarly, the percentages were high in Brussels (12%) and Liège (9%), while a much lower proportion was observed in Ghent (4%) (Van Rossem, 2018). In some Antwerp neighbourhoods, particularly near the port, households averaged between 9 and 12 occupants per house (Bertels et al., 2010). Sanitation infrastructure (sewage) lagged. Piped water was introduced in 1881, but the distribution of the water network across the city did not occur until the 1920s (Van Craenenbroeck, 1998).

Table 1 *Occupational structure (%) of men in Brussels, Antwerp, Ghent, and Liège (1910)*

	Antwerp	Brussels	Ghent	Liège
Industry				
Construction	6.6	10.1	10.5	7.9
Metals	6.2	8.6	11.5	30.2
Clothing	2.6	8.1	2.6	3.2
Timber and furniture	5.7	7.9	9.5	6.4
Transport	30.4	6.8	11.2	8.2
Food	5.4	5.4	5.6	4.6
Leather	1.9	5.1	2.3	2.9
Printing	2.1	4.6	2.5	2.0
Art	9.2	3.7	1.4	1.1
Textiles	0.3	1.0	21.7	0.6
Tobacco	1.5	0.4	1.2	0.8
Mining	0.0	0.1	0.1	11.1
Other	1.6	2.1	2.9	2.2
Trade				
Sales	15.9	20.0	12.4	13.6
Catering	4.3	9.4	2.8	3.1
Banking	1.4	3.0	0.5	0.8
Insurance	0.9	1.1	0.4	0.6
Intermediary	3.4	1.0	0.5	0.3
Leisure	0.2	0.3	0.3	0.2
Unclassified				
	0.5	1.4	0.1	0.3

Table 2 *Occupational structure (%) of women in Brussels, Antwerp, Ghent, and Liège (1910)*

	Antwerp	Brussels	Ghent	Liège
Industry				
Clothing	28.5	39.5	21.9	35.1
Textiles	2.5	3.0	43.9	3.6
Leather	0.4	2.6	0.4	0.7
Printing	0.4	2.1	0.3	1.6
Art	2.0	1.1	0.2	0.2
Food	2.5	1.1	0.6	2.0
Timber and furniture	0.3	1.0	0.5	1.0
Metals	0.2	0.9	0.2	4.7
Tobacco	2.3	0.8	0.1	1.8
Transport	1.6	0.4	0.4	0.7
Construction	0.1	0.2	0.1	0.1
Mining	0.0	0.0	0.0	1.4
Other	1.1	2.1	2.1	2.3
Trade				
Sales	35.2	31.4	17.3	35.0
Catering	22.1	11.9	11.7	9.2
Intermediary	0.4	0.3	0.1	0.1
Leisure	0.1	0.2	0.3	0.1
Banking	0.1	0.1	0.0	0.1
Insurance	0.1	0.1	0.0	0.1
Unclassified				
	0.1	1.4	0.0	0.3

Sources: Statistique de la Belgique, 1910, Recensement de l'industrie et du commerce, 31 décembre 1910. *Bruxelles, Ministère de l'Industrie et du Travail. Accessed through Van Rossem (2018) and LOKSTAT (n.d.).*

The changing labour market brought about changing working conditions. Unlike the industrial centers of Liège and Ghent, where labour unions had a strong presence in large factories and helped improve working conditions, Antwerp's port laborers experienced limited unionization before 1914 (Deferme, 2007; Van Rossem, 2018). Although working conditions were harsh, and wages and job security were low (reflecting loose labour), actions remained limited, apart from the general strike in 1907 (Vanfraechem, 2005). This is remarkable, considering the many occupational health hazards associated with working in the port. Dockers, in particular, were vulnerable during the loading and unloading of ships, facing risks such as broken bones, suffocation, drowning, and burns (Van Elsen, 2003).

3 SOURCES, DATA AND METHODS

The reconstruction of mortality risks and life expectancies at the city level for the early 20th century in this article are based on the population census of 1910 and *Le Mouvement de la Population et de l'Etat Civil* (State Archives Belgium, 1908–1912). The decennial population census delivers population numbers by age and sex, while *Le Mouvement* summarises yearly vital events per municipality. Since 1886, cause-of-death data have also been included. They are based on the individual-level cause-of-death registers that Belgian municipalities have been obliged to maintain since 1851. Besides the cause of death, specific data had to be collected with the name of the deceased, surname, sex, occupation, age, marital status, and date and place of death (Velle, 1985). Unfortunately, most of these individual-level municipal registers were destroyed for privacy reasons (Antwerp is a notable exception). The quality of the cause-of-death registers, however, depended on the medical knowledge of the person completing them. In many municipalities, it was common practice for civil servants to fill out the forms, relying on family members or neighbours to provide the cause. In some places, however, a doctor was appointed for the task, and in large cities such as Antwerp, Brussels and Liège, specific physicians were appointed as *médecins vérificateur* (Hacha, forthcoming).

Le Mouvement provides at census years an age-specific classification of causes of death, using six age categories: <1 year, 1–6, 7–14, 15–20, 21–49, 50+. It employs a classification system based on 40 diseases and 10 headings. This system was introduced in 1903, coinciding with the introduction of the first International Classification of Diseases (ICD-1) at the municipal level. Compared to earlier classifications, it was more detailed and paid more attention to degenerative diseases. In other words, while the causes of death in municipal registers were classified according to ICD-1, a separate and less detailed classification scheme was used in *Le Mouvement* for the aggregated municipal data at the national level. In this article, we use the data for 1910 from *Le Mouvement*, as it is the first year for which the cause-specific mortality data based on the new extended nomenclature in 1903 is distinguished by age.

We reclassified the 40 causes of death in *Le Mouvement* into 14 categories. This reclassification is primarily based on the 10 headings in *Le Mouvement*, but we reassigned some diseases for historical purposes. The following disease categories remained unchanged: (1) cardiovascular diseases; (2) diseases related to perinatal conditions (lack of viability of the infant); (3) diseases related to childbirth (mother); (4) respiratory diseases; and (5) urogenital diseases. We separated out several diseases from the original category of general diseases because of their historical importance: (6) pulmonary tuberculosis and (7) cancer were classified as separate categories (see also Reid et al., 2015). Pulmonary tuberculosis was a typical disease of the industrial era, while cancer as a degenerative disease became increasingly important during the epidemiological transition. Tuberculosis of the meninges was reassigned from the category of general diseases to the category of (8) neurological diseases because of its strong link to meningitis. A similar procedure was taken for acute and chronic alcoholism that was placed with the (9) gastrointestinal diseases, due to its relation with liver cirrhosis which was probably also caused by alcohol abuse. The remaining general diseases were classified under the new heading of (10) infectious diseases. We furthermore separated out (11) accidents from the category of (12) violent deaths, because we suppose a relationship with working conditions. This was also the case for (13) enteritis from the gastrointestinal diseases, as it was a prime cause of childhood deaths. Finally, because the category old age was not a well-defined category we included it among the group of (14) other causes of mortality. The so-called doubtful cases were also reassigned from the category of violent deaths to the category other causes. This was also the case for sudden death and unspecified or poorly defined causes of death (previously the separate category of unspecified or poorly defined causes).

4 MORTALITY

4.1 URBAN HEALTH PENALTIES IN THE 19TH CENTURY

In a previous study, we set the stage for a more detailed analysis of mortality in Antwerp by cause of death (Devos & Van Rossem, 2015). In an article in the *Journal of Belgian History*, we showed that in 19th-century Belgium the urban penalty was evident, but not in every city to the same extent. Throughout the 19th century, life expectancies in the four largest cities were consistently lower than the national average, illustrating the common burden of urban living conditions. Yet, Antwerp often fared better than its peers, especially Brussels. In 1846, life expectancy at birth in Antwerp stood at 37.3 years, close to the Belgian average (37.8 years). After a significant drop in life expectancy due to a cholera epidemic in 1866, Antwerp rebounded quickly, surpassing cities like Ghent and Brussels in life expectancy. By 1900, life expectancy in Antwerp had risen to nearly 43 years (Belgium), exceeding that of Ghent (41 years) and Brussels (39 years), but below Liège (45 years). These numbers reflect not just the general decline in mortality in Belgium (Devos, 2006), but also Antwerp's comparatively favourable health outcomes (Devos & Van Rossem, 2015).

4.2 MALE AND FEMALE LIFE EXPECTANCY IN ANTWERP IN THE EARLY 20TH CENTURY

To get better insight into the determinants of the Antwerp health advantage and the particularity of the cause-of-death profile of the port city, we here examine men and women separately. We calculated life tables over five years for the period 1908–1912 to smooth out possible short-term fluctuations. Comparing the four cities in 1908–1912, we see in Table 3 that the male life expectancy was highest in Liège (45.7 years), closely followed by Antwerp (45.5 years) and then Ghent (43.6 years). In the capital however it was over seven years lower, with only 38.1 years. For the Antwerp women the figures were the highest with 52.2 years, compared to 50.6 years in Liège, 48.4 in Ghent and only 43.8 years in Brussels.

Table 3 clearly shows that urban penalties affected men and women in each city differently. Although life expectancy in Antwerp was comparatively high, gender differences were also the highest here. In 1910 we observe a gap of no less than 6.7 years between the life span of men and women, compared to 4 years in the rest of Belgium, nearly 5 years in Ghent and Liège, and ca. 5.6 years in Brussels. The age-specific mortality probabilities of dying for males and females (see Table A1 in the Appendix) highlight that Antwerp outperforms the other cities at most ages, except for children below age 5 in Liège. At working ages, however, Ghent exhibits the lowest risks of dying.

Table 3 *Male and female life expectancy at birth in Antwerp compared to Brussels, Ghent and Liège (1908–1912)*

	Men	Women
e0 Antwerp	45.5 years	52.2 years
Difference with Brussels	+7.4	+8.5
Difference with Ghent	+1.9	+3.8
Difference with Liège	-0.2	+1.5
Difference with Belgium	-3.4	-0.5

Figure 1 *Sex ratio (male to female) of probabilities of dying (nQx) in Antwerp, Brussels, Ghent and Liège (1908–1912)*

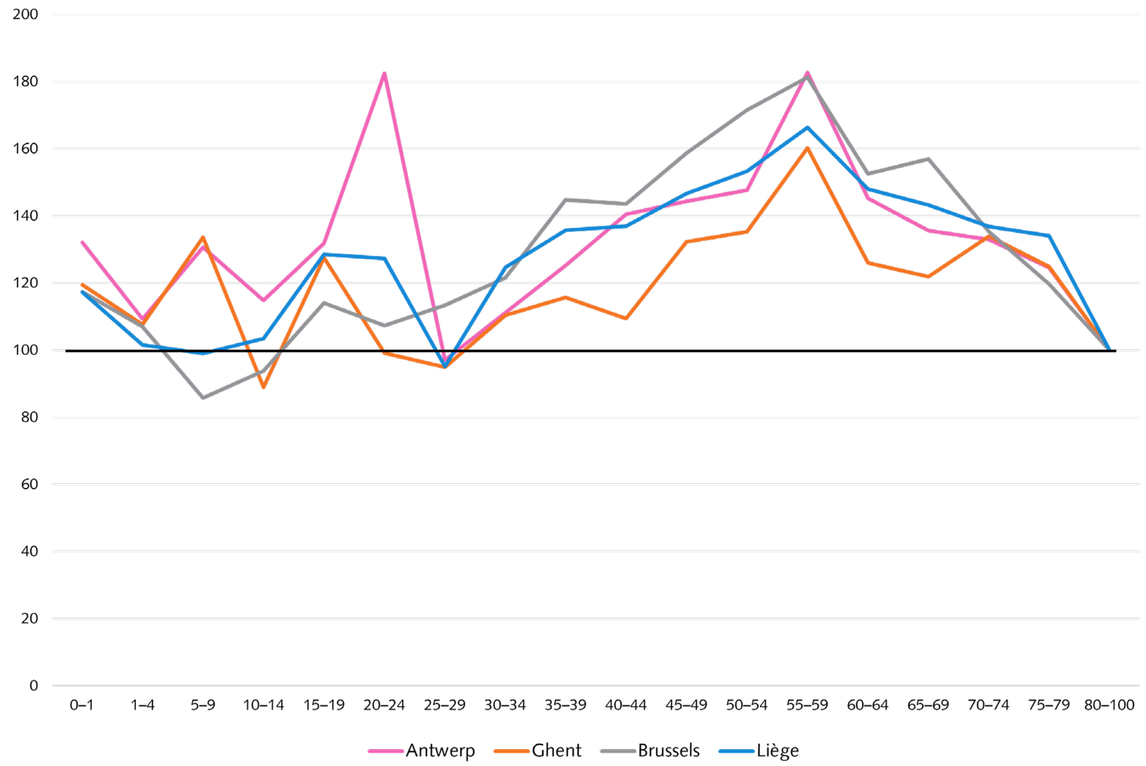


Figure 1 with the sex ratio of the age-specific mortality risks (male to female) shows in fact that urban hazards in Antwerp were particularly severe for adult males, especially at ages 20–24. In an earlier study, we suggested that employment conditions are to blame and pointed to the specificity of the urban labour market and its associated health hazards (Devos & Van Rossem, 2015). We suggested that men's disadvantages in Antwerp can be linked to the working conditions in the port. Research has shown that the transformation of Antwerp into a booming international port center had fundamental implications for employment opportunities. Antwerp's labour market was heavily segmented according to gender, age, and origin. Most of the emerging employment in the port and trading sectors was taken up by single men. The men found their way to hazardous occupations, such as loading and unloading ships, which demanded physical strength and endurance (Greefs & Winter, 2020; Van Elsen, 2003; Winter, 2009). It is therefore necessary to examine whether these workplace hazards are reflected in the cause-of-death pattern.

5 CAUSES OF DEATH

To unravel the determinants of the Antwerp health advantage, we first examine the underlying causes of death, and then compare its cause-of-death profile with that of the other three cities, using Arriaga's decomposition method. We focus on the year 1910, as *Le Mouvement* only provides age-specific cause-of-death data at census years.

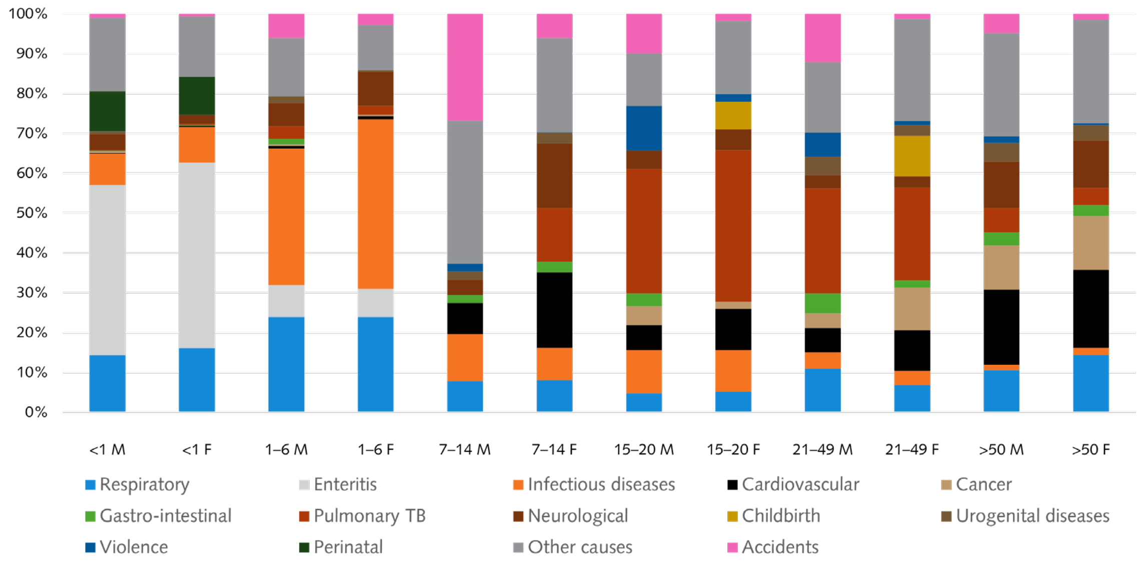
5.1 CAUSE-OF-DEATH PATTERN OF MEN AND WOMEN IN ANTWERP

Figure 2 shows the deaths of men and women by age group and cause of death category. Although a significant portion of deaths, approximately 11% to 35%, lacks a clearly assigned medical cause, several important conclusions can be drawn. Enteritis (diarrhoeal disease) is the leading cause of death for infants, accounting for more than 40% of infant deaths. Excluding other causes of death, the second most important category is respiratory diseases, which account for 15%. For young children, infectious diseases are the most predominant cause of death, explaining 34% and 42% of male and female deaths, respectively. The second most important category for this group is respiratory diseases, which account for about 24%. For children aged 7 and older, the cause of death profile becomes more gendered. Boys are notably more vulnerable to accidents, which account for 27% of their deaths, while girls are more likely to die from heart diseases (18%), neurological diseases (e.g. meningitis) (16%), or pulmonary tuberculosis (13%). Among adolescents and young adults, pulmonary tuberculosis is the leading cause of death, with approximately one in three adolescents and one in four young adults dying from it. Additionally, maternal mortality for women and violent or accidental deaths for men are significant causes of death in these age groups. The high proportion of young adult females dying from degenerative diseases, specifically cardiovascular diseases (10%) and cancer (10%), is striking in comparison to men, where these causes account for 6% and 4%, respectively. For adults aged 50 years and older, cardiovascular diseases occupy the top spot, responsible for 19% of deaths in both men and women. Cancer (12%), neurological diseases (11%), and respiratory diseases, particularly among women (14%), are the other most significant causes of death in Antwerp. For adults aged 50 years or older, cardiovascular diseases occupy the top spot, responsible for 19% of deaths in both men and women. Cancer (12%), neurological diseases (11%), and respiratory diseases — particularly among women (14%) — are the other most significant causes of death in Antwerp.

5.2 CAUSE-SPECIFIC CONTRIBUTIONS TO MALE AND FEMALE LIFE EXPECTANCY

Now that we have established the main causes of death for men, women, and children in Antwerp, it is important to compare these results with those of Brussels, Ghent, and Liège in order to detect any particularities in the cause-of-death patterns of a port city like Antwerp. This comparison will provide insights into which (lethal) diseases were relatively less common in Antwerp and may help explain the city's health advantage or, conversely, reveal conditions that were masked by this advantage.

Figure 2 *Causes of death (% of total deaths) by sex and age group, Antwerp (1910)*



We use Arriaga's decomposition method to break down the male and female life expectancy difference between Antwerp and the three selected cities into cause-of-death-specific components (Arriaga, 1984). While the more analytically precise decomposition method by Pollard generally yields similar results, Arriaga's method is conceptually simpler and easier to apply using traditional life table data (Auger et al., 2014). The method generates components that reflect how much of the difference in life expectancy, by age group, can be attributed to specific causes of death. The age-specific calculation considers that part of the difference is due to age-specific mortality rates in the compared populations (direct effect), while another part can be attributed to variations in survivor proportions arising from different mortality rates (indirect effect). The direct and indirect effects focus on mortality differences within a single age group. However, the calculation also considers that a small part of the difference is due to interaction effects, as a distinct number of survivors experience changed death rates at older ages. The proportions of deaths due to certain causes within specific age groups are used to calculate the contributions of these causes to the life expectancy gap. In our analysis, a positive component indicates lower mortality from a particular cause of death in Antwerp compared to the other cities. A negative component reflects higher cause-specific mortality in Antwerp. The method allows for the distinct consideration of contributions from competing causes of death within the same age group, which may cancel each other out.

Figures 3 and 4 (details in the Appendix Table A2) show the contributions of various causes of death to the life expectancy gap in Antwerp for both men and women. To avoid overburdening the text with graphs, we opt to compare Antwerp with the three cities combined (unweighted average). The figures indicate positive contributions from most causes of death, suggesting lower survival rates in Antwerp. However, there are negative contributions from accidents for adult men (-0.15 years for ages 21–49 and -0.11 years for ages 50+), and from childbirth for women (0.11 years for ages 21–49). The excess mortality from accidents among adult males in Antwerp is likely due to the concentration of male workers in hazardous port-related occupations. Unlike in the industrial city of Ghent, where labor organizations had succeeded in advocating for safer working conditions. The higher mortality rate among Antwerp women due to childbirth may reflect the vulnerability of the increasing number of single immigrant women in the port city (Greefs & Winter, 2016). Infectious diseases contributed significantly to mortality among infants and young children (-0.25 to -0.28 years for male and female infants, and -0.59 to -0.89 years for male and female children aged 1–6). While diseases such as enteritis and perinatal conditions in infants, and respiratory and neurological disorders affected children in Antwerp less than in other cities, it is crucial to note that infectious diseases show the opposite trend: more children in Antwerp die from infectious diseases compared to those in the other three cities. This may suggest a differential impact of certain determinants (e.g., water infrastructure, childcare, crowding) in these cities. However, it is important to highlight the contribution of 'other diseases', which were notably much higher in the other cities. This could be related to the more cautious registration practices by the Antwerp health service compared to those in the other cities (Hacha, forthcoming), where some (infectious) causes may have been misclassified under the wrong heading or left unidentified during the registration and the disease categorisation process (Alter & Carmichael, 1999; Janssens & Devos, 2022; Reid et al., 2015). Unfortunately, the aggregated cause-of-death categories in *Le Mouvement* do not allow for much reclassification and a more detailed analysis. To improve this, individual-level data are needed.

Figure 3 *Cause-specific contributions by age group to the difference in life expectancy between Antwerp and the other cities (1910): men*

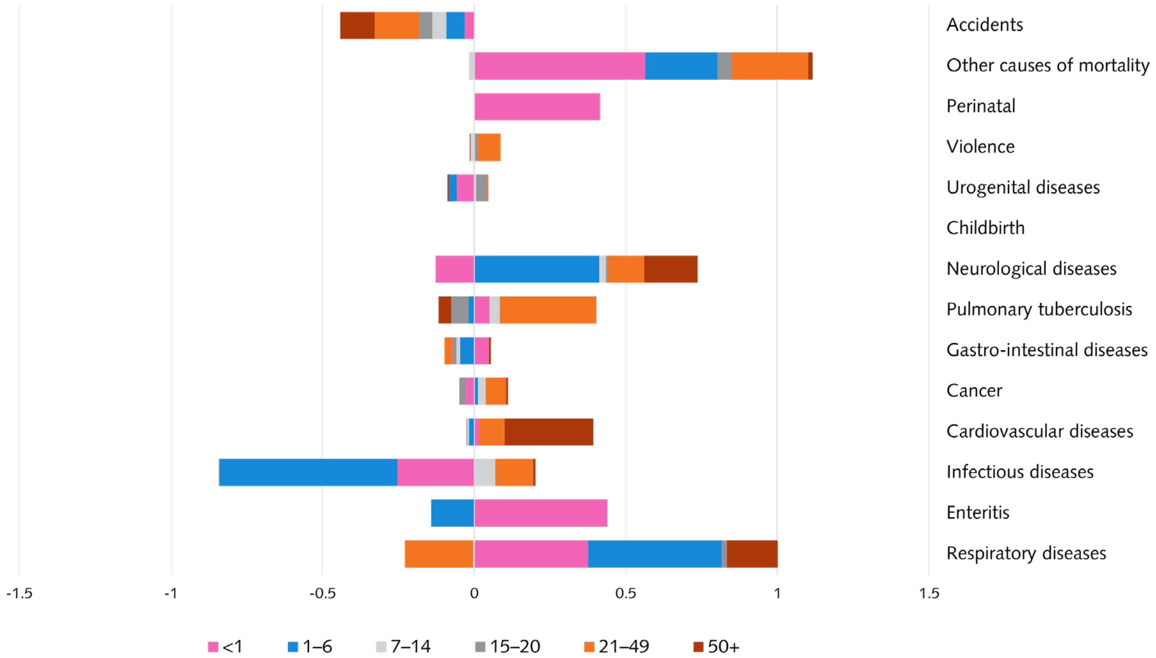
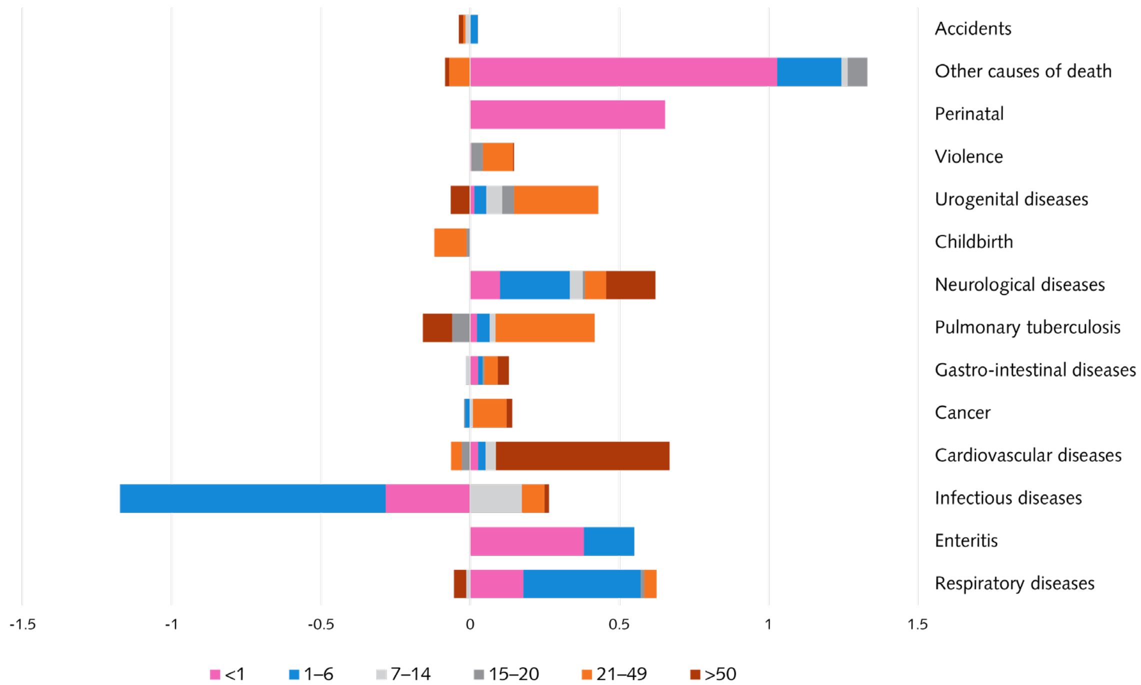


Figure 4 *Cause-specific contributions by age group to the difference in life expectancy between Antwerp and the other cities (1910): women*



6 CONCLUSIONS

In this article, we have explored cause-specific mortality patterns in early 20th-century Antwerp, focusing on how they compare to those of Brussels, Ghent, and Liège, and how these findings fit within the conceptual framework proposed by Janssens and the SHiP network. The results provide several important insights into the distinct health environment of Antwerp as a major international port city.

Contrary to the common assumption that port cities are characterised by higher mortality risks due to high mobility, trade, and dense populations, Antwerp exhibited a comparative health advantage. Life expectancy in early 20th-century Antwerp was the second highest among Belgium's four largest cities for men (45.5 years) and the highest for women (52.2 years). However, our decomposition approach revealed that this health advantage masks important gendered and age-specific vulnerabilities. Specifically, men in Antwerp experienced higher mortality from accidents in working-age groups, which can be directly linked to the city's occupational structure, particularly its reliance on physically hazardous port labour. While women had higher overall life expectancy, they faced some excess mortality during childbirth, likely reflecting the socioeconomic vulnerabilities of working-class women in Antwerp, many of whom were unmarried migrants. Another key finding relates to childhood mortality. Despite Antwerp's relatively high life expectancy, the city saw significant excess mortality in children due to infectious diseases, a trend consistent with the findings in the Dutch port cities Amsterdam and Rotterdam examined by Janssens and Walhout. However, we should be wary of incorrect disease categorisations, considering the limited medical knowledge at the time. The category of ‘other diseases' was notably higher in the three other cities, which may have encompassed a range of (infectious) diseases that were either misclassified or unidentified.

Overall, these results reinforce Janssens' argument that port cities were rather unique socio-spatial contexts in which specific risks and protections coexisted. This aligns with SHiP's focus on the social ecology of port cities, where mobility and labour dynamics intersect with gender in shaping health risks. Antwerp serves as an example of a booming port city navigating the epidemiological transition, yet still constrained by the occupational and gendered hazards embedded in its urban and economic structure.

Still, in interpreting the findings, it is important to acknowledge the limitations in our data. First, the cause-of-death data are based on a snapshot from 1910. While this offers useful information on mortality patterns, a more comprehensive analysis over a longer period is essential to draw more definitive conclusions. Second, the aggregated nature of the cause-of-death records in this study may obscure the episodic, often seasonal, nature of specific infectious diseases.

To better understand how port cities like Antwerp managed, or failed to manage, such diseases, future research should use individual-level cause-of-death data. Antwerp is unique in Belgium for having preserved a long cause-of-death register (1820–1946), presenting a promising opportunity for more granular investigations. The ongoing large-scale citizen science project SOS Antwerpen (www.sosantwerpen.be) is working to make these individual-level records more accessible. Inspired by earlier work on Amsterdam led by Angélique Janssens, this initiative holds great potential for improving our understanding of how port cities adapted to the burden of infectious diseases over time (Devos & Janssens, 2017; Devos et al., 2023). Further research into different time periods and additional cities will be crucial in determining whether the epidemiological trajectories observed in Antwerp, Amsterdam, and Rotterdam are representative of 19th- and early 20th-century port cities more broadly. Ultimately, detailed and comparative individual-level studies like these are essential for validating and deepening the conclusions drawn from aggregated analyses such as this one.

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APPENDIX

Table A1 *Age-specific probabilities of dying (nQx) in Antwerp and the three other cities (1908–1912): men and women*

Males (nQx)	Antwerp	Ghent	Brussels	Liège	Ghent/ Antwerp	Brussels/ Antwerp	Liège/ Antwerp
0–1	0.18	0.24	0.23	0.16	130	128	86
1–4	0.08	0.08	0.11	0.07	101	136	89
5–9	0.02	0.02	0.02	0.02	101	111	103
10–14	0.01	0.01	0.01	0.01	94	155	123
15–19	0.02	0.02	0.02	0.02	91	116	105
20–24	0.03	0.02	0.03	0.03	65	102	99
25–29	0.02	0.02	0.04	0.03	89	173	117
30–34	0.03	0.03	0.04	0.04	89	156	128
35–39	0.04	0.03	0.06	0.04	76	155	109
40–44	0.05	0.04	0.07	0.06	82	151	117
45–49	0.06	0.06	0.10	0.08	90	161	126
50–54	0.09	0.08	0.13	0.11	89	145	116
55–59	0.14	0.12	0.18	0.15	86	127	112
60–64	0.18	0.16	0.22	0.21	89	124	117
65–69	0.24	0.25	0.33	0.29	104	135	120
70–74	0.35	0.36	0.41	0.42	104	116	119
75–79	0.50	0.52	0.51	0.59	103	101	117
80–100	1.00	1.00	1.00	1.00	100	100	100

Females (nQx)	Antwerp	Ghent	Brussels	Liège	Ghent/ Antwerp	Brussels/ Antwerp	Liège/ Antwerp
0–1	0.138	0.199	0.200	0.133	143	144	96
1–5	0.076	0.077	0.105	0.073	102	139	96
5–10	0.013	0.013	0.021	0.017	99	169	136
10–15	0.008	0.010	0.015	0.011	121	189	137
15–20	0.015	0.014	0.020	0.016	94	134	108
20–25	0.016	0.019	0.027	0.022	120	173	142
25–30	0.022	0.020	0.033	0.027	91	148	120
30–35	0.026	0.023	0.037	0.029	89	143	114
35–40	0.031	0.025	0.041	0.031	82	134	101
40–45	0.034	0.035	0.050	0.040	105	147	120
45–50	0.043	0.042	0.063	0.054	98	146	124
50–55	0.062	0.060	0.077	0.069	97	125	112
55–60	0.076	0.074	0.097	0.093	98	128	123
60–65	0.125	0.128	0.147	0.143	103	118	115
65–70	0.179	0.208	0.208	0.203	116	116	113
70–75	0.264	0.272	0.301	0.304	103	114	115
75–80	0.404	0.414	0.427	0.440	102	106	109
80–100	1.000	1.000	1.000	1.000	100	100	100

Table A2 *Cause-specific contributions by age group to the difference in life expectancy between Antwerp and the three other cities (1910): men and women*

	Accidents	**Cancer**	**CVD**	**Gastro.**	**Enteritis**	**Infectious**	**Respir.**	**Pulm. TB**	**Neuro.**	**Urogen.**	**Childbirth**	**Perinatal**	**Violence**	**Other**
Men <1	-0.03	0.00	0.02	0.05	0.44	-0.25	0.38	0.05	-0.13	-0.06		0.41	0.00	0.56
1–6	-0.06	0.00	-0.02	-0.05	-0.14	-0.59	0.44	-0.02	0.41	-0.02		0.00	0.00	0.24
7–14	-0.05	0.00	-0.01	-0.01	0.00	0.07	0.00	0.03	0.02	0.01		0.00	-0.01	-0.02
15–20	-0.04	0.00	0.00	-0.01	0.00	0.00	0.02	-0.06	0.01	0.04		0.00	0.01	0.05
21–49	-0.15	0.00	0.08	-0.03	0.00	0.12	-0.23	0.32	0.12	0.00		0.00	0.07	0.25
50+	-0.11	0.00	0.29	0.01	0.00	0.01	0.17	-0.04	0.18	-0.01		0.00	0.00	0.01
Women <1	0.00	0.00	0.03	0.03	0.38	-0.28	0.18	0.02	0.10	0.01	0.00	0.65	0.00	1.03
1–6	0.03	-0.02	0.02	0.01	0.17	-0.89	0.39	0.04	0.23	0.04	0.00	0.00	0.00	0.21
7–14	-0.01	0.01	0.04	-0.01	0.00	0.17	-0.01	0.02	0.04	0.05	0.00	0.00	0.00	0.02
15–20	0.00	0.00	-0.03	0.01	0.00	0.00	0.01	-0.06	0.01	0.04	-0.01	0.00	0.04	0.07
21–49	-0.01	0.11	-0.04	0.05	0.00	0.08	0.04	0.33	0.07	0.28	-0.11	0.00	0.10	-0.07
50+	-0.01	0.02	0.58	0.04	0.00	0.01	-0.04	-0.10	0.17	-0.07	0.00	0.00	0.00	-0.01