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# The de jure/de facto enigma. The impact of unregistered attendees and absentees in nineteenth and early twentieth century Belgium on urban mortality figures

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## *Abstract*

*Because people do not always reside in the municipality where they are registered, there are important differences between the de jure population, i.e. the legal population of a territorial area, and the de facto or the actual population living in the area. This discrepancy causes difficulties determining the correct population at risk for the construction of demographic measures. Nineteenth and twentieth century mortality figures for local populations in Belgium for instance can be distorted because of the de jure notation of the population and the de facto notation of deaths in the original sources. In this article we develop a method to determine the bias of unregistered numbers of (temporarily) absent and present people on nineteenth century mortality figures. We use data on the de facto and de jure deaths to estimate the amount of unregistered attendees and absentees in Belgian municipalities. By applying this estimation method to the mortality figures of the four largest Belgian cities around 1900, we demonstrate the need to control for these numbers for the interpretation of mortality figures, and especially for the comparison of mortality figures of different areas.*

***Keywords:*** unregistered migration, mortality, historical sources, Brussels

## I. Introduction

When reconstructing life expectancies and age-specific mortality estimates, demographers are confronted with a bias from unregistered migration movements. The frequent misreporting or non-reporting of temporarily attendees and absentees can lead to an over- or underestimation of the correct population at risk, which causes in turn errors in the calculated mortality rates of territorial areas and their relative health risks (Ocaña-Riola et al., 2009; Alter, Devos and Kvetko, 2009). Besides illegal migration movements, especially short-term movements complicate the notation and calculation of the correct population at risk (Skeldon, 1987). Students, soldiers, prisoners and hospitalized people, for example, belong for certain weeks or months to the actual population of one municipality while they are registered as legal inhabitants of another municipality. And also the very short-time movements of commuting imply that some workers are exposed to health risks in another municipality than the one where they reside. As such, there can be large differences between the de facto population, i.e. the actual population present at a certain moment in time, and the de jure population, i.e. the legal population of registered inhabitants regardless whether they are present or not. The complexity of this difference for the calculation and comparison of demographic measures is noted for contemporary populations of developed and developing countries (e.g. Ocaña-Riola et al., 2009; Skeldon, 1987; Van Hook and Bean, 1998) as well as for historical populations (e.g. Eggerickx and Debuisson, 1990; Thorvaldsen, 2006).

To reconstruct the mortality estimates of the Belgian population during the nineteenth century researchers make use of data on population size and composition referring to the de jure population and data on vital events referring to the de facto population. This implies that the population data include people listed in the population registers who were not present in the municipality at the time of the census and exclude people who were present in the municipality without being registered. In contrast, the mortality data include people who died in a particular municipality without being registered as living there and exclude registered people who died elsewhere. As such, mortality rates are overestimated in areas with many unregistered attendees and underestimated in areas with many unregistered absentees. In this article we develop a method to determine the bias of these unregistered movements on mortality rates of local populations in Belgium at the turn of the twentieth century. The rich Belgian sources contain in fact unique data on the de facto and de jure deaths that can be used to estimate the number of unregistered attendees and absentees. Although it is designated to correct the mortality figures of rural as well as urban populations, the method we develop in this article is particularly based on the experiences of citizens. Since most people moved towards or from cities, the possible bias is largest for the mortality figures of urban populations. We prove the utility of the method by applying it to the interpretation and comparison of the demographic measures of the four largest Belgian cities. We focus on the Belgian capital of Brussels in particular, to determine whether the noted surplus mortality around 1900 (see Eggerickx and Debuisson, 1990) can be the result of unregistered movements. As capital city, Brussels attracted indeed many (unregistered) migrants, commuting workers and servants.

## II. Belgian population and mortality data

Belgian researchers usually consult two comprehensive sources to reconstruct mortality figures for large Belgian municipalities and cities from 1886 onwards. Age-specific population data of the de jure population are derived from the population censuses, while age-specific mortality data on de facto deaths are collected through *Le Mouvement de la Population et de l'Etat Civil.*

### *Population censuses*

The first Belgian population census was conducted in 1846[1]. It was organised by the Ministry of Interior and Public Education, while the actual count and processing of the data was entrusted to the municipal authorities. A new edition followed each approximately 10 years, and from the volume of 1866 onwards the population numbers referred to the legal instead of the actual population (Preneel, 2010). The censuses contain a lot of information on the characteristics of the population of the different Belgian municipalities, such as place of birth and spoken languages. Age-specific population figures were published for all municipalities with 10,000 inhabitants or more.

### *Le Mouvement de la Population et de l'Etat Civil*

From 1886 onward, the Belgian central government published comprehensive and age-specific mortality statistics for all Belgian municipalities in *Le Mouvement de la Population et de l'Etat Civil*[2]. The first edition of *Le Mouvement* dates back to 1841, but this central register of vital events was only kept up to date since the 1880s. It provided until 1976 a comprehensive basis on natality, mortality, migration and nuptiality for each of the 2,583 municipalities, the 41 districts and the 9 provinces in Belgium. The information in the

[1] Statistique de la Belgique, *Population. Recensement général du 15 Octobre 1846.* Bruxelles: Ministère de l'Intérieur.

[2] National Archives in Brussels, *Statistiques du Mouvement de la Population et de l'Etat Civil 1841-1976.*

*Mouvement* was derived from the local population and civil registers, of which the municipal government had to make a yearly summary on pre-printed forms (Preneel, 2010).

The registers of *Le Mouvement* are divided into eight '*cadres*', each delivering different information on the vital events of the local populations in a certain year. Data on general deaths (non cause-specific) were written down in four of the eight cadres. Besides information on the age composition of the de facto deaths, they contain information on the total number of the de jure deaths and the number of registered inhabitants who died inside and outside the municipality. Our estimation method is primarily based on these data, because they offer a unique clue on the number of unregistered attendees and absentees in the different Belgian municipalities.

## III. Estimation method of mortality rates of the de facto population

***Estimation of the de facto population***

Because of unregistered movements, there is a discrepancy between the de facto deaths included in the nominator and the de jure population at risk included in the denominator of the mortality rates. We therefore develop an estimation method to reconstruct the age-specific mortality rates of the de facto population. When sex-specific mortality data are available, it is designated to calculate the estimated value and age distribution of the de facto population separately for males and females. We start from the following data:

P(dj): the total number of the de jure population;
D(df): the total number of de facto deaths;
D(dj) : the total number of de jure deaths;
D(R, I) : the number of people who were registered in the studied city and died there;
D(R, O): the number of people who were registered in the studied city but died elsewhere;
D(U, I): the number of deaths of people who were registered elsewhere but died in the studied city.

All values except D(U,I) are directly derived from the population census or *Le Mouvement.* D(U, I) is calculated as the difference between the total number of de facto deaths D(df) and the number of registered people that died in the city D(R,I).

We use these data to estimate the age distribution of the de facto population and to correct the mortality figures. Both the age distribution and the total number of the male and female de facto population have to be estimated, because no general source includes this type of data. To calculate the total number of actual inhabitants (de facto) of a city the total number of legal inhabitants (de jure) needs to be reduced with the number of registered people who resided elsewhere and augmented with the number of unregistered people who did reside in the city. Hence, the following equation should be true:

$$P(df) = P(dj) - P(R,O) + P(U,I) \quad (\mathbf{1})$$

Where
P(df) is the total number of the de facto population;
P(R, O) is the number of people who were registered in the studied city but were staying elsewhere; and
P(U, I) is the number of people who were registered elsewhere but were living in the studied city.

The value of P(dj) is known through the population censuses, but the values of P(R, O) and P(U, I) need to be estimated. In order to calculate these numbers, we assume that unregistered attendees and residents experienced similar mortality risks. The differential mortality of citizens and immigrants has been the subject of discussion. Some scholars state that rural migrants had higher mortality risks due to their lower disease immunities when arriving in an urban setting (e.g. Lee, 1997). Also, the presence of institutions such as hospitals and orphanages attracted probably many vulnerable people with higher mortality risks.  Research for Belgium on the industrial areas of Liège, Verviers and Limburg by Oris and Alter (Oris & Alter, 2001; Alter & Oris, 2005) on the other hand has revealed health advantages of rural adult migrants, as a result of selection effects as well as positive health effects from their rural childhood environment. Rural migrants experienced only higher mortality levels in epidemic years because they lacked defences against a variety of epidemic diseases as well as certain social skills, for example to get access to healthy water. Citizens and migrants from urban origins experienced quite similar mortality risks in urban environments. Unfortunately, the Belgian sources do not allow disentangling whether the group of (deceased) unregistered attendees in cities was mainly composed out of rural or urban migrants, young or old people, labour migrants, sick people who were to be hospitalized, etcetera. As such, we assume that the health advantage of young labour migrants and the disadvantage of institutionalised persons resulted in similar mortality risks for unregistered attendees and citizens.

If the mortality risks of unregistered attendees and residents were indeed equal, ratio's 2 and 3 should be each other's equivalent, which enables us to calculate the unknown values of P(R,O) and P(U, I) and to estimate the value of the total number of the de facto population in a certain city:

$$\frac{D(R,O)}{D(dj)} = \frac{\boldsymbol{P(R,O)}}{P(dj)} \quad \mathbf{(2)}$$

&

$$\frac{D(U,I)}{D(dj)} = \frac{\boldsymbol{P(U,I)}}{P(dj)} \quad \mathbf{(3)}$$

The notation of the number of deaths of registered people according to their place of death in *Le Mouvement*, i.e. D(R, I) and D(R,O), offers thus the opportunity to estimate the number of people who were not staying in the municipality where they were registered. As such, we can calculate the estimated de facto population in a certain municipality or city.

If equations (2) and (3) are equal, these are also true:

$$\frac{D(R,O)}{D(df)} = \frac{P(R,O)}{P(df)} \quad \mathbf{(4)}$$

&

$$\frac{D(U,I)}{D(df)} = \frac{P(U,I)}{P(df)} \quad (\mathbf{5})$$

&

$$\frac{D(U,I)}{D(R,O)} = \frac{P(U,I)}{P(R,O)} \quad (\mathbf{6})$$

***Age distribution of the de facto population***

The next step is to calculate the age distribution of the estimated values of the male and female de facto population. We use the following age categories to construct abridged life tables: [0 < 1; [1 < 5; [5 < 10; [10 < 15; …. ; [80 < 85; [85 < 90; [90+. We keep the age distribution of the de jure population as noted in the population censuses and add (or subtract) to this value in each age group a part of the difference between the estimated de facto and de jure population, i.e. the difference between the number of unregistered attendees and absentees[3]. As today, the age distribution of (registered) immigrants resembled in most urban environments probably an inverse U-curve, because of the large number of young adults moving for employment opportunities. Also, the number of immigrants was usually much higher than the number of emigrants in cities. As such, we add a larger part of the difference between the de facto and de jure population to the age groups of young children and adults[4]. In this article, we assume in fact that 60% of the difference was due to movements of people aged between 15 and 45 years. 60% of the difference of the de facto and de jure population is thus added to the six age groups between 15 and 45 according to the respective proportions of the de jure population of adults in these age groups. The other part of the difference is added to the remaining fourteen age groups according to the respective proportions of the de jure population of these age groups in the fourteen categories. Finally, by dividing the number of de facto deaths in each age group through the estimated number of the de facto population in these age groups, we obtain age-specific mortality estimates of the de facto population.

Unfortunately, there are no comprehensive data available upon the age distribution of (unregistered) attendees and absentees with which we can refine the above-mentioned assumption. We tested the impact of the distribution of various proportions to alternating adult age groups on the ultimate age distribution of the difference, and these showed that a proportion of 60% in the age groups of 15 to 45 years was suitable for the cities under study because of two reasons: (1) By taking into account the age structure of the de jure population for the distribution, the age curve of the unregistered attendees is then for every city nicely graduated with a peak in the adult age groups of 15 to 40 years (see appendix A). (2) The application of a higher percentage creates a very high peak in the age groups of the mobile young adults. We should nevertheless take into account that also a part of the unregistered absentees belonged to the adult age groups.

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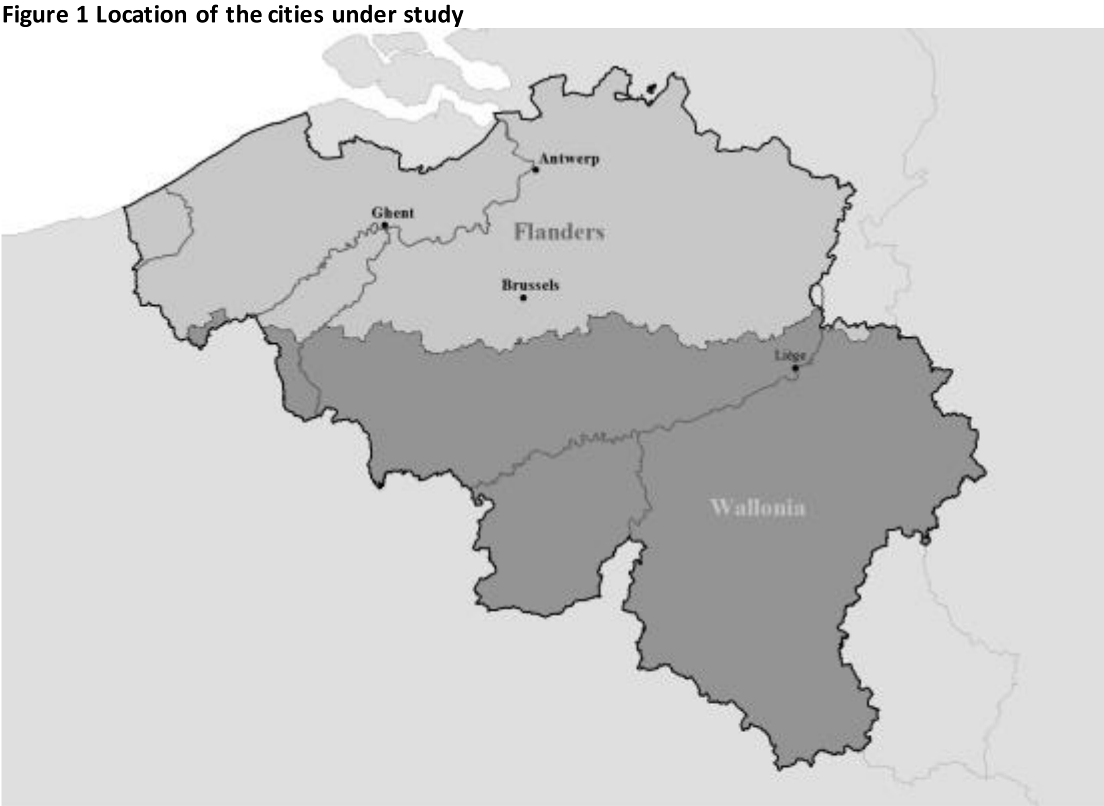
[3] The number of people that were noted without age in the population censuses is uniformly distributed over all age categories.

[4] In those cities or towns where the difference between the de facto and de jure population was negative and there were more emigrants than immigrants, the distribution should perhaps be reconsidered. If it occurred for instance due to putting-out infants with wet nurses in the countryside and return migration or hospital admission of elderly in another town or city, the majority of the difference should in fact be counted with the youngest and oldest age groups. Otherwise, it is also possible that the difference was related to employment opportunities of adults in a neighbouring town, in which case the current distribution can be retained.

## IV. Case study

To prove the utility of our estimation method, we apply it to the interpretation and comparison of the mortality rates of the four largest Belgian cities around 1900. It concerns the capital city of Brussels and the cities of Antwerp, Ghent and Liège. The location of these cities is shown on figure 1.

**Figure 1 Location of the cities under study**




Map constructed by Torsten Wiedemann, Ghent University

### *Mortality rates of the de jure population*

In table 1 we present the mortality rates of the de jure population of the largest Belgian cities for the year 1900. The source for the age-specific population data is the population census of 1900 (de jure), while the age-specific mortality figures are derived from *Le Mouvement* of the years 1899, 1900 and 1901 (de facto)[5]. We used the Wunsch method to calculate the mortality rates (Wunsch and Termote, 1978).

[5] The mortality figures for the cities of Antwerp and Ghent are based on the average of the years 1899 and 1901 because of an incorrect registration of the number of unregistered people who died in these cities in the year 1900. According to *Le Mouvement*, there were 0 unregistered people who died in these cities in 1900, which is implausible for cities of this size.

**Table 1 Mortality rates (per 1000) of the de jure population of Belgian cities according to sex and age group, 1900**

| | Brussels | Antwerp | Ghent | Liège |
|---|---|---|---|---|
| **Males** | | | | |
| 00-<01 | 291 | 249 | 355 | 170 |
| 01-<20 | 10 | 10 | 9 | 9 |
| 20-<40 | 11 | 8 | 8 | 9 |
| 40-<60 | 26 | 21 | 19 | 24 |
| 60-<80 | 80 | 61 | 67 | 81 |
| **Females** | | | | |
| 00-<01 | 258 | 184 | 281 | 157 |
| 01-<20 | 9 | 8 | 8 | 8 |
| 20-<40 | 8 | 6 | 6 | 7 |
| 40-<60 | 15 | 12 | 14 | 14 |
| 60-<80 | 56 | 52 | 54 | 59 |

Source: Own calculations based on le Recensement général de la Population du 31 décembre 1900 and Le Mouvement de la Population et de l'Etat Civil, 1899-1900-1901.

The question is to which extent these mortality rates are biased due to the use of the de jure population as population at risk. In addition, we can use our estimation method to examine whether the de jure/de facto difference affects the comparability of the mortality figures. Table 2 shows the ratio of mortality in the Flemish and Walloon cities compared to the mortality in Brussels when the de jure population is used as population at risk. Previous research has already demonstrated the exceptionally high mortality levels in the Brussels city centre at the turn of the twentieth century (Eggerickx and Debuisson, 1990; Eggerickx, 2013; Devos and Van Rossem, forthcoming). From table 2 it also appears that the mortality rates for most ages were much higher in Brussels than elsewhere. Especially the excess mortality of adult males in the capital was striking. Although it was probably related to environmental factors, the noted mortality surplus can in part be an artefact. Since the capital attracted many (unregistered) migrants, commuting workers and servants, there was probably a large discrepancy between the de facto and the de jure population. This was, however, not per se true for the other cities with which its mortality level is compared. Indeed, from table 3 it appears that a large amount of people died in Brussels without being registered as an inhabitant (D(U, I)), while this occurred to a much lesser extent in the cities of Antwerp and Ghent. In sum, 5.88% of the males and 8.18% of the females who died in Brussels around 1900 are not represented in the number of the de jure population at risk. This results in an overestimation of the Brussels' mortality rates. The opposite is true for the mortality rates of females in Antwerp, because there were more deaths of registered females in another municipality than of unregistered females in the city.

**Table 2 Mortality rates of the de jure population of Belgian cities compared to the mortality rate of the de jure population of Brussels according to sex and age group, 1900**

| | Brussels | Antwerp | Ghent | Liège |
|---|---|---|---|---|
| **Males** | | | | |
| 00-<01 | 100 | 86 | 122 | 58 |
| 01-<20 | 100 | 100 | 90 | 90 |
| 20-<40 | 100 | 73 | 73 | 82 |
| 40-<60 | 100 | 81 | 73 | 92 |
| 60-<80 | 100 | 76 | 84 | 101 |
| **Females** | | | | |
| 00-<01 | 100 | 71 | 109 | 61 |
| 01-<20 | 100 | 89 | 89 | 89 |
| 20-<40 | 100 | 75 | 75 | 88 |
| 40-<60 | 100 | 80 | 93 | 93 |
| 60-<80 | 100 | 93 | 96 | 105 |

Source: Own calculations based on le Recensement general de la Population du 31 décembre 1900 and Le Mouvement de la Population et de l'Etat Civil, 1899-1900-1901.

**Table 3 Mortality in Belgian cities according to sex, place of registration and death, 1900**

| | Brussels | Antwerp | Ghent | Liège |
|---|---|---|---|---|
| **Males** | | | | |
| $D(R, I)_m$ | 1,702 | 2,476 | 1,676 | 1,387 |
| $D(R, O)_m$ | 235 | 191 | 36 | 89 |
| $D(U, I)_m$ | 356 | 214 | 108 | 202 |
| $D(dj)_m$ | 1,937 | 2,667 | 1,712 | 1,476 |
| $D(df)_m$ | 2,058 | 2,690 | 1,784 | 1,589 |
| **% diff$_m$** | **5.88** | **0.86** | **4.04** | **7.11** |
| **Females** | | | | |
| $D(R, I)_f$ | 1,657 | 2,194 | 1,626 | 1,316 |
| $D(R, O)_f$ | 172 | 125 | 29 | 54 |
| $D(U, I)_f$ | 335 | 113 | 65 | 118 |
| $D(dj)_f$ | 1,829 | 2,318 | 1,655 | 1,370 |
| $D(df)_f$ | 1,993 | 2,306 | 1,691 | 1,434 |
| **% diff$_f$** | **8.18** | **-0.52** | **2.13** | **4.46** |

Note: D(R, I) = number of deaths of registered people who died inside city; D(R, O) = number of deaths of registered people who died outside city; D (U, I) = number of deaths of unregistered people who died inside city; D(dj) = total number of deaths of registered people of the city; D(df) = total number of deaths of people who died inside the city; % diff = [(D(U, I) – D(R, O)) / D(df)] * 100
Source: Mouvement de la Population et de l'Etat Civil, 1899-1900-1901.

### *Estimation of the age distribution of the de facto population*

To calculate mortality rates of the de facto population of these cities, we first need to estimate the total number of the de facto population. Besides the figures in table 3, we therefore need information on the total number of the de jure population in 1900. According to the population census of 31 December 1900, the city of Brussels counted for instance 83,598 male inhabitants. Then we apply formulas (2) and (3):

$$\frac{235}{1{,}937} = \frac{P(R,O)\mathrm{m}}{83{,}598} <=> P(R,O)\mathrm{m} = 10{,}142$$

&

$$\frac{356}{1{,}937} = \frac{P(U,I)\mathrm{m}}{83{,}598} <=> P(U,I)\mathrm{m} = 15{,}364$$

By applying the values of $P(R, O)_m$ and $P(U, I)_m$ in formula (1), we calculate the estimated value of the total number of the de facto population of males in Brussels in 1900:

$$P(df)m = 83{,}598 - 10{,}142 + 15{,}364 <=> P(df)m = 88{,}820$$

The difference between the de jure population and the estimated de facto population amounts thus to 5,222 inhabitants. We add 60% of them (3,134 inhabitants) to the age groups between 15 and 45 years old. In table 4 we present the age-specific distribution of the de jure population as derived from the population census, the multiplier for each of the age groups, the added number of de facto inhabitants, and finally the age-specific distribution of this estimated de facto population. As mentioned, the calculation of the multiplier and the added number of inhabitants differ between the adult categories and the rest of the population. The multiplier for children aged 1 to 5 year is for example calculated by dividing the de jure population in this age group (5,966) by the sum of the four youngest and the ten oldest age categories (39,522). Next, we multiply this proportion (0.1510) by 40% of the difference between the de jure and de facto population (2,088). This number (315) is added to the number of the de jure population in this age group (5,966), resulting in an estimation that there were 6,281 male children aged 1 to 5 actually present in the city of Brussels in 1900. For adults aged 35 to 40 year, however, the multiplier is calculated by dividing the de jure population in this group (6,310) by the sum of the adult groups (44,076). This proportion (0.1432) is then multiplied with 60% of the difference between the de jure and de facto population (3,134). This results in an estimation of 449, which is the difference between the group of unregistered males aged 35 to 40 who were living in Brussels in 1900 and the group of registered males of this age who were living elsewhere. By adding this number to the de jure population of the age group, we conclude that in 1900 there were probably 6,759 men aged 35 to 40 present in the Belgian capital.

**Table 4 Age distribution of the estimated de facto population of males in Brussels, 1900**

| | De jure population | Multiplier | Addition | De facto population |
|---|---|---|---|---|
| **Age groups** | | | | |
| 00-<01 | 1,708 | 0.0432 | 90 | 1,798 |
| 01-<05 | 5,966 | 0.1510 | 315 | 6,281 |
| 05-<10 | 7,080 | 0.1791 | 374 | 7,454 |
| 10-<15 | 7,148 | 0.1809 | 378 | 7,526 |
| 15-<20 | 8,034 | 0.1823 | 571 | 8,605 |
| 20-<25 | 8,578 | 0.1946 | 610 | 9,188 |
| 25-<30 | 8,392 | 0.1904 | 597 | 8,989 |
| 30-<35 | 7,143 | 0.1621 | 508 | 7,651 |
| 35-<40 | 6,310 | 0.1432 | 449 | 6,759 |
| 40-<45 | 5,619 | 0.1275 | 399 | 6,018 |
| 45-<50 | 4,783 | 0.1210 | 253 | 5,036 |
| 50-<55 | 3,888 | 0.0984 | 205 | 4,093 |
| 55-<60 | 3,189 | 0.0807 | 169 | 3,358 |
| 60-<65 | 2,301 | 0.0582 | 122 | 2,423 |
| 65-<70 | 1,602 | 0.0405 | 85 | 1,687 |
| 70-<75 | 1,009 | 0.0255 | 53 | 1,062 |
| 75-<80 | 550 | 0.0139 | 29 | 579 |
| 80-<85 | 229 | 0.0058 | 12 | 241 |
| 85-<90 | 59 | 0.0015 | 3 | 62 |
| 90+ | 10 | 0.0003 | 1 | 11 |
| **Summary** | | | | |
| 15-<45 | 44,076 | 1 | 3,134 | 47,210 |
| (00-<15),(45-<90+) | 39,522 | 1 | 2,088 | 41,610 |
| **00-90+** | **83,598** | **2** | **5,222** | **88,820** |

Source: Own calculations based on le Recensement général de la Population du 31 décembre 1900 and Le Mouvement de la Population et de l'Etat Civil, 1899-1900-1901.

Using the same methodology, we calculate the de facto population of females in Brussels and the de facto population in the other cities. The comparison between the given de jure population and the estimated de facto population of males and females is presented for the four cities under study in table 5. The proportional age distribution of the added number of attendees is shown for each city in appendix A.

**Table 5 Comparison between the estimated de facto population and the de jure population of Belgian cities according to sex, 1900**

| | Brussels | Antwerp | Ghent | Liège |
|---|---|---|---|---|
| **Males** | | | | |
| $P(dj)_m$ | 83,598 | 129,957 | 74,159 | 74,480 |
| $P(df)_m$ | 88,820 | 131,078 | 77,300 | 80,147 |
| **$diff_m$** | **+5,222** | **+1,121** | **+3,141** | **+5,667** |
| **Females** | | | | |
| $P(dj)_f$ | 100,088 | 142,874 | 85,974 | 83,280 |
| $P(df)_f$ | 109,008 | 142,134 | 87,845 | 87,170 |
| **$diff_f$** | **+8,920** | **-740** | **+1,871** | **+3,890** |

Source: Own calculations based on le Recensement général de la Population du 31 décembre 1900 and Le Mouvement de la Population et de l'Etat Civil, 1899-1900-1901.

***Comparison between the mortality rates of the de jure and de facto population***

Tables 6 and 7 show the mortality rates of the largest Belgian cities when we use the estimated de facto population as the population at risk. The mortality rates of the cities where there was only a small difference between the de jure and de facto deaths, i.e. the cities of Antwerp and Ghent, show a strong resemblance with those of table 1. The mortality rates of Brussels and Liège are on the other hand clearly lower. This proves that the mortality rates of the de jure population of several cities are indeed slightly biased because of a discrepancy between the number of unregistered attendees and absentees.

Especially when the mortality rates of different cities are compared, such distortion can be problematic. If we compare the ratios of table 7 with those of table 2, there is for most age groups a slight decrease in the surplus mortality of Brussels compared to the other cities. However, the excess mortality is still apparent and we establish that the surplus mortality in Brussels was thus not entirely caused by data problems. It is obvious that researchers should be extremely careful when comparing the mortality rates of cities with very large differences in the number of temporarily present and absent people.

**Table 6 Mortality rates (per 1000) of the estimated de facto population of Belgian cities according to sex and age group, 1900**

| | Brussels | Antwerp | Ghent | Liège |
|---|---|---|---|---|
| **Males** | | | | |
| 00-<01 | 277 | 247 | 344 | 160 |
| 01-<20 | 9 | 10 | 8 | 8 |
| 20-<40 | 10 | 8 | 7 | 8 |
| 40-<60 | 25 | 20 | 18 | 23 |
| 60-<80 | 76 | 61 | 65 | 77 |
| **Females** | | | | |
| 00-<01 | 240 | 184 | 277 | 151 |
| 01-<20 | 8 | 8 | 8 | 7 |
| 20-<40 | 7 | 6 | 6 | 6 |
| 40-<60 | 14 | 12 | 13 | 14 |
| 60-<80 | 52 | 53 | 53 | 57 |

Source: Own calculations based on le Recensement général de la Population du 31 décembre 1900 and Le Mouvement de la Population et de l'Etat Civil, 1899-1900-1901.

**Table 7 Mortality rates of the estimated de facto population of Belgian cities compared to the mortality rate of the estimated de facto population of Brussels according to sex and age group, 1900**

| | Brussels | Antwerp | Ghent | Liège |
|---|---|---|---|---|
| **Males** | | | | |
| 00-<01 | 100 | 89 | 124 | 58 |
| 01-<20 | 100 | 111 | 89 | 89 |
| 20-<40 | 100 | 80 | 70 | 80 |
| 40-<60 | 100 | 80 | 72 | 92 |
| 60-<80 | 100 | 80 | 86 | 101 |
| **Females** | | | | |
| <1 | 100 | 77 | 115 | 63 |
| 1-<20 | 100 | 100 | 100 | 88 |
| 20-<40 | 100 | 86 | 86 | 86 |
| 40-<60 | 100 | 86 | 93 | 100 |
| 60-<80 | 100 | 102 | 102 | 110 |

Source: Own calculations based on le Recensement général de la Population du 31 décembre 1900 and Le Mouvement de la Population et de l'Etat Civil, 1899-1900-1901.

## V. Discussion

The results in this article clearly demonstrate that differences in registration practices, in particular of migration, distort the interpretation and comparability of Belgian mortality estimates. This is because the population data of censuses since 1866 refer to the de jure population, while the mortality data of *Le Mouvement* refer to the de facto deaths. As such, the traditionally used mortality rates are overestimated in cities with many unregistered attendees and underestimated in cities with many unregistered absentees. The method we developed in this article allows to receive some insight into the probable value of this bias and to refine historical demographic measures. We were, however, confronted with several problems while estimating the mortality rates of the de facto population. We mainly lacked information upon the mortality risks of (unregistered) attendees and absentees and upon their age distribution. If there is more information upon the composition of attendees, such as the predominance of labour migrants or hospitalised patients in a certain city or municipality, the assumption on the comparable mortality risks of temporarily attendees and residents can be refined. Likewise, data on the age distribution of registered migrants can be used to adjust the distribution of the estimated difference between the de facto and de jure population upon the different age groups. For the purposes of this article, we applied the general assumption that it were particularly young adults who moved towards (and from) cities.

Despite these difficulties, this paper demonstrates the possibility to rule out (or confirm) that the excess mortality in a certain Belgian municipality was an artefact. Therefore, researchers can use data on the number of de jure and de facto deaths in a certain municipality from '*Le Mouvement*' and various plausible assumptions upon the mortality risks and age distribution of unregistered attendees and absentees. Then, it is possible to construct several scenarios to explore the impact of the different registration practices on the calculated mortality rates. The starting point of the estimation method is moreover sufficiently reliable, because we depart from actual data on the difference between de facto and de jure deaths that were noted in '*Le Mouvement*'. The data in '*Le Mouvement'* were of high quality at the end of the nineteenth century, because of developed resources of the public administration, clear guidelines for counting and processing of the data, and supervision of the municipalities' data collection by the central government (Preneel, 2010). Also, the age distribution of the difference between the number of unregistered attendees and absentees is based upon the actual age distribution of the de jure population.

Hence, it is designated to use (a variant of) our estimation method to control for the population at risk when interpreting or comparing mortality rates. In general, the changes to the mortality rates were however minimal, because only a limited number of people died in another municipality than the one where they were registered. If this is the case, also the demographic measures that are based on a mix of de jure and de facto data are thus relatively reliable.

## VI. References

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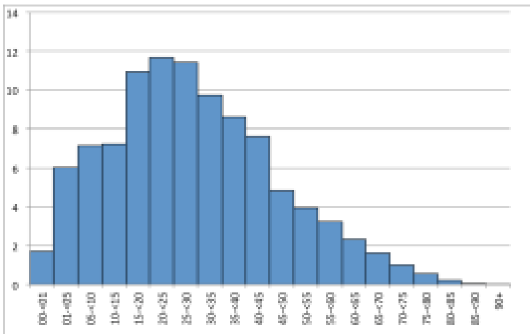
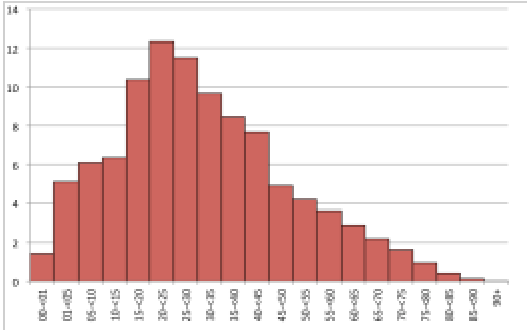
## Appendix A: the proportional age distribution of the difference between the number of unregistered attendees and absentees

### *Brussels, 1900*

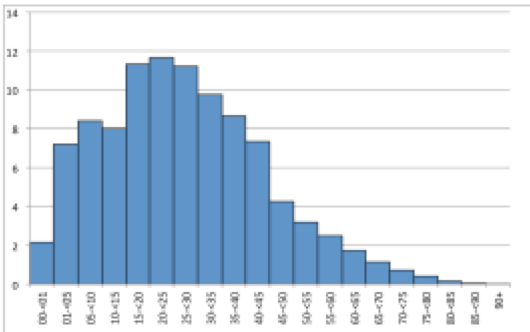
**Figures 1 and 2 Proportional age distribution of the difference between the number of unregistered male or female attendees and absentees, Brussels, 1900**

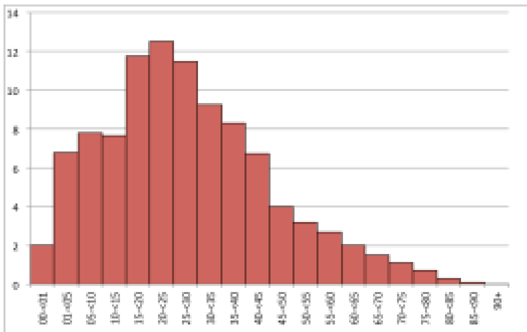




### *Antwerp, 1900*

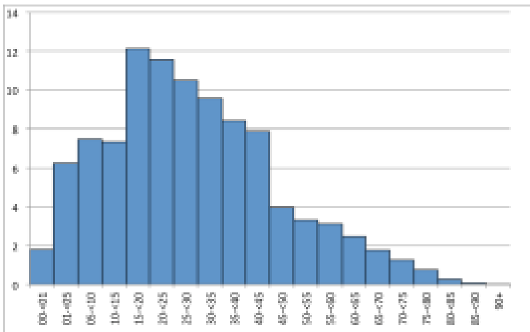
**Figures 3 and 4 Proportional age distribution of the difference between the number of unregistered male or female attendees and absentees, Antwerp, 1900**

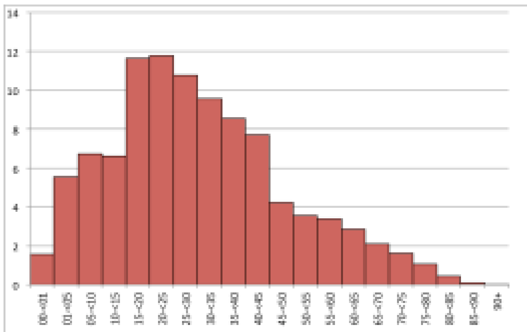




### *Ghent, 1900*

**Figures 5 and 6 Proportional age distribution of the difference between the number of unregistered male or female attendees and absentees, Ghent, 1900**





## *Liège, 1900*

**Figures 7 and 8 Proportional age distribution of the difference between the number of unregistered male or female attendees and absentees, Liège, 1900**