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Migration and Mortality: What Do We Know?

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*Migration and Mortality: What Do We Know?**

Tuba Bircan, Johan Surkyn, and Ahmad Wali Ahmad Yar†

Abstract

This working paper seeks to utilise mortality data, when linked to population register data, to assess the potential of such data in developing robust estimators for hard-to-reach groups, specifically undocumented migrants. Recognising the gaps in current migration statistics, the study proposes this novel approach as a means to offer more accurate and nuanced indicators of irregular migration. Addressing the existing challenges related to international migration data, such as its incompleteness, lack of recency, and the need for harmonization, the paper asserts that mortality data can provide valuable insights into these issues, further shedding light on the demographics, living conditions, and health access of undocumented migrants. Using Belgium as a case study, the research demonstrates how death registry data can be employed to develop migration indicators. By applying this method, we can better identify and understand the characteristics of unregistered populations, offering age- and gender-specific results that could significantly inform future policy decisions. By investigating the mortality paradox among migrants, the paper reveals fascinating trends that offer deeper insights into the factors influencing migrant mortality. The study posits that the mortality extrapolation methodology could serve as a crucial tool to fill in the knowledge gaps in migration statistics, and hence, a valuable source of harmonised statistics on irregular populations in Europe. However, the paper also acknowledges the necessity for improved data quality and the development of more advanced statistical tools to effectively analyse this type of data. Given the piecemeal nature of current migration information, it emphasises the importance of broadening our comprehension of the mortality-migration relationship to enable the formulation of more effective, evidence-based policy decisions.

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Table of contents

1. Introduction

Historically, the discourse on migration has pivoted on economic theories, focusing on labour markets and the pursuit of economic advantages (Borjas, 1989). However, the advent of the 21st century has seen a shift in the scholarly landscape, with an emerging consensus that health, embodied in mortality rates and longevity, is a significant dimension of migration narratives. After all, the mere act of migration involves a self-selection process often favouring healthier individuals, subsequently influencing the mortality rates within and between migrant populations—a phenomenon often referred to as the 'healthy migrant effect' (Aldridge et al., 2018).

Notwithstanding, our understanding of the intricate relationships between migration and mortality remains far from comprehensive. Discrepancies in the methodology, dearth of longitudinal data, and divergent operational definitions of 'migrants' have contributed to an inconclusive and occasionally contradictory body of evidence (Lu et al., 2013; Ahmad Yar &Bircan, 2021). Moreover, existing research tends to adopt a binary approach, focusing predominantly on the dichotomy of positive and negative health outcomes, thus overlooking the nuanced interplay of socio-cultural, economic, and political factors that shape migrant health trajectories.

The intricate nexus between migration and mortality remains a compelling area of academic inquiry. In recent years, mortality data has become an essential tool for researchers, policymakers, and migration researchers. It is collected on almost all population categories in many European countries, including migrants with or without documents, general population, and sometimes citizens residing abroad. Demographers have started to explore mortality data as a potentially rich source of information for understanding migration patterns (Riosmena et al., 2015; Vollset et al., 2020). Recent advancements in computational methods have also allowed for the improved use of mortality data in migration studies. For instance, the development of innovative statistical models, such as the Bayesian hierarchical model, has enabled the estimation of age-specific mortality rates in small populations, thereby allowing for detailed comparisons between migrant and non-migrant populations (Congdon, 2019). However, more frequently, researchers use mortality data, rates, estimations, and patterns to identify the reasons for the death of the population. Migration researchers utilise mortality data to compare the death rates among migrants and the native population, and subsequently across different migrant categories.

With the documented gaps in migration statistics, alternative data sources and new approaches to develop indicators and estimations for migration measures are capturing the attention of both scholars and policymakers. In this compelling exploration, this paper’s goal is assessing the potential of mortality data to develop and improve indicators, particularly for irregular migration. Through a

rigorous review of literature, robust assessment of a new methodological approach, and critical appraisal, we aim to synthesise and then improve the knowledge accumulated thus far and identifying gaps for future research. Accordingly, in this paper, after summarising the conceptual framework for mortality and migration, we elaborate on the persistent gaps in international migration measures and indicators with an emphasis on the utilisation of alternative data sources to address those challenges. We then illustrate a stocktaking exercise aimed at the Belgian level, including the estimation of the undocumented migrant population by major nationality groups.

2. Mortality in the Context of Migration

Traditionally, mortality rates have served as robust demographic indices for appraising the dynamism of population structures over temporal frameworks (Preston et al, 2001; Hashim et al., 2020). Mortality, exhibiting a high degree of stability and consistency across demographic parameters, emerges as a pertinent factor in the discourse of population longevity, wherein populations characterized by lower life expectancies typically manifest elevated mortality rates across all age strata. Moreover, when traced over the entirety of the life course, patterns of mortality tend to retain their stability.

Several facets of migration studies can significantly benefit from the insights gleaned from mortality data. Firstly, the incorporation of mortality statistics in migration research unravels salient understanding into the health outcomes and adversities encountered by migrating communities (Riosmena et al, 2013; Juárez et al., 2019). These statistics, encompassing data on death incidences and their underlying causes within specific populations, offer an empirical framework for evaluating the health discrepancies and vulnerabilities inherent to migrant populations. Beyond the mere scrutiny of overall mortality rates, researchers can investigate precise causative agents of death to gain a profound comprehension of the health adversities that migrants grapple with such as infectious disease trajectories, chronic disease patterns, mental health spectrums, and exogenous influences such as accidental injuries or acts of violence (Lu et al, 2019). The identification of the distribution and determinants of specific causes of death within migrant groups can steer public health initiatives and healthcare provisions towards addressing the unique requirements and risks associated with migrant demographics.

Dissecting mortality patterns and rates among distinct migrant clusters allows researchers to discern health outcome disparities compared to host country populations or the wider populace (Gushulak et al, 2009; Vearey et al., 2020). These disparities are frequently mediated by an intricate confluence of

determinants, including socioeconomic positioning, healthcare accessibility, linguistic barriers, discrimination, and cultural variances (El Alaoui-Faris, 2022). Longitudinal investigations that monitor mortality patterns over extended time horizons provide an invaluable evidence base for appraising the effectiveness of healthcare interventions, policy initiatives, and social integration endeavours targeted towards enhancing the health and welfare of migrant cohorts. In this light, mortality data paves the way for pinpointing specific health threats and ailments that might disproportionately afflict migrant populations, thereby illuminating potential avenues for policy-making and interventional strategies (Zimmerman et al., 2011; Congdon, 2019).

The empirical evidence surrounding health and mortality disparities amongst immigrant cohorts presents a diverse narrative. Research has overwhelmingly shown that a mortality advantage among migrant populations is evident across different countries and continents in contrast with the native population. A mortality advantage is frequently observed in first-generation immigrants relative to their native counterparts, a phenomenon seemingly paradoxical given their oftentimes disadvantaged socioeconomic status, typically associated with lower life expectancy (Abraido-Lanza et al., 1999; Markides & Eschbach, 2005). A plausible explanation for this anomaly may be potential data artefacts, such as misclassification or underreporting of deaths in these communities (Wallace & Darlington-Pollock, 2022). However, research indicates that differences in mortality rates between native populations and immigrant groups tend to diminish over time as immigrants acclimate to their host countries (Aldridge et al., 2018; Vanthomme & Vandenheede, 2019). The longevity and health outcomes of migrants improve as they continue to reside and adapt to the host environment, with factors such as integration into local communities, better access to healthcare, and changes in lifestyle contributing to this trend (Williams, 2010; Maskileyson, 2019).

Moreover, several key theories seek to explain this 'migrant mortality paradox' (Khlat & Darmon, 2003; Shor et al., 2017; Wallace & Wilson, 2019). Firstly, the 'healthy migrant effect' or 'salmon bias' stipulates that migrants constitute a self-selected group of individuals who are healthier and more resilient than average, thereby equipping them for the physical and mental rigors of the migration process (Tarnutzer & Bopp; 2012; Kennedy et al., 2015). The 'healthy migrant effect' refers to the observation that migrants often have better health outcomes compared to non-migrants in the host country, while the latter refers to the phenomenon of sick migrants returning to their home countries, potentially leading to underestimations of health disparities between migrants and non-migrants in the host country. This bias postulate that immigrants are often a self-selected group of healthy individuals who possess the physical ability and resilience to undertake the migration journey (Kristiansen et al., 2016). As such, these migrants may initially have lower mortality rates than the native population, although this advantage may decrease over time due to acculturation and

associated lifestyle changes (Brown, 2018). Secondly, the adoption of healthier lifestyles prevalent in host countries can contribute to better health outcomes for migrants (Tarnutzer & Bopp; 2012; Helgesson et al., 2019). This acculturation effect could partially explain the observed mortality advantage, particularly if migrants' countries of origin had higher mortality rates or less health-promoting lifestyles. Lastly, the influence of advanced, well-functioning healthcare systems in host countries can potentially aid in maintaining or improving the health status of migrants, particularly if these systems offer superior care compared to those in migrants' countries of origin (Borjas, 2015; Permananad et al., 2016). Individuals migrating to improve their living conditions and work opportunities typically experience a consequent improvement in health outcomes, an illustration of the environmental impact on mortality.

Mortality rates among the migrant and non-migrant populations could be studied based on their socio-demographic characteristics such as age ranges, gender, education level, years of living in the host country, residence document type, occupation and employment, and the country of origin of the migrants. These demographic characteristics are all highly important for investigating the social and medical conditions of the migrant population, which are not always available in the existing databases. In recent years, the usage of migrants' mortality data has been extended beyond traditional purposes. One of the usages is demographic modelling, extracting information from such data on the population itself. Mortality rates are used as one of the multiple variables for demographic modelling to project estimations on the number and size of undocumented migrants. Moreover, mortality data is used for conducting extrapolative methods to get information on the population itself including estimating the number of patients of certain diseases based on their mortality rates. However, for that, researchers require complete and reliable data. The quality of mortality data across well-developed countries has improved considerably in terms of timeliness and punctuality, accessibility and clarity, coherence, and comparability. In this report, we explore the usage of mortality data for estimating undocumented migrants in Belgium, using the Belgian case as an example.

3. Measuring International Migration: Persistent Challenges with Data and Indicators

The field of international migration is notably hindered by substantial lacunae in data availability, recency, variable completeness, and harmonisation for comparability. Predominantly affluent regions and nations have demonstrated a superior capability to amass more reliable data than their economically disadvantaged counterparts, attributable to the substantial financial and resource requirements integral to data collection (United Nations, 2017). Data related to regular migration typically exhibit better quality and comprehensiveness, despite long-lasting shortcomings such as data

availability, timeliness, missing variables, and a lack of data harmonisation for comparability purposes (Ahmad Yar & Bircan, 2021). In contrast, data concerning irregular migration, encompassing both migratory flows and stocks, poses considerable collection challenges (Amran et al., 2016; Kraler & Reichel, 2022). The requisites for successful collection extend beyond monetary resources, necessitating the establishment of robust methodologies (IOM, 2018).

Regarding definitions and metrics, a universally accepted definition of migration remains elusive, complicating cross-country data comparisons (Bircan et al., 2020). This definitional divergence impacts both stock and flow measures. The dearth of information or comprehensive insight into the causative factors underlying migration diminishes the utility of the collected data. The formulation of efficacious policies necessitates a profound understanding of migration motivations, an understanding frequently lacking within migration data sets (Czaika & de Haas, 2013).

Geographical coverage within migration data is frequently incomplete, with certain nations and regions exhibiting superior data than others. This inconsistency obstructs the generation of a holistic perspective on global migration patterns. Demographic data gaps signify that crucial information on characteristics such as age, gender, and educational attainment is often missing, thereby inhibiting the comprehension of the distinct needs of diverse migrant demographics (United Nations, 2017). Furthermore, the time lag inherent in data availability often results in migration data that is not contemporaneous, posing challenges for adapting to shifting migration patterns and necessities. These hurdles pervade both regular and irregular migration data (Clemens, 2015).

In recent years, there have been some improvements in data availability and the harmonisation of definitions for regular migrants, particularly in the EU (Mooyaart et al., 2021). However, for irregular migrants, only data on asylum applications, asylum decisions, and subsequent asylum applications are available (Eurostat, 2020). Therefore, it is important to gather data on the living conditions, scale, mobility, and other information about undocumented irregular migrants (Sanchez & Achilli, 2019). Just as data on regular migrants are important for economic planning, data on irregular migrants can help policymakers and researchers understand the size and characteristics of this population, their living conditions, and their access to healthcare and other services. This information can inform policies and programs that address the needs of this population and promote their integration into society. Moreover, having accurate data on irregular migrants can dispel myths and stereotypes about this population and promote a more informed public debate on migration issues. However, obtaining data on irregular migrants is difficult because they are often hesitant to come forward and provide information to authorities due to fear of deportation or other legal consequences. Additionally, irregular migrants may lack official documents or use false documents, making it challenging for

authorities to identify and track them. As a result, there may be an underestimation of the size of the irregular migrant population and a lack of accurate data on their living conditions and needs.

Improving the quality of data and collecting high-quality data would take a long time and require coordination among many stakeholders, including National Statistical Institutions, NGOs, the UN Population Division, and other organizations. To overcome the limitations of collecting high-quality data on regular and irregular migrants, researchers and academics have tried to supplement the gap by using statistical methods and alternative sources (Bohning et al., 2017). These methods focus, among others, on estimating the population through other measures instead of directly collecting data on the population. Estimating different migration indicators has been the focus of demographers and social scientists. Estimating and projecting data on regular migration is relatively easy because migrants must go through administrative procedures, and the data automatically gets recorded in many countries. However, estimating irregular migrants and particularly undocumented populations is exceptionally challenging. Some of the methods previously used to estimate irregular migrants are Multiple Systems Estimation (MSE), Capture-Recapture (CR) method, Demographic Estimation (DE) method, Social Network Analysis (SNA), Border Flow Index (BFI), and Expert Opinion Surveys (EOS) (Jandl, 2004). These methods are used to estimate the size of hidden populations and clandestine entries of illegal migrants. However, all the mentioned methods have their limitations and cannot provide a precise estimation of the population. One of the methods that looks promising in providing almost precise estimation is the extrapolation method using high-quality mortality data. This method will be elaborated on in the coming sections.

Alternative Data Sources

In the evolving field of migration studies, the advent of alternative data sources has provided unprecedented opportunities for developing myriad indicators of migration patterns, trends, and impacts. Mobile phone data, web scraping, and social media data have been utilised extensively to delineate population mobility patterns (Sirbu et al., 2021; Salat et al., 2022). These encompass measures such as migration flows and stocks, origin-destination matrices, remittance patterns, assimilation, and integration trajectories, among others (Zamani et al., 2020). Researchers have commonly employed satellite images to ascertain population densities in census-inaccessible regions, mobile phone data, web scraping, and social media data from platforms like LinkedIn, Facebook, Instagram, and Twitter, to potentially generate migration or mobility statistics (Zamani et al., 2020;

Tjaden, 2021; Bircan & Salah, 2023). In-depth studies of internal migrations have often incorporated data derived from web scraping techniques and mobile phones (Blumenstock, 2012; Salah et al., 2019), whereas population estimations and stock analyses have primarily harnessed satellite images (Bircan, 2022). Big data from mobile positioning, vehicle sensors, and accommodation system websites form the cornerstone of research into daily and short-term mobilities (Zhao et al., 2021). Mobile positioning data and details pertaining to inbound and domestic visits and their characteristics have been investigated in the context of tourism statistics (Li et al, 2013; Silm et al., 2021). It is crucial to mention, though, that along with their promises each of these methods carries its own limitations and ethical considerations, particularly concerning privacy and the risk of harm to vulnerable populations.

Although migration and human mobility studies have been enhanced by the use of a diverse array of alternative data sources, these have been extensively harnessed to elucidate nuanced aspects of regular migration. Despite these significant strides, the measurement and understanding of irregular migration remain markedly less developed. Irregular migration, encapsulating any type of irregularity along the migratory journey such as subsequent changes in access to authorised documents regarding legal status, unauthorised border crossings, visa overstays, etc. poses unique challenges for data collection and analysis. The ununiform nature of these activities, coupled with the inherent vulnerability of irregular migrants, renders conventional data collection methods ineffective or ethically contentious. Moreover, irregular migrants often remain under the radar of standard administrative records, leading to their underrepresentation in migration statistics (Czaika & de Haas, 2017).

In addition to alternative data sources, alternative methodologies can be beneficial for improving irregular migration statistics. For instance, indirect estimation methods, like the residual method, offer another avenue for better representation of irregular migrants. This method compares the total foreign-born population with the legally resident foreign-born population to offer an estimate of the irregular migrant population (Jandl, 2011; Vespe et al., 2017). Nevertheless, these methods also need to be employed with care due to their inherent limitations and assumptions.

4. Assessing Death Register Data to Develop Migration Indicators: The Case of Belgium

As a new approach, the assessment of mortality data in the context of migration, instead of investigating the death rates during the migration journey, we examine what mortality can say about migration and migrants (Surkyn et al., 2022). Accordingly, we demonstrate the

mortality and age specific mortality differentials between migrant and native populations, with cross-country comparisons where possible.

4.1. Methodology

As a case study, we assess how mortality data can be utilized to develop migration indicators for hard-to-reach migrant groups, we propose using unique datasets for Belgium where we link administrative population register data with the statistical mortality registry for 1998-2016. Following data preparations and data cleaning of mortality data in order to isolate deaths occurring in diverse populations such as non-nationals, undocumented migrants, tourists and travellers, international personnel belonging to multinationals and European bodies etc., detailed extrapolations are made.

First, we analyse the statistical death registry to identify people whose death certificates were prepared in Belgium (which means their death was observed within Belgian borders) but do not appear in the population register. Those cases are labelled as “unlinked deaths”. These unlinked deaths will provide us insight into the undocumented migrants and their demographics in Belgium. It is important to note that unlinked deaths on Belgian soil can occur in occasional visitors and in non-registered foreigners with valid documents, as well as in those without proper documents. For terminological convenience, we will refer to these unregistered populations as “informal migrants” when it concerns documented foreigners in a short or prolonged stay, and as “irregular migrants” when those foreigners do not possess proper valid documents. We fully understand that this is a non-standard use of classic migration concepts.

The technique practiced estimating stocks of informal and irregular migrants from mortality data is quite straightforward. It simply extrapolates numbers and characteristics of unlinked deaths (people who died on Belgian soil but where unknown to the population register) based on mortality rates. However, it relies not on a single extrapolation factor, but on a separate multiplier for each combination of age, gender, and origin. Since mortality rates are highly dependent on age and gender, the multipliers must vary accordingly to produce correct and detailed results. Lifetables provide suitable multipliers. They are a summary of the absolute level (=life expectancy) and of the age-dependency of mortality in a population. The age-specific mortality rate is a key variable in that respect. It indicates the relative number of

deaths in a population age segment, where that segment is the average population during the year in which deaths were counted. It is a simple mathematical expression of the relationship between the average number of people alive, and the number of deaths. As an example, it could be equal to 0,001 in a certain age group if 3 people died in an age group that counted 3.000 individuals on average. Therefore, if we would know that the mortality rate is equal to that figure of 0,001, and 5 deaths have occurred in an unknown population, we can assume that the unknown population counts around 5.000 persons. So, as the mortality rate m(x) measures the number of deaths for a unit average population, then simply inversing it (1/m(x)) measures the average number of people alive for each observed death. In short: the inverses of the mortality rates are the multipliers used for extrapolation.

4.2. Migrant mortality differentials

Migrant mortality differentials can be looked at from different angles. From a social inequality point of view, we can focus on the differences between migrant and native populations, or between western and non-western immigrant populations. We will show that observed mortality differences do not align with the classic finding of lower life-expectancy (=higher mortality) in socially underprivileged strata of society. Immigrants from less technically advanced countries, who often belong to those underprivileged groups, even tend to have lower observed mortality according to our Belgian data. A majority of studies worldwide have independently from each other come to similar conclusions, coining the term “Healthy Migrant Paradox”. Understanding and explaining the healthy migrant paradox has been - and still is - a thriving subject in health inequality studies. But can findings on mortality in regular migrants, especially that paradoxical finding of an immigrant mortality advantage, also be applied to informal and irregular migrants?

Using our own findings in migrant mortality, which were recorded in registered migrant groups only, and applying that knowledge to informal and irregular migrants where it cannot be empirically verified, requires addressing that somewhat enigmatic migrant mortality paradox more thoroughly. The reason is simple. If it is already a debated finding in regular migrants, then it must be scrutinised even more deeply in informal/irregular immigrants who are often living and working in precarious conditions, having poor access to health services and limited means for self-reliance. For that reason, we first investigate mortality from the

angle of migrant/native and Western/non-Western contrasts to detect whether mortality advantages are actually found in Belgium's immigrant populations. Next, we look at mortality in the most recently immigrated groups, because those can be considered most relevant for informal/irregular migrants. Finally, we study the unrolling of mortality trends between migration cohorts by the duration of stay or by migration period. Those trends are particularly revealing for the forces driving migrant mortality.

4.2.1. Migrant mortality and social inequality

It is a persistent finding in social epidemiology that higher mortality levels are linked to lower levels of income, education, and general social status. In most western arrival countries, immigrants defy that finding in having lower overall mortality levels despite social disadvantage that newcomers often experience. In this section, we investigate the Belgian case.

Figures 1 and 2 show relative mortality levels of immigrants from all non-OECD countries combined from the moment of arrival in Belgium up to 30+ years of residence. The figures map the contrast between migrant and native populations in terms of mortality ratios. A ratio of 1 indicates equal levels of mortality. Values below one indicates lower mortality (migrant mortality advantage) and values above one indicates higher relative mortality (migrant mortality disadvantage). Mortality ratios are age-adjusted and therefore to be interpreted as net differences in mortality level. For all non-OECD countries combined, mortality levels are about 20% lower in migrants compared to non-migrants. However, in the first years after arrival mortality levels are higher than in later years, especially in male immigrant newcomers. This could be explained as a break-in phase, in which newcomers establish stable incomes, housing and access to health care. It is also worth noting that the 20% mortality advantage is quite stable after those first five years, with no visible adjustment of migrant mortality towards the native level. In short, these findings support a general migrant mortality advantage consistent with the before-mentioned paradox.

Figure 1

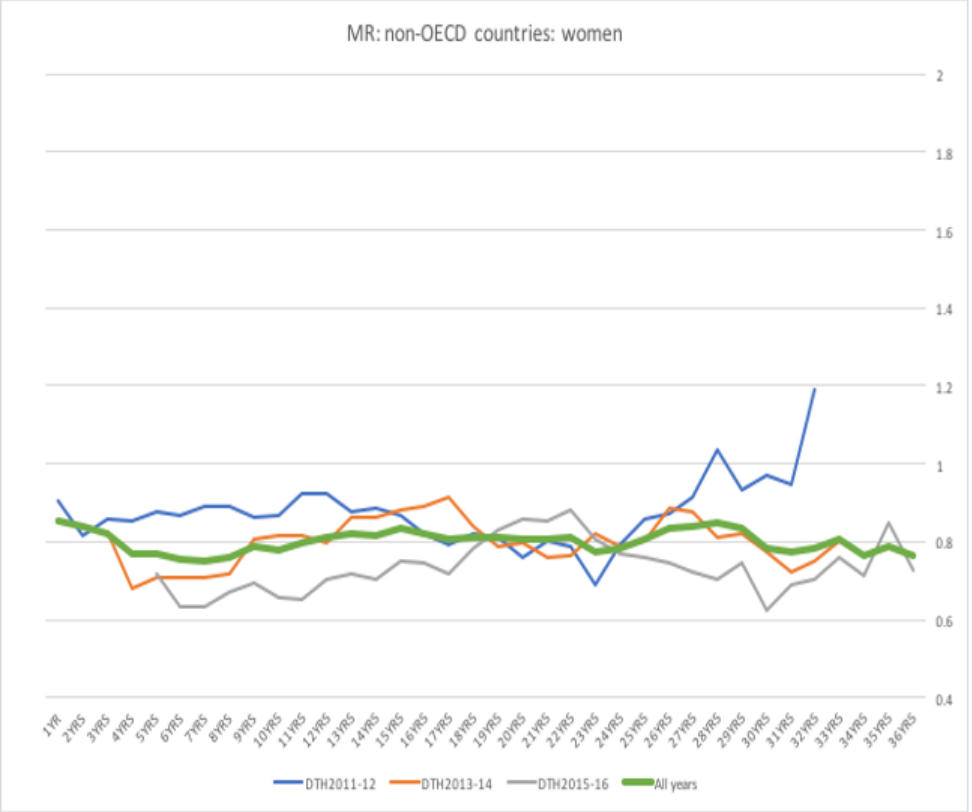


Figure 2

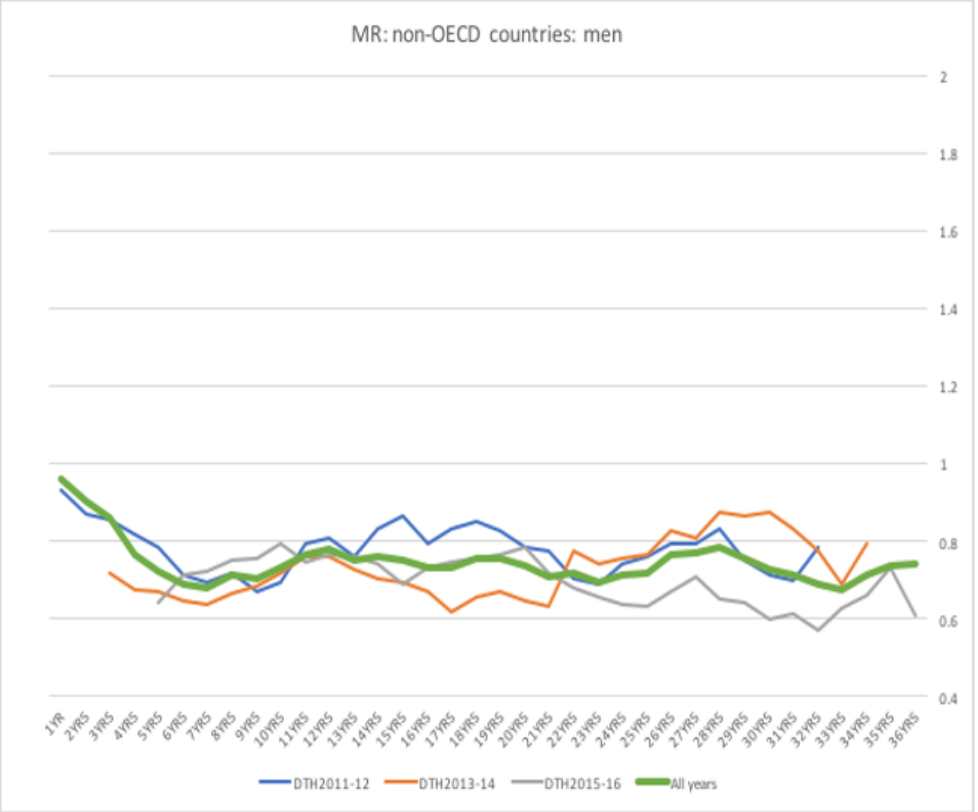


Figure 3

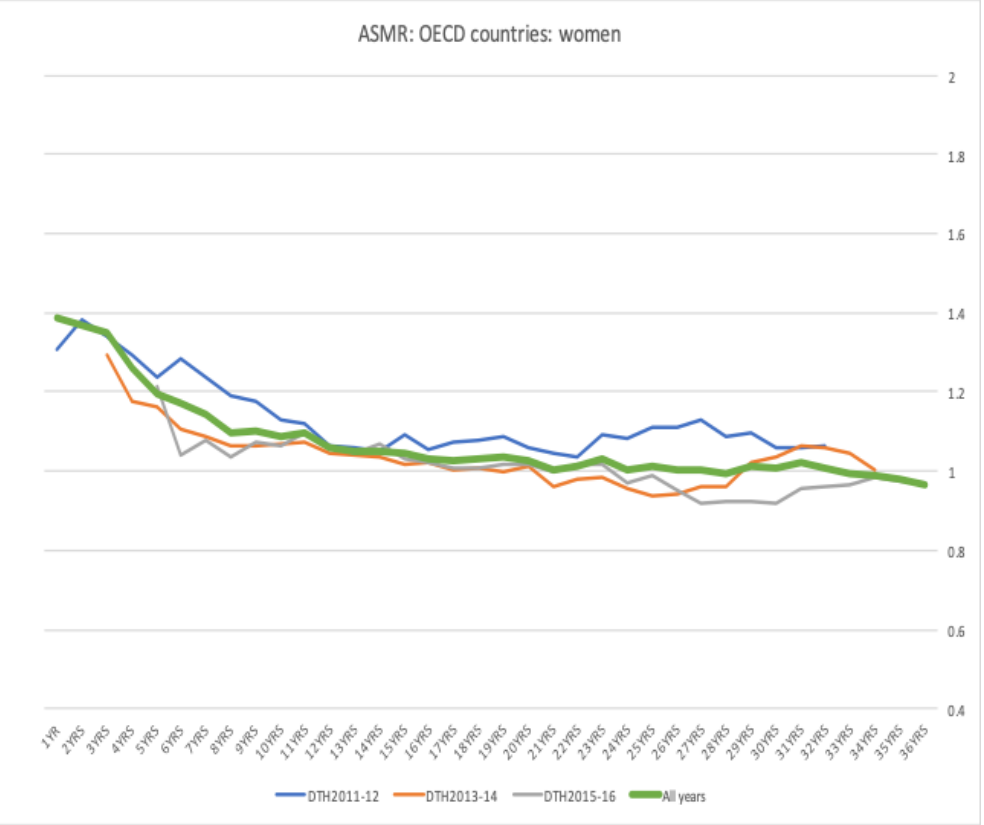
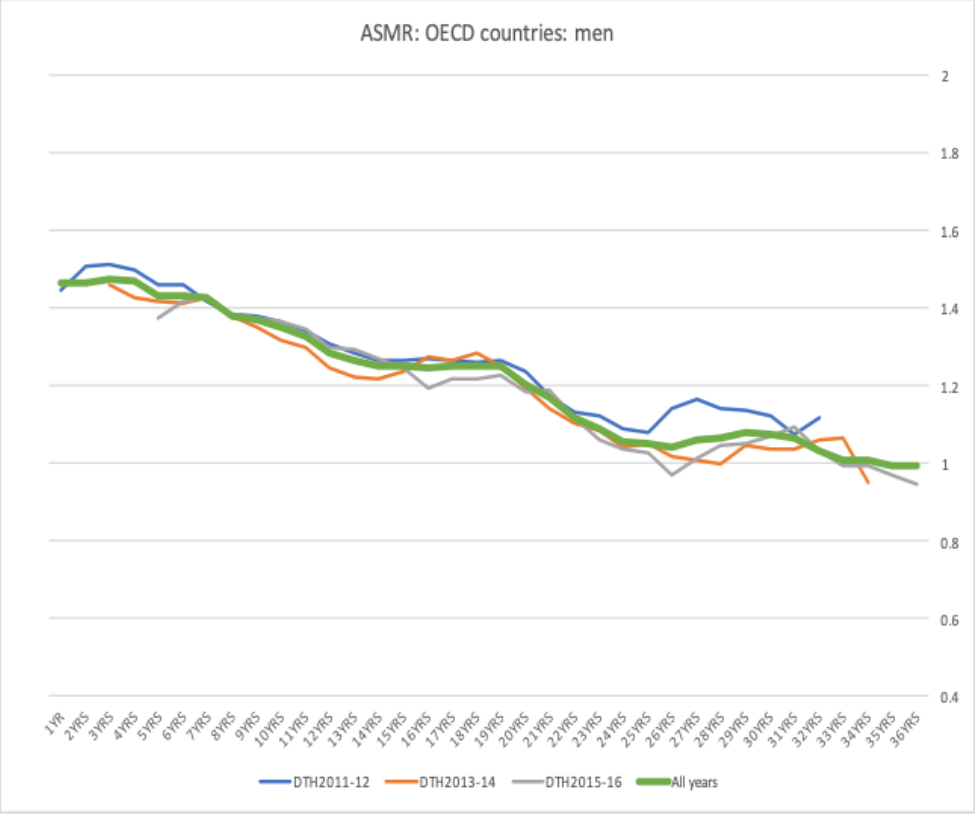


Figure 4



Figures 3 and 4 picture immigrants from OECD countries. Here, the trend is very different. Newly arrived immigrants of OECD-origin have significantly higher mortality levels than non-migrants living in Belgium. This early mortality disadvantage amounts to around 40%, but mortality drops as duration of residence accumulates and eventually converges completely with general Belgian mortality. That convergence occurs in about 10 years for women of OECD-origin but takes about 25 years for their male counterparts.

Such a strong mortality disadvantage for OECD newcomers may come as a surprise. Looking more deeply into the matter, we found that immigration from neighbouring France was influential in that pattern, especially in the case of French women. The French are by far the largest foreign nationality group living in Belgium. For males, newcomers from Eastern Europe were influential. Both these French and Eastern European newcomers exhibit significantly higher mortality levels shortly after arrival, but in both those cases differences fade out on the longer run.

When data are aggregated geographically rather than by OECD-membership a similar picture emerges. We distinguished four non-European regional entities. In two of them, significantly lower mortality levels were found, with advantages ranging around 25 to 30% among North-African immigrants and even 40 to 50% in Latin-American immigrants. However, in the latter case that advantage quickly fades out. Comparative mortality patterns in Sub-Saharan African immigrants were mixed: a limited advantage of around 10% for men, but no clear advantage for women. Finally, Turkish immigrants show no overall mortality advantage, but when only those with a duration of stay of over 25 years are considered, a clear mortality advantage appears within that group.

It is clear from these results that immigrants to Belgium do not show a universal mortality advantage. However, for those immigrated from less industrialized parts of the world, mortality levels are generally lower. This aligns perfectly with the literature. Another trend that better withstands economic divides is that recent newcomers have somewhat higher mortality levels in the first years after arrival. Those with very long stays usually approach native mortality levels, but as shown in the Turkish case, there are exceptions to that rule.

4.2.2. Driving forces in migrant mortality

The previous section made clear that the healthy migrant paradox applies to a large section of the immigrated population in Belgium, certainly among those originating from the African and South American continent. But we also mentioned that mortality trends sometimes diverge considerably between gender groups, between regional origins, and between cohorts entering Belgium in different timeframes. In this section we seek to explain that diversity. For that purpose, as an analytical instrument, we no longer focus on the migrant/native contrast but purely on the contrast between recent immigrants and long-term immigrants. In other words, migrant cohorts are now investigated depending on the duration of their stay.

From an ontological point of view, the drivers of a migrant mortality advantage can be divided in those supporting an intrinsic advantage, and others that link such an advantage to an observational bias. Arguably the most prominent rationales defending the thesis of an intrinsic mortality advantage are first self-selection prior to migration (the “healthy migrant effect”), and second the health transition thesis. The self-selection thesis states that the anticipated social, mental, and physical hardships of long-distance international migration and the prospect of required self-sufficiency in the destination country positively selects the most healthy and strong individuals as candidates for migration out of the sending countries. In theory, positive health selection prior to migration could produce a long-lasting health and mortality advantage in immigrants.

The health transition thesis, on the other hand, is a very elegant explanation that focuses on differences in health systems between developed and developing countries. Such differences explain why in developing countries infectious disease is still among the most prominent causes of death, while fatal outcome of infectious disease is largely ruled out in industrialized countries with modern health care systems. In the Western world, welfare disease has partly replaced infectious disease as a cause of death, featuring coronary illness, certain cancers, and some types of diabetes high on the list. The crucial element in the argumentation is that while infectious disease generally strikes shortly after infection, welfare disease risk only slowly accumulates over long periods of time. All elements combined, immigrants from developing countries can be seen as “epidemiological time-travellers", witnessing an almost immediate drop in risk of life-threatening infectious disease when entering destination countries whilst

being safe from welfare disease consequences for extended periods of time to come, especially if a healthy lifestyle and diet is maintained. Immigrant mortality advantages due to this fast-forwarding of the health transition are expected to wear off over time, or more specifically, with increasing duration of residence in the destination country. Eventually, driven by health acculturation, lifestyle related health risks will become more prominent in immigrants, gradually eroding their health advantage.

An entirely different line of explanations focusses on biases and measurement issues. The most cited example is “Salmon bias”, reasoning that if migrants return to their country of origin linked to deteriorating health, this creates another positive health selection effect among those who stay. Moreover, if returning migrants fail to declare leaving the country, it becomes likely that death occurs abroad and will not be recorded correctly (untimely) in the Belgian population register. The risk of such bias is quite real and can indeed artificially drive-up estimates of immigrant life expectancy.

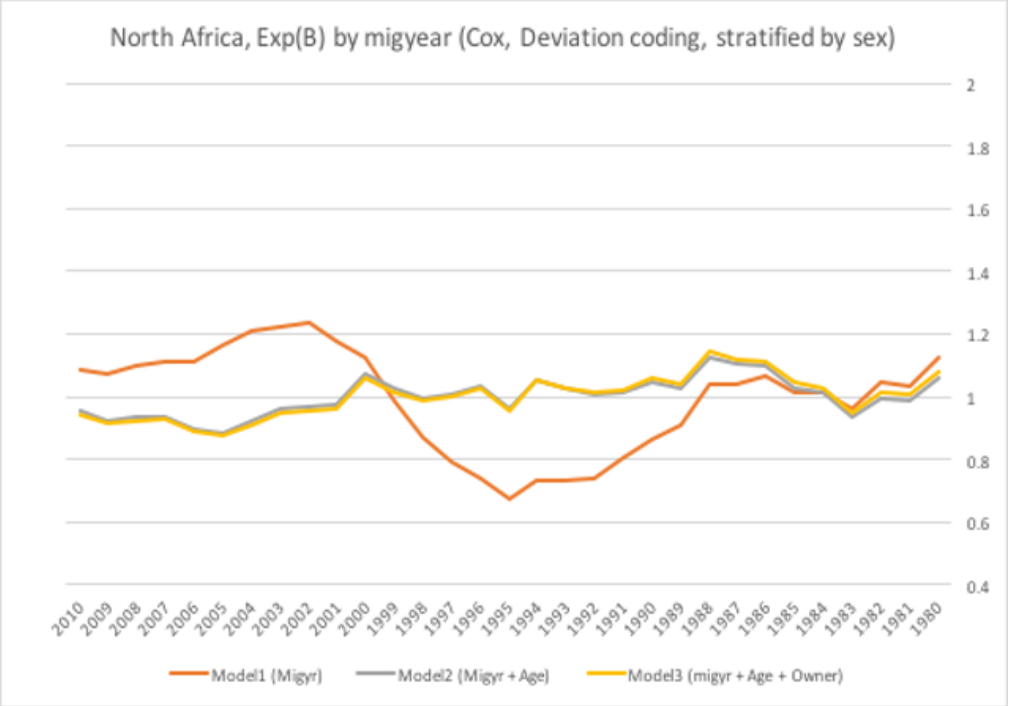
As is evident from this selection of explanations, the long-lasting and vigorous debate on the healthy migrant paradox has incited scholars to meticulously investigate all possibilities that would explain such an advantage as real or as fictitious, processing evidence collected in all kinds of settings and in different formats. The ensuing richness of empirical and theoretical discussions is highly relevant for estimating mortality trends in hard-to-reach migrant populations in which only the outcome of mortality can be observed (deaths), but not the relative pattern (mortality rates).

The mechanisms underlying immigrant/native mortality differences are not mutually exclusive. They can be at work simultaneously, but contextual differences may promote some more than others. To diagnose which mechanisms are influential in different settings, studying mortality differentials by duration of stay is highly revealing. For instance, health transition related mortality advantages are expected to fade out over time (duration of stay), and to do so in a gradual and unidirectional trajectory. After all, it is hard to imagine the health transition returning on its footsteps and for immigrant health patterns to move in other ways than in a one-way trajectory towards the host society. Therefore, mortality advantages showing reversing trends over time (between migration periods or between different durations of stay) undermine the health transition thesis as the main driver of migrant mortality differentials.

The pre-migration selection hypothesis, on the other hand, could be reconciled with reversing mortality trends, but only if selection criteria can be shown to vary over time, putting higher or lower stress on health-related covariates depending on the migration period.

Figure 5 shows the time trend in mortality in North African immigrants according to year of arrival in Belgium. Included in the analysis were all immigrants present at the 2011 Belgian population census. Therefore, year of arrival and duration of stay are largely interchangeable: those immigrated before 1991 had at least 20 years of stay, and so on.

Figure 5.

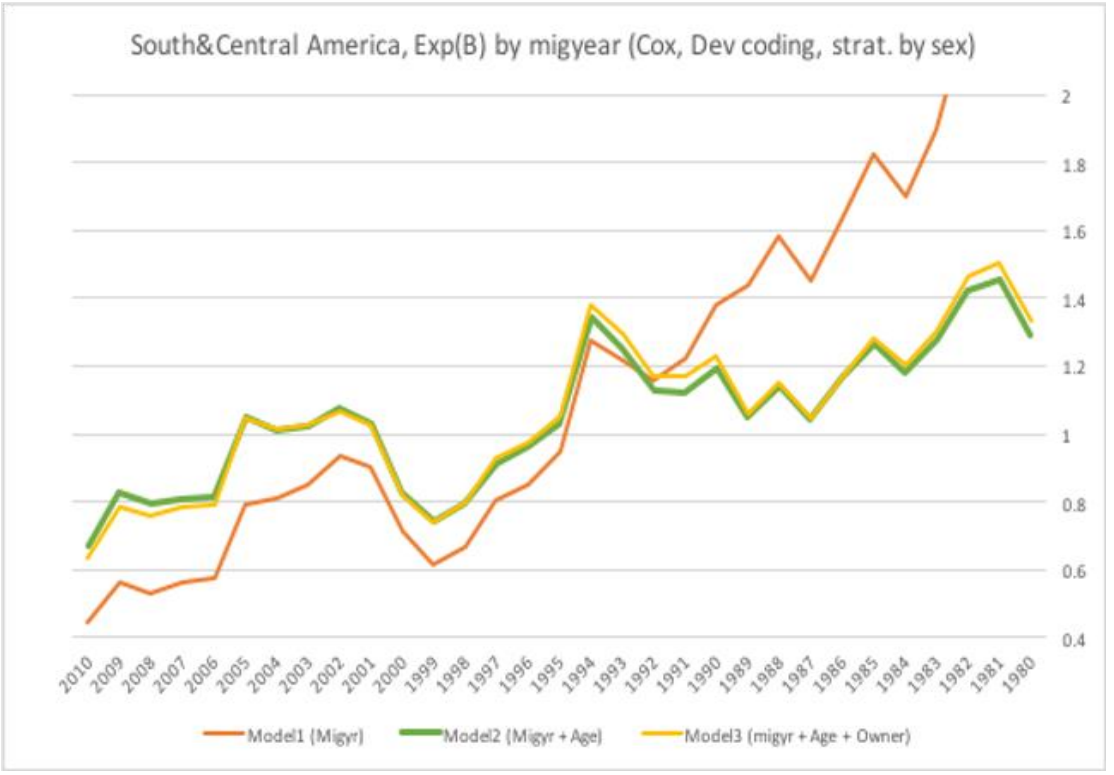


In contrast to figures 1 to 4, the graph in figure 5 shows only the time trend in mortality. In other words, it maps differences between subsequent cohorts of migrants and no longer between migrants and natives. As always, age effects are neutralized to make clean comparisons. The general trend is a slow increase in relative mortality as years of stay in Belgium accumulate. For those arrived before the late 1980's, having very long durations of stay, mortality does not keep rising as it did in the first years after arrival. It is even somewhat lower again. Given that the overall mortality level in North African immigrants was about 25% lower than among non-migrants, we witness a gradual convergence towards native mortality levels except for that very earliest immigrated subgroup. That trend is largely compatible with

the theoretical framework of the health transition theory, but the enduring mortality advantage of the earliest arriving subgroup suggests they carry an enduring positive health effect which may be linked to positive self-selection.

Figure 6 shows the time trend in Latin American immigrants' mortality. It is a stronger and even more convincing example of mortality convergence, in the sense that a large initial health advantage shortly after arrival drops drastically over the next years. It could again be interpreted by the image of the epidemiological time-traveller enjoying the best of both worlds when arriving in Belgium but loosing that advantage over time as predicted by the health transition theory.

Figure 6.

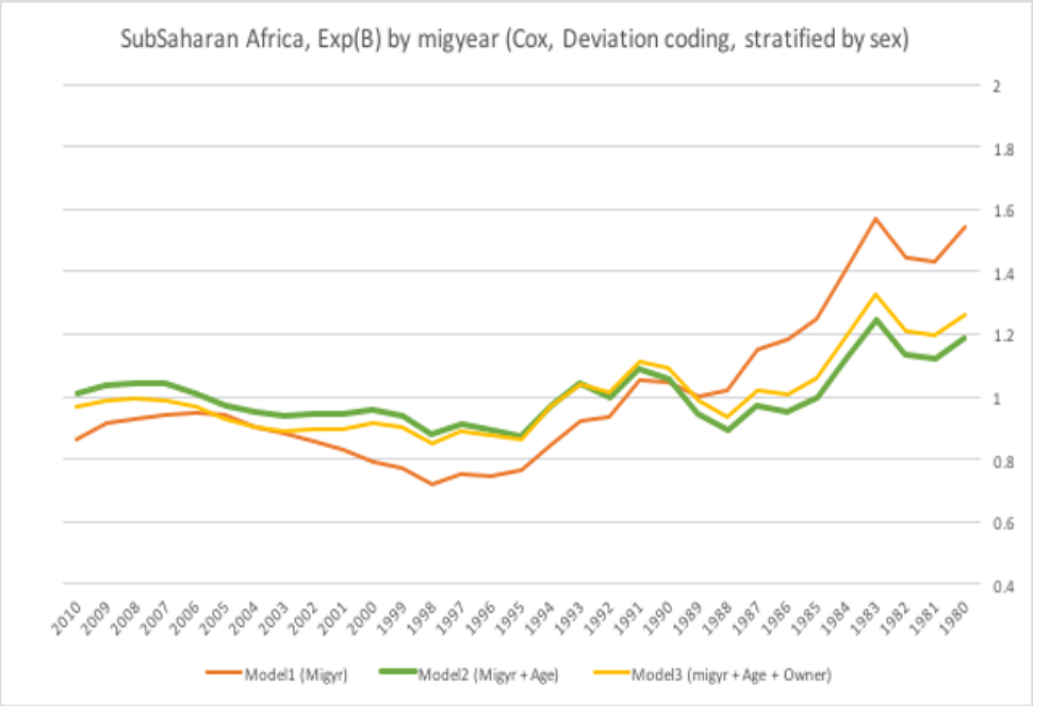


The lower mortality levels found for those arriving in the late 1990's, however, does not completely fit the trend.

In Sub-Subharan African mortality, a more complex trend is evident (Figure 7). The curve is slightly U-shaped showing a first phase of relative decline, followed by an upward trend in mortality for those having arrived before about 1995. The trend itself, and the fact that Sub-Saharan Africans living in Belgium did not have a consistent mortality advantage in the first

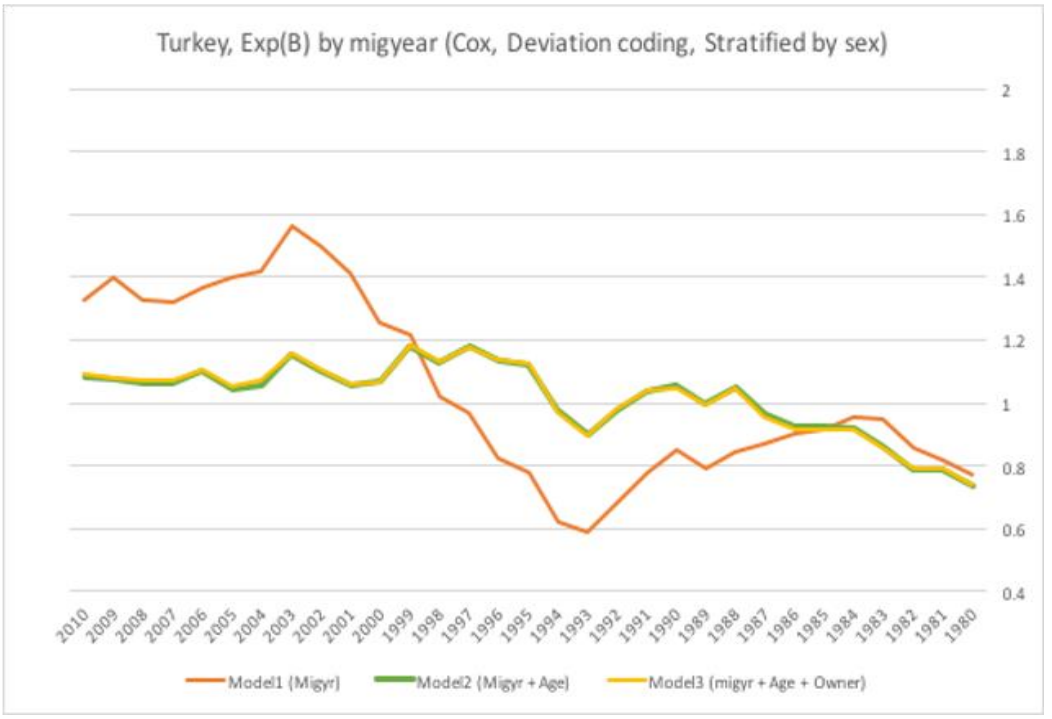
place, render explanations along the lines of positive health selection and health transition rather superfluous.

Figure 7.



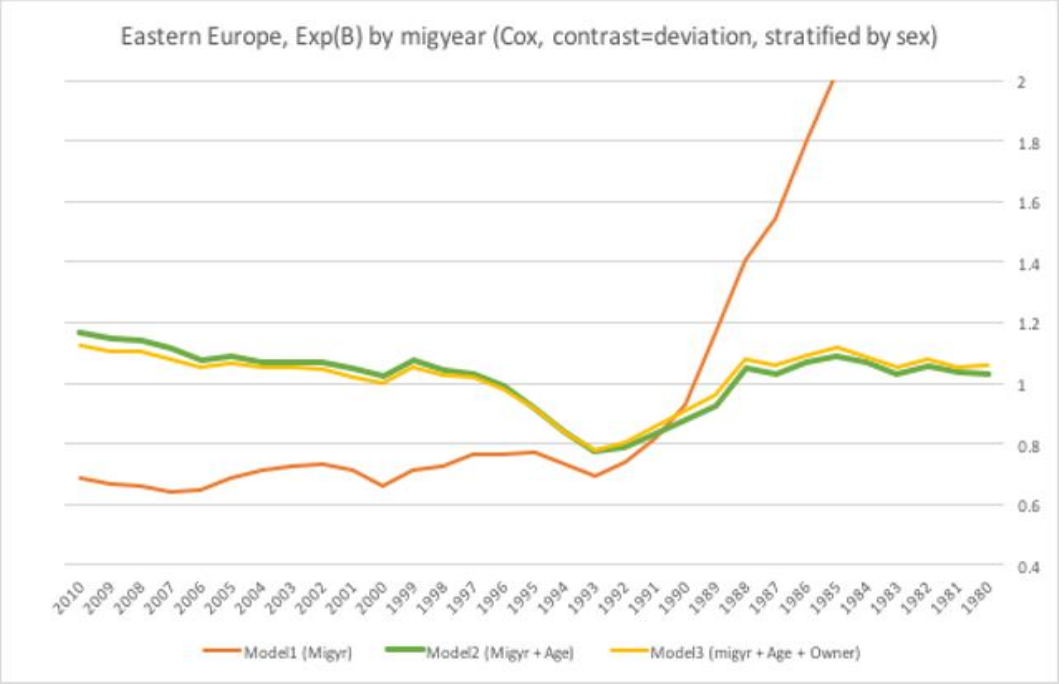
An even more puzzling case is found in Turkish immigrants (Figure 8). For those arrived after 1995 mortality levels are stable, but two other cohorts are marked by significantly lower mortality: those arriving around 1992-1993 and those arriving in the earliest days of Turkish immigration. Health transition is no satisfactory explanation for such evolutions, but it could possibly be explained by selection mechanisms: the healthy worker effect for the earliest immigrants, and perhaps marriage-market effects for those in the early 1990's, when labour migration and family re-unification were past their peaks for immigration into Belgium.

Figure 8.



The final example of mortality trends concerns Eastern-European immigrants (Figure 9). Initially, recent newcomers had higher mortality levels than non-migrants in Belgium, and the long-term trend is a drop towards the overall Belgian level. However, those arrived shortly after the political revolutions in Eastern Europe around 1989 show a strong dip in mortality levels that lasts for almost a decade (roughly 1989 to 998). Just like in Turkish immigrants, it is quite remarkable that such cohort effects are still visible in lower mortality levels twenty or more years after immigration.

Figure 9.



The five examples presented above cover large sections of immigrant populations in Belgium. They contain sufficient evidence to conclude on the drivers of mortality differentials in migrant populations, and specifically on the Healthy Migrant Paradox. A healthy migrant effect can be observed in Belgium, but it is limited to regional subgroups (North African and Latin American immigrants) and sometimes concentrated in the earliest arrivals (Turkish immigrants). In some cases, intermediate migration cohorts stand out in having lower mortality, such as early 1990's immigration from Eastern Europe. This illustrates that linear convergence of immigrant mortality towards native mortality is not the general rule. On the other hand, gradual convergence towards native mortality patterns is sometimes observed. It happened at a strong pace in Latin American newcomers where the initial health advantage was impressive, and at a far slower pace in North-African newcomers. Convergence towards the native level of mortality is not only found in situations with an initial health advantage for immigrants, but just as well in situations where newcomers have higher mortality (e.g., Eastern Europe and France). However, mortality convergence is a slow and enduring force that often takes decades to produce significant effects. Selection, on the other hand, can produce large tempo-shifts from one year to the next.

4.2.3. Regular and irregular migrant mortality

Now that mortality in Belgium's regular immigrants is better understood, the question arises on how to apply that knowledge to informal and irregular migrants. A pragmatic answer is to use mortality in recently registered newcomers as a proxy for their unregistered counterparts. The basic idea is that many migrant newcomers have spent some time as an informal migrant before officially entering Belgium, including periods as a tourist, a visa-holder or as an applicant for a long-term status. In that case, in terms of demographic characteristics, informal migrants are separated from regular migrants only by time. In other words, they could be conceptualized as citizens with a negative duration of stay, on the doorstep of legal entry into to country and therefore most closely comparable to recently immigrated regular newcomers.

The remaining question is then whether the difficult living and working conditions for large shares of informal migrants would not have boosted mortality to significantly higher levels compared to those recently arrived regular newcomers who have full access to health care and guaranteed working conditions. In other words, does the migrant mortality advantage (or the lack of a disadvantage) apply to informal migrants where social disadvantage is even more accentuated?

Only circumstantial evidence is available to address that question. We analysed causes of death, searching for lethal marks of hazardous living conditions such as deaths to non-natural causes (suicide, violent death, accidents, …). Surprisingly, no increased share of non-natural death compared to regular immigrants was found. Given that irregular migrants are over-represented in younger age groups where accidents and suicide are high on the list of mortal causes, this is a significant finding supporting our pragmatic solution. It is quite possible that while informal immigrants are exposed to higher health risks in some circumstances, they are protected from others by living in urban areas, not driving or owning a car and living quietly in a limited radius around home. Also, they may be accumulating lifestyle related health risks that will become apparent in chronic disease or in increased mortality in later stages of life. Even if far from optimal and in some circumstances downright inhumane, the living conditions of informal and irregular immigrants in Belgium are quite different from circumstances and dangers during migration journeys on many routes across land or sea. We must also point at

the fact that immigrants from third countries who are not in the population register are not necessarily living clandestine lives without support networks.

4.3. Results

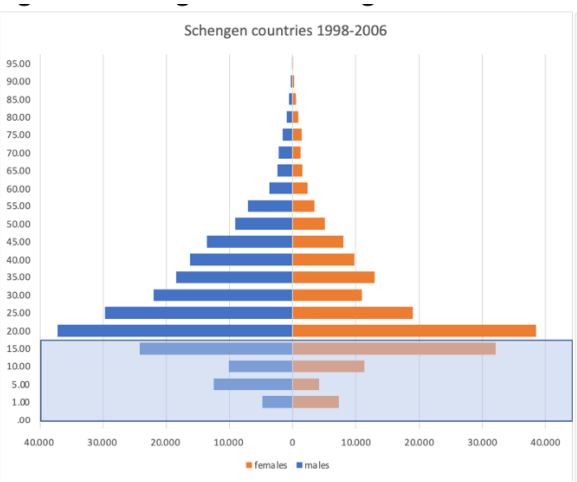
Between 1998 and 2016, roughly 40.000 unlinked deaths were encountered in Belgium. The majority were EU-citizens, primarily from Belgium's neighbouring countries. A second important group had Belgian nationality but was not registered as living in Belgium at time of death. Most of them were Belgian expats or foreign-origin Belgian nationals who no longer had an official residence in Belgium. Non-EU-nationals accounted for the remaining 3.500 unlinked deaths. That is a small number, which does not allow informal/irregular immigrants from third countries to be detailed by country of origin. Except for Turkey, larger regional aggregates of countries are used in extrapolations. For each group, mortality among recently registered newcomers was calculated based on the population register. In order to eliminate small cell variation and get a smoother mortality distribution, observed life tables were substituted by model life tables with the same overall mortality level. The multipliers used for extrapolation were taken from the smoothened version of the life tables. Extrapolation itself was a straightforward process of multiplying all age/gender specific numbers of unlinked deaths with the inverse of the mortality rates for the same age/gender combination. The process was repeated for each country group and for three periods (1998-2006, 2007-2011, and 2012-2016).

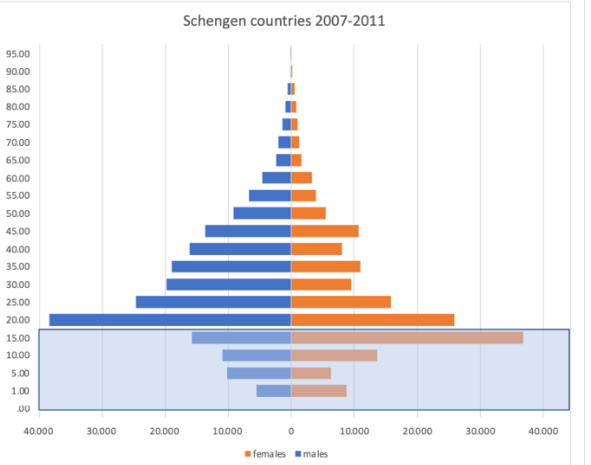
The procedure of building up population totals from small age/gender cells creates detailed output in terms of an age structure in 5-year groups from birth up to 100+ years of age. However, given the limited number of observations, we must be cautious in age groups where population is exceedingly small, or where mortality rates are exceedingly low. For that reason, below the age of 20, our estimates must be interpreted as rough indicators rather than as reliable indicators. Similarly, results are far more reliable for large country aggregations (EU-total/non-EU-total) than in smaller regional entities.

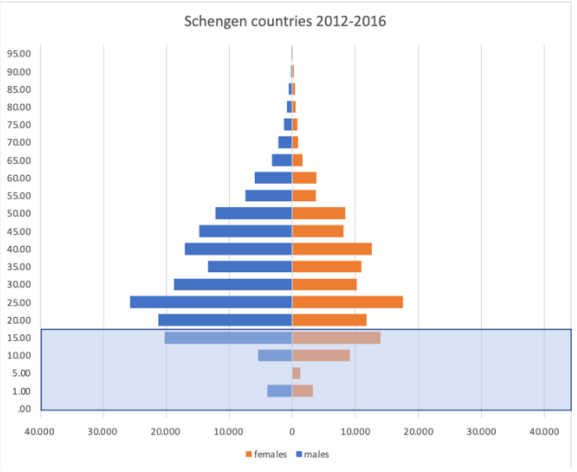
Splitting-up results between Schengen and non-Schengen countries of origin (Figures 10 and 11), it becomes evident that third countries represent around 40% of unregistered immigrants in Belgium, leaving the remaining 60% for EU-Schengen-citizens. More detailed estimations reveal that informal immigrants of French nationality alone are about as large in size as all

third countries combined (around 200.000). Over time EU-origin informal immigrants are slowly dropping in numbers.

Figure 10.





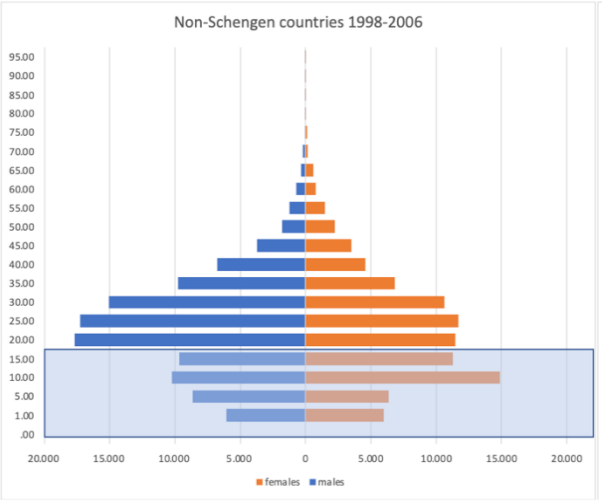


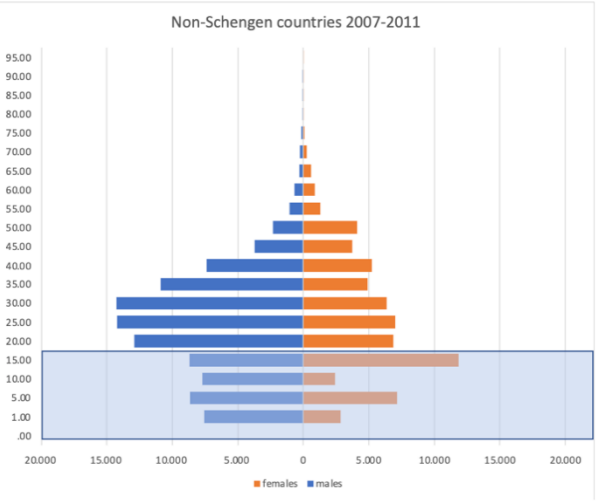
1998-2006	Male	Female	Total
Total population	217000	171000	388000
Gender %	56%	44%	100%
Mean age	31,3	28,4	30,0
Population 0-19	52000	55000	107000
Population 20-39	107000	81000	188000
Population 40+	58000	35000	93000
2007-2011	**Male**	**Female**	**Total**
Total population	202000	164000	366000
Gender %	55%	45%	100%
Mean age	32,0	27,9	30,1
Population 0-19	42000	65000	108000
Population 20-39	102000	62000	164000
Population 40+	58000	37000	94000
2012-2016	**Male**	**Female**	**Total**
Total population	175000	119000	294000
Gender %	59%	41%	100%
Mean age	35,6	33,7	34,8
Population 0-19	30000	27000	57000
Population 20-39	79000	51000	130000
Population 40+	66000	41000	107000

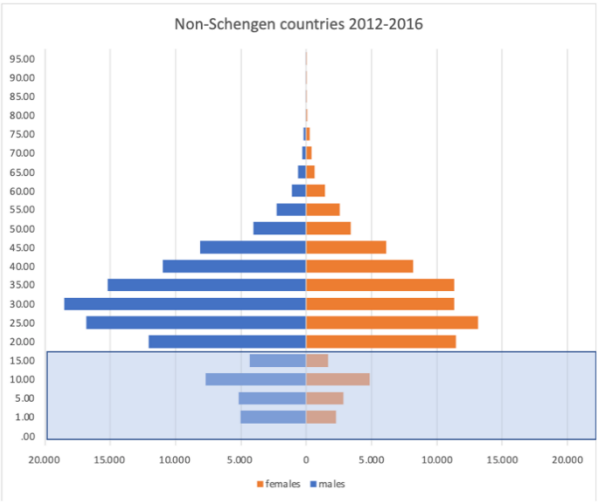
Third country irregular/informal immigrants are more less maintaining their totals. More precisely, age groups above 20 are growing in numbers whilst children and teenagers go down. Together, this causes a significant ageing within the unregistered population.

Looking at trends over the three periods, a significant drop is noted in the years 2007-2011 compared to earlier years. Numbers go down by 35.000 according to our estimations, with woman and children decreasing more intensely than adult men. The regularization campaign of 2009-2011 is behind that drop. Under the new rules of that campaign, 28.000 people allegedly received a regular status. Those rules prioritized families with school-going children, which coincides with the finding of those groups reducing more strongly during these years.

Figure 11.







1998-2006	Male	Female	Total
Total population	109000	93000	202000
Gender %	54%	46%	100%
Mean age	25,9	24,9	25,4
Population 0-19	34000	39000	73000
Population 20-39	60000	40000	101000
Population 40+	15000	14000	28000
2007-2011	**Male**	**Female**	**Total**
Total population	101000	66000	167000
Gender %	61%	39%	100%
Mean age	26,4	28,2	27,1
Population 0-19	33000	25000	57000
Population 20-39	52000	25000	78000
Population 40+	16000	16000	32000
2012-2016	**Male**	**Female**	**Total**
Total population	113000	82000	195000
Gender %	58%	42%	100%
Mean age	31,0	32,7	31,7
Population 0-19	23000	12000	34000
Population 20-39	62000	47000	110000
Population 40+	28000	23000	51000

4.4. Informal and irregular immigrants

Results presented above are computed as extrapolations of deaths in the population that is not included in the population register (unlinked deaths). That population includes every non-citizen of Belgium being present on Belgian soil at the time of death, for whatever motive or duration and regardless of legal status. Therefore, informal immigrants are included as well as irregular ones. In the estimated 195.000 third country unregistered immigrants and the 294.000 unregistered Schengen nationals, the regular fraction can be estimated by looking at the number of visas issued each year, touristic information provided by hotels, and official statistics on other groups that have a documented status without being covered by Belgium's national register. The largest of these documented groups are asylum applicants during the

application procedure. Within the 195.000 estimated non-registered third country immigrants, asylum seekers account for 50.000. Other important groups are short term visa holders, protected diplomatic staff of international and EU institutions, and regular tourists. All those documented groups together account for an estimated 83.000 third-country immigrants and visitors, leaving around 112.000 irregular third country immigrants.

It is not common to make estimates for the number of EU-citizens in an irregular stay. However, EU-nationals are required to declare their presence and register in the municipality of residence for uninterrupted stays exceeding three months and for repeated stays within a reference period. With an estimated total of 294.000 mostly neighbouring country citizens, it is clear that the phenomenon is not limited to regular short visits. It effectively concerns stable residence, mostly concentrated in border regions with France and the Netherlands. If we apply the same method as for non-EU-citizens, a total of around 77.000 persons are estimated to be in a regular residence status, leaving 217.000 supposedly irregular EU-nationals living in Belgium. However, within those 217.000 an unknown number of visitors could be travelling back and forth within the three-month registration-free period to maintain a regular status. For that reason, larger margins of error should be taken into account for the estimated Schengen-population living in Belgium.

5. Discussion

Mortality data can bring important contributions to the measurement and understanding of irregular migration (Surkyn et al., 2022). The quality of mortality-based estimations is expressed in several ways. Results are detailed in terms of gender and age, and very smooth age distributions demonstrate the stability of the outcomes. Such detail can be extremely useful for translating outcomes into policy. Our estimations have clearly shown the effects of the 2009-2011 regularisation campaign, and how it affected children and women in certain age groups. Similarly, the aging of unregistered immigrants as a group indicates that the return rate in higher age groups is probably quite low. In other words, the image of a highly mobile population that is constantly kept young by new arrivals may not apply to all. It seems likely that a growing group of older people is trapped in a situation of irregularity.

Apart from results that are detailed and corroborated by independent sources, the method of mortality extrapolation has several methodological advantages. Firstly, it is transparent in the use of multipliers and weights in the estimation model. The multipliers are found in life tables computed for immigrant populations. The only model hypothesis is that mortality in recently registered migrants is a good estimator of mortality in irregular and informal immigrants.

In terms of data requirements, the technique relies on two sources of information. The first is lifetables that are valid for recent immigrants. The second is the number of deaths in occurring within the population of interest, detail by age, gender, and origin. In Belgium, that information was constructed indirectly by subtracting deaths in the national register from the larger dataset of statistical death registration which covers all death on Belgian soil. Similar double registration of mortality exists in other EU-countries, allowing identification of unlinked or non-register deaths. In other countries direct methods of counting deaths in informal immigrant populations may be available based on diplomatic procedures relating to death of foreign citizens within their borders.

This means that mortality extrapolation can be an adequate source of harmonised statistics on irregular populations in Europe. Therefore, given the fragmented and hardly comparable information that is currently available, mortality extrapolation potentially fills a major knowledge gap in migration statistics. In short, despite these challenges, the potential of mortality data in enriching our understanding of irregular migration patterns is evident. The existing efforts will bring in more in-depth insights about the potential of the extrapolation methodology. The European Commission funded HumMingBird[1] and MirreM[2] projects are currently working elaborating the methods we discussed here. Future research should focus on improving the quality of mortality data and developing more sophisticated statistical tools for analysing these data.

[1] https://hummingbird-h2020.eu/
[2] https://www.irregularmigration.eu/

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