Introduction

Belgium is an immigration country with population growth largely attributed to international migration, and a relatively high proportion of immigrants (17.1% of foreign-born) in 2018 (Statbel, 2019). Regarded as country with a robust social protection system and high-quality healthcare, it comprises three communities or linguistic regions (Dutch, French, and German) and three administrative regions (Flanders, Wallonia, and Brussels-Capital) where integration and healthcare policies may differ from one another. This triple multicultural context, ethnic diversity, and universal access to healthcare may have significant implications for healthcare accessibility and satisfaction, impacting immigrants and their health-related experiences. Such a context provides a unique opportunity to conduct in-depth and detailed analyses of under-5 mortality (U5M) according to parental origin. U5M serves as a classical indicator of child health, reflecting socio-economic inequalities at different levels: prenatal, post-neonatal and neonatal.

In studies of infant health according to their parents' migratory or ethnic background, the paternal characteristics are rarely accounted for (Palatnik et al., 2021). However, there is evidence that they could have a substantial impact on infant health. A comprehensive analysis of various perinatal indicators, including gestational diabetes, gestational hypertension, preterm birth, cesarean delivery, low birth weight, five-minute Apgar score, admission to a neonatal intensive care unit, and assisted ventilation, revealed a strong association between the father's ethnicity and adverse outcomes (Palatnik et al., 2021). Further evidence comes from studies indicating absence of the father or unwanted pregnancies exhibited the poorest health outcomes (Ma, 2008; Palatnik et al., 2021; Payne-Sturges et al., 2022). These different studies suggest that paternal characteristics, including ethnicity, origin, or migratory status, should be considered alongside maternal characteristics when assessing infant health indicators. Moreover, despite a significant decline in infant mortality (UN IGME, 2019), regional disparities in infant mortality persist in Belgium (Debuisson, 2001; Statbel, 2023). These regional differences deserve to be investigated from the perspective of immigrant-native gap because, as Dauvrin et al. (2012) suggest, the implementation of equitable health policies for migrants and ethnic minorities might face challenges due to Belgium's north-south legal and administrative divide.

The aim of this paper is to measure the immigrant-native U5M gap and to identify the risk factors associated with this gap. The specific objectives are to measure levels and variations in the immigrant-native U5M gap at national, regional and provincial levels, quantify the impact of associated risk factors and assess the extent to which socio-economic differences are associated with the immigrant-native U5M gap and finally examine whether these results vary based on the mother's or father's origin.

This paper is structured as follows. The next section presents an overview of the literature, focusing on strands that are most closely related to the objectives listed above, after a brief presentation of the Belgian context. We will then describe the data and the method used for our analyses and present our results. The paper will conclude with a discussion of the results and limitations, and provide an outlook regarding opportunities for further research.

1. Literature review

1.1. Belgian context

Belgium is a federal state made up of three administrative regions: Flanders, Wallonia and Brussels. Each region has its own government and parliament. Flanders, the northern part of the country, is divided into five provinces: Antwerp, Limburg, East Flanders, Flemish Brabant and West Flanders. It has around 6.6 million inhabitants in 2019 and covers an area of 13,624 km². It has 62 maternity units, the highest number in the country in 2016 (Lefèvre et al., 2019). The Walloon region is the southern region divided also into five provinces such as Walloon Brabant, Hainaut, Liege, Luxembourg, Namur. It is home to the German-speaking minority (in eastern Wallonia), which forms Belgium's German-speaking community. It covers an area of 16,845 km² and a its population is around 3.6 million in 2019, with 35 maternity units in 2016 (Lefèvre et al., 2019). The Brussels-Capital region, located on the southern border of Flanders, has a population of 1.2 million inhabitants and covers an area of 161.4 km² in 2019. In 2016, it was equipped with 11 maternity units (Lefèvre et al., 2019). It is home to university referral centers (Van Leeuw

& Leroy, 2020), which are more likely to intervene in the event of pregnancy complications. There are regional disparities in the healthcare system in Belgium. Depending on the region, women encounter various healthcare providers and facilities, and this can influence their access to healthcare services. These regional disparities, symbolic of the North-South dichotomy, are also evident in certain indicators of child health described in some reports (INAMI et al., 2014; Devos et al., 2019).

1.2. Infant characteristics, SES and infant health

While congenital anomalies, whether of structural, functional, metabolic, genetic, or other origins, are the main cause of infant mortality across all industrialized countries (Hercot et al., 2015), the sociodemographic and socioeconomic factors related to both the infant and their parents play an significant role on infant health.

Sex, being a biological trait, serves as a basis for expressing health disparities. Female children experience lower mortality rates than their male counterparts primarily because of their inherent biological advantages (Bergeron-Boucher et al., 2018; Riswick & Hsieh, 2020). Another child-related characteristic is multiple births, which is associated with pregnancy complications, higher risks of preterm birth and infant mortality (Monden et al., 2021). To conclude on infant characteristics, birth weight and birth rank have been shown to be strongly associated with infant mortality. Indeed, (very) low birth weight (Evans & Alberman, 1989; Farré, 2016; Štípková, 2016; Ballon et al., 2019; Kihal-Talantikite et al., 2019) and being a first-born child (Elder et al., 2016; Menashe-Oren et al., 2023) are important predictors of infant mortality. Indeed, infants with low or very low birth weight are more susceptible to complications such as respiratory distress, infections, and developmental delays, which significantly increase their risk of death in the neonatal period and beyond. Low birth weight is often associated with preterm birth, maternal malnutrition, or other adverse prenatal conditions. The expected effect of low birth weight on infant mortality is negative, meaning that lower birth weights lead to higher mortality rates. Being a first-born child is another key predictor of infant mortality. First-borns often face higher risks due to a combination of biological and social factors. Biologically, first pregnancies may be more prone to complications, including premature birth or labor difficulties. Socially, first-time parents may lack experience in infant care, which can lead to higher risks of inadequate nutrition, poor management of illness, and accidents. The expected effect of being a first-born child on infant mortality is also negative, meaning that first-borns tend to have higher mortality risks compared to later-born children. In summary, both low birth weight and first-born status are associated with higher infant mortality because they increase vulnerability to health complications and less experienced care, respectively.

Socioeconomic status (SES) of parents, especially the mother has been extensively studied in relation to infant health. These include socio-professional categories, education, age and marital status.

Socio-professional categories (SPC) serve as an indicator of hierarchical social positioning, allowing individuals from privileged social classes to access greater economic resources to meet their essential needs and those of their families. This advantage includes providing better nutrition and adequate healthcare for their children. Consequently, a child born to a parent in executive and intellectual positions would be more likely to survive than a child born to a manual workers parent, assuming all other factors are equal. However, demonstrating a clear and consistent effect of this variable on children's health has become increasingly challenging. A multivariate analysis of infant mortality based on according to the mother's socio-professional category (SPC) in France during the period 2004-2009 showed no significant differences between the groups, except for inactive women. In this group, the infant mortality rate (IMR) was significantly higher compared to executives (Niel, 2011). Another similar analysis covering the period 2008-2017 in France confirms this result with the father's SPC, demonstrating that despite the increase in Odds Ratios from intermediate positions (compared with executive and intellectual positions), through office workers to manual workers, the 95% confidence intervals of all these estimates overlap (Wallace et al., 2020). Such complexity is also evident in the results of a multi-country European analysis of socio-economic inequalities in stillbirths (Zeitlin et al., 2016). Indeed, for mothers' occupations, the median relative risk (RR) comparing outcomes among manual workers with managers and professionals was 1.6 (interquartile range, IQR: 1.0–2.1) whereas for fathers' occupations, the median RR was 1.4 (IQR: 1.2–1.8) (Zeitlin et al., 2016).These results, indicative of the tightening of social inequalities, could be explained by the quality of this variable, according to Niel (2011). He argues that SPC couldn’t explain IMR but rather the level of attention to public health issues and education itself, linked to SPC.

The link between women's education and infant mortality is one of the most consistent and robust findings in public health (Shorette & Burroway, 2022). A high level of education is likely to improve medical knowledge (Hoffmann et al.,2018), promote healthier practices (Jadalla et al., 2015) and provide easier access to economic and social resources (Green & Hamilton, 2019). Empirical evidence supporting the positive link between education and children's health has been provided in numerous studies. For example, Smith-Greenaway (2020) showed that parental education is independently associated with a reduced risk of low birth weight in their children in Sub-Saharan Africa. In addition, a higher level of mother or father’s education is associated with lower infant mortality (Saarela & Finnäs, 2014; Balaj et al., 2021).

Mother's age at childbirth is a crucial factor in child health. Early motherhood poses risks not only for the mother but also for the child due to physiological reasons; the woman's body might not be fully prepared for childbirth, increasing the chances of neonatal infections (Mitha et al., 2013) and low birth weight (Fishman, 2020). While early motherhood presents risks, so does childbirth at later stages. Advanced maternal age, for instance, is a significant factor in multiple births (Monden et al., 2021). As reported earlier, Multiple births are a risk factor for infant mortality, underscoring maternal age as a predictor of infant health and mortality (Riswick & Hsieh, 2020).

The mechanisms through which marital status could impact infant health are manifold. Existing literature offers several insights into the pathways leading to adverse health outcomes in unmarried women. Indeed, several studies have demonstrated that single mothers, much like their married counterparts, typically experience more adverse socio-economic conditions (Fiori, 2020; Algava et al., 2021; Iceland, 2021). They often face poverty, work fewer hours than other families, and more frequently reside in overcrowded housing (Algava et al., 2021; Iceland, 2021). Given these unfavorable factors, they are less likely to seek timely prenatal care compared to married mothers, considering that all these factors increase the risk of preterm birth and low birth weight (Castro-Martin, 2010).

1.3. Infant health and paternal characteristics

While the exact mechanism through which the father's characteristics influence infant health remains unclear. Some studies highlight disorders such as genetic mutations and sporadic autosomal dominant congenital diseases (Apert, Lesch-Nyhan, Crouzon, Pfeiffer, Noonan and Costello syndromes, multiple endocrine neoplasia and achondroplasia) linked to paternal age (Courtenay & Gordon, 1977; Janeczko et al., 2020). Some of these congenital abnormalities can adversely affect infant health (Reichman & Teitler, 2006) and, in severe cases, even infant mortality (Gourbin & Wunsch, 1999). While these studies have focused on biological factors, literature on the effect of the father versus the mother is scarce. Some studies have analyzed the absence of information on the father in birth certificate as a proxy of father effect. For example, referring to adverse infant health outcomes linked to the absence of information on the father in birth certificate, Ma (2008) suggested that this could be the case for unwanted pregnancies, unwanted children, and particularly vulnerable children. The latter are likely to receive less care than others during pregnancy and after birth, which is an additional risk factor for their survival.

1.4. Methods for analysis of racial or ethnic disparities in child health

A substantial body of literature has been dedicated to examining disparities in infant health among different ethnic or racial groups. It focused mainly on Hispanics, Latin Americans, African Americans, and Whites in the U.S., as well as between immigrant and native populations in Canada and some European countries using several methods. Some studies used classical regression models. In these models, the outcome variable indicating infant health is controlled for various individual and contextual factors along with racial/ethnic background (see Racape et al. (2010), Minsart et al.(2013), Gillet et al. (2014), Racape et al.(2016), Sow et al. (2019), Sow et al. (2021) and Wallace et al. (2020) for more details on this approach). Another method, which follows on from the previous one, is to run regressions for each group and derive the gap, as in the study of Collins & Thomasson (2002). Research focused on trends in racial disparities in infant health includes the use of jointpoint regression modeling (Goovaerts & Xiao, 2011; Gennuso et al., 2019).The Oaxaca–Blinder (O-B) regression-based decomposition method is an alternative to traditional logistic or linear regression modeling used to explain infant health gap among racial or ethnic groups (DeSisto et al., 2018; Powers, 2016; Stanek et al., 2020, 2021). The latter, on which the present research is based, is able to identify, through observed differences, the exact and direct levers on which public policies could be based for better infant health outcomes. Its usefulness as a tool to guide decision-making for policymakers is therefore obvious (Lam et al., 2021; Rahimi & Hashemi Nazari, 2021).

1.5. What can drive the changes in racial/ethnic gaps in infant health?

The decreasing or increasing disparity in infant health between two groups based on ethnic or migratory background could result from various factors. These factors may be modifiable or not. Modifiable factors, which are the levers that public authorities can act upon to improve infant health, make infant health a flexible metric (Elder et al., 2016). Among these factors are public health, social, and migration policies.

Public policies can have a dual effect on immigrant health, as noted by Juárez et al. (2019) and Mendoza (2009), promoting well-being while contributing to health inequalities. Among these policies are migration policies, the impact of which on children's health has been reported in numerous U.S. studies. The Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) of 1996 is an example of this, as it limits immigrants' eligibility for federal welfare while giving states the option of creating alternative benefits. Joyce et al (2001) found that PRWORA-induced changes in funding for prenatal care and childbirth between 1995 and 1998 increased the number of low (and very low) birthweight infants among non-Dominican women in New York City. While the law improved prenatal care and birth outcomes for eligible pregnant immigrant women in California (Korenbrot et al., 2000), an analysis by Cho (2011) associated it with increased infant mortality rates among poorly educated Mexican immigrants in states that provided little post-reform support. In addition, Watson(2006) highlighted cost-effective federal sanitation interventions in 1960 on U.S. Indian reservations, explaining nearly 40% of the convergence of American Indian and IMR in reservation counties. In European immigration countries, little is known about the effects of migration policies on children's health. An overview of the European literature on the topic provides limited insights. A systematic review on the association between pregnancy outcomes and integration policies from a dozen European countries revealed that immigrant women showed a clear disadvantage for all the outcomes (low birth weight, pre-term delivery, perinatal mortality, and congenital malformations) compared to native women. The risks were clearly and significantly reduced in countries with a strong integration policy including Belgium (Bollini et al., 2009).

Paid maternity leave is one of the social policies that can have an impact on infant health. A study has rightly shown that paid maternity leave is associated with a significant decrease in neonatal, infant, and child mortality in 141 member and non-member countries of the Organization for Economic Cooperation and Development (OECD) (Heymann et al., 2011). A more recent study than the previous ones suggested that perinatal outcomes can vary by host countries due to integration policies. It revealed that perinatal mortality risk was substantially reduced in countries with strong integration policies (Minsart et al., 2013).

While public policies can directly influence the improvement or deterioration of child health based on migration or ethnic origin, as mentioned earlier, they can also operate indirectly. Flores (2017) rightly emphasized the influence of public policies, especially anti-immigrant laws, which can not only shape and encourage behaviors and attitudes hostile to immigrants but also create discrimination. There is growing evidence that racial or ethnically related discrimination is detrimental to both maternal and infant health (Rich-Edwards et al., 2001; Rosenberg et al., 2002; Mustillo et al., 2004; Giurgescu et al., 2011; Daalen et al., 2022; UNFPA, 2023).

2. Methodology

2.1. Data

We used a dataset that includes civil registration records (birth and death certificates) and census data (2001 and 2011). Only births for which the identifier of at least one parent was recorded on the birth certificate were included. A total of 2,692,524 live births in Belgium from 1998 to 2020, 74% of them Belgian-born, met this criterion and were therefore included.

2.2. Variables

The outcome variable is a binary variable indicating whether a child died before age 5 or not. Two indicators were used to measure the main independent variable. These were the father's country of birth and the mother's country of birth. Each of these indicators was transformed into a binary variable, indicating the migratory status of the father and mother respectively. The two categories identified are: Belgian-born (native) and foreign-born (immigrant).

Alongside the parental origin, we adjusted for several other predictor variables that included infant or other parental characteristics. Infant characteristics include sex, multiple births, birth rank and birth weight. These variables have previously been shown to have a significant impact on infant mortality and are readily available in the birth certificate. Parental characteristics including the mother's and father's date of birth, their marital status and their socioeconomic index, were obtained by matching the birth certificate to the 2001 and 2011 censuses.

The mother's and father's date of birth were used to compute the mother's age and the father's age at the child's birth.

The socioeconomic index is a metric quantifying social disparity in mortality, based on four dimensions of social status measured at individual level: education, employment, housing and income. Developed by Sanderson et al.(2023) using census data (1981, 1991, 2001 and 2011), this index, similar to the Human Development Index (HDI), is calculated by summing scores from its four component dimensions. It is categorized into quartiles, ranging from the most economically disadvantaged to the most affluent. For instance, the first quartile includes a higher proportion of elderly and retired individuals, belonging to smaller households, with lower education level, mostly renters, and blue-collar workers. In contrast, the fourth quartile includes younger, active, individuals with higher level of education, mostly homeowners, grouping individuals with higher SES.

2.3. Statistical analysis

To carry out our statistical analyses, we used descriptive and multivariate analyses.

The descriptive analyses involved several regional indicators, the distribution of certain mortality risk factors according to migratory status, the distribution of under-5 mortality rate (U5MR) according to certain mortality risk factors and migratory status, and the annual changes in immigrant-native U5M gap from 2000 to 2019. For a more detailed analysis, we explored immigrant-native U5M gap at the provincial level using maps.

The multivariate analysis is based on the Oaxaca-Blinder (O-B) double decomposition. Initially introduced by Oaxaca (1973) and Blinder (1973), this method serves to identify, quantify, and distinguish the various contributions influencing differences in the outcomes of interest between two groups. In essence, it discerns the portion attributed to disparities in observed characteristic levels between the groups (which determines the share that would be reduced or increased if both groups had the same characteristics), along with the portion attributed to discrimination and other unknown associated factors (Rahimi & Hashemi Nazari, 2021) such as the mother's state of health on arrival, her level of education, her eating and smoking habits, the number of births, access to care, monitoring of pregnancy and the first year of life by the health services, language barriers, cultural differences, endogamy in certain immigrant communities, etc. The non-linear version of this method was applied due to the binary type of the mother's and father's migration status variables.

Thus, if we consider the following multivariate logistic model:

$$r_{gp} = F(X_{gp}\beta_{gp}) = e^{X_{gp}\beta_{gp}}, \text{ g} \in \{I_m, N_a\} \text{ et p} \in \{M, F\} \qquad (1)$$

Where

r denotes for each group gp, the binary variable indicating 1 if the child died before age five and 0 otherwise,

F is the cumulative distribution function of the logistic distribution.

X denotes the set of independent variables or risk factors for infant mortality, β denotes the set of parameters of the regression coefficients,

g distinguishes immigrant-born (I_m) from native-born (N_a) and

p is used to distinguish between parents M for the mother and F for the father.

The overall mortality gap is as follows:

$$\Delta = r_{I_m p} \text{-} r_{N_a p} \tag{2}$$

$$= \overline{F(X_{I_m p}\beta_{I_m p})} \text{-} \overline{F\left(X_{N_a p}\beta_{N_a p}\right)}$$

$$\Delta = \underbrace{\left[\!\left[\overline{F(X_{I_m p}\beta_{I_m p})} - \overline{F(X_{N_a p}\beta_{I_m p})}\right]\!\right]}_{E} + \underbrace{\left[\!\left[\overline{F(X_{N_a p}\beta_{I_m p})} - \overline{F(X_{N_a p}\beta_{N_a p})}\right]\!\right]}_{C} \tag{3}$$

p ∈ $\{M, F\}$

Performed separately for each parent, the double O-B decomposition makes it possible to distinguish the E component attributable to differences in risk factors or "composition effect" from the C component unexplained by the effects of these risk factors.

In the previous equation, immigrant-born is considered the reference group, while the comparison group is made up of native-born. The composition effect reflects a counterfactual comparison of the expected U5M gap if the risk factor distributions of immigrant-born and native-born were equalized. Similarly, the unexplained component reflects a counterfactual comparison of the U5M gap if immigrant-born and native-born were subjected to the same effects of these risk factors.

Note that the sum of the contributions of the two components is always equal to 100%. Nevertheless, a component can have a negative contribution or a contribution greater than 100%. Thus, whenever the contribution of one component is negative, it is offset by the contribution of the other component which exceeds 100%. The contribution of each component corresponds to the sum of the contributions of each factor (E=$\sum_k E_k$ et C=$\sum_k C_k$). A positive (or negative) coefficient of a factor implies a decrease (respectively an increase) in the mortality gap if the distribution of this risk factor were fixed to that of native but the effects of these risk factors among immigrant were unchanged.

The decomposition of U5M using logit coefficient estimates from pooled sample was performed. The calendar year variable was introduced into the model to assess variations in the immigrant-native U5M gap over the period 2000-2019. The categorical variables were implemented on the basis of indicator variables, which essentially represent their respective categories. To clarify, categorical variables were transformed into binary variables. This transformation helps standardize the categorical variables in response to the identification issue of non-linear O-B decomposition method that arises when using non-linear models, such as logistic regression or probit models. (Yun, 2005).

The categories retained for infant characteristics are: "female" for sex, "children of rank 1" for birth rank, "very low birth weight" (weight less than 1500 g) for birth weight, and "multiple birth" for multiple births. Regarding parental marital status, the category "parent in union" (married or cohabiting) was introduced into the models. The first quartile of socioeconomic index was used. Finally, for the variable 'age of mother or father at childbirth,' the continuous version was used.

In order to quantify average variations in immigrant-native U5M gap in each region, the multivariate analysis (including the calendar year variable) was replicated on each of the three regions.

3. Results

3.1. Descriptive results

Of the 2,692,524 live births during the period, 10,463 died before the age 5, giving an U5MR of 3.89‰. Some of the regional indicators are listed in table 1.

Tab *1:* Selected regional indicators

Regions	Births	% Births	<5 Deaths	U5MR (‰)	95% IC	
Flanders	1,388,862	51.58	5,146	3.71	3.81	4.00
Wallonia	795,970	29.56	2,907	3.65	3.60	3.90
Brussels-Capital	485,816	18.04	2,296	4.73	4.61	5.01

Note: *Missing values for region of birth are 0.81%.
Source : Own calculations based upon birth certificate 1998–2020

Tab 1 shows that Flanders accounts for more than half of all births in Belgium, while the Brussels-Capital region exhibited the highest U5MR from 1998 to 2020.

The following table shows the distribution of mortality risk factors according to migration status.

Tab 2: Covariates distribution according to parents' migratory status

Risk factors	Mother's migratory status (%)			Father's migratory status (%)		
	Total N = 2,692,524 (100.00)	*Immigrant-born N = 689,893 (25.62)*	*Native-born N =2,002,631 (74.38)*	*Total N = 2,692,524 (100.00)*	*Immigrant-born N = 758,059 (28.15)*	*Native-born N =1,934,465 (71.85)*
Female	48.83	48.92	48.8	48.83	48.91	48.79
Children of rank 1	43.56	36.11	46.13	43.56	36.67	46.26
Very Low Birth Weight	0.33	0.38	0.31	0.33	0.41	0.29
Multiple births	3.43	3.32	3.47	3.43	3.41	3.44
Mean mother's age (SD)	29.02 (4.75)	29.63 (4.85)	28.81 (4.69)	29.02 (4.75)	29.39 (5.12)	28.88 (4.59)
Mean father's age (SD)	29.00 (4.76)	29.53 (4.93)	28.82 (4.69)	29.00 (4.76)	29.32 (5.12)	28.87 (4.60)
Parent in union	51.99	51.89	52.03	51.99	49.67	52.91
Mother's 1st quartile SES	20.58	33.15	16.24	20.58	34.89	14.97
Father's 1st quartile SES	17.71	27.17	14.45	17.71	26.63	14.22

Note: SD= standard deviation

Source: Own calculations based upon birth certificate 1998–2020 and 2001 & 2011 censuses

Tab 2 shows a compositional difference in terms of the prevalence of: birth rank 1, very low birth weight, multiple births, parent in union, and the first quartile of the mother's or father's socioeconomic index between immigrant-born and native-born. This also applies to variables related to the age of the mother or father at the child's birth. For instance, immigrant women face a slightly lower prevalence of multiple births (3.3% vs. 3.5% for native-born). When considering the mother's origin, immigrant women are marginally less likely to be in a union (married or cohabiting) compared to native-born women. However, accounting for the father's origin shows a significantly lower proportion of immigrants in a union compared to natives. Disparities in low birth weight are also notable between these groups, with immigrant children often being born with significantly lower weights than their native-born counterparts. This difference is more pronounced when the father's origin is considered. As expected, differences in distribution are most prominent in the first quartile of SES. At least a third of immigrants fall within the first quartile of SES, while this is the case for approximately one in six natives. We also note that, similar to the very low birth weight and socio-economic status of mother and father variables, the differences between immigrant and native-born are more important for the birth rank variable compared to other variables, where the differences are relatively small.

Tab 3 goes a step further by examining the intersection of three variables: migration status, mortality risk factors and U5M.

Tab 3: U5MR (5q0) according to mortality risk factors and migratory status

Risk factors	Mother's migratory status		Father's migratory status	
	U5MR (‰)		U5MR (‰)	
	Immigrant-born	Native-born	Immigrant-born	Native-born
	4.27 (4.12-4.42)	3.75 (3.67-3.84)	4.98 (4.82-5.14)	3.46 (3.37-3.54)
Female	3.81 (3.45-3.99)	3.11 (2.94-3.32)	4.63 (4.32-4.79)	2.66 (2.58-2.82)
Children of rank 1	3.81 (3.53-4.12)	3.33 (3.13-3.42)	4.92 (4.55-5.22)	2.91 (2.77-3.02)
Very Low Birth Weight	267.81 (248.79-288.01)	278.67 (265.49-292.41)	341.21 (296.42-332.88)	249.44 (235.90-263.58)
Multiple births	14.02 (12.22-16.07)	15.65 (14.54-16.92)	16.78 (14.99-18.77)	14.45 (13.33-15.72)
Parent in union	4.11 (3.86-4.40)	3.23 (3.01-3.27)	4.73 (4.48-4.97)	2.86 (2.80-3.12)
Mother's 1st quartile SES	6.11 (5.79-6.44)	4.93 (4.61-5.34)	6.23 (5.91-6.62)	4.91 (4.56-5.34)
Father's 1st quartile SES	4.54 (4.11-4.89)	4.72 (4.44-5.03)	4.52 (4.21-4.87)	4.72 (4.44-5.02)

Note: 95% CIs in parentheses, computed using Kaplan-Meier estimator.

Source: Own calculations based upon Belgian Vital Statistics and 2001 & 2011 censuses

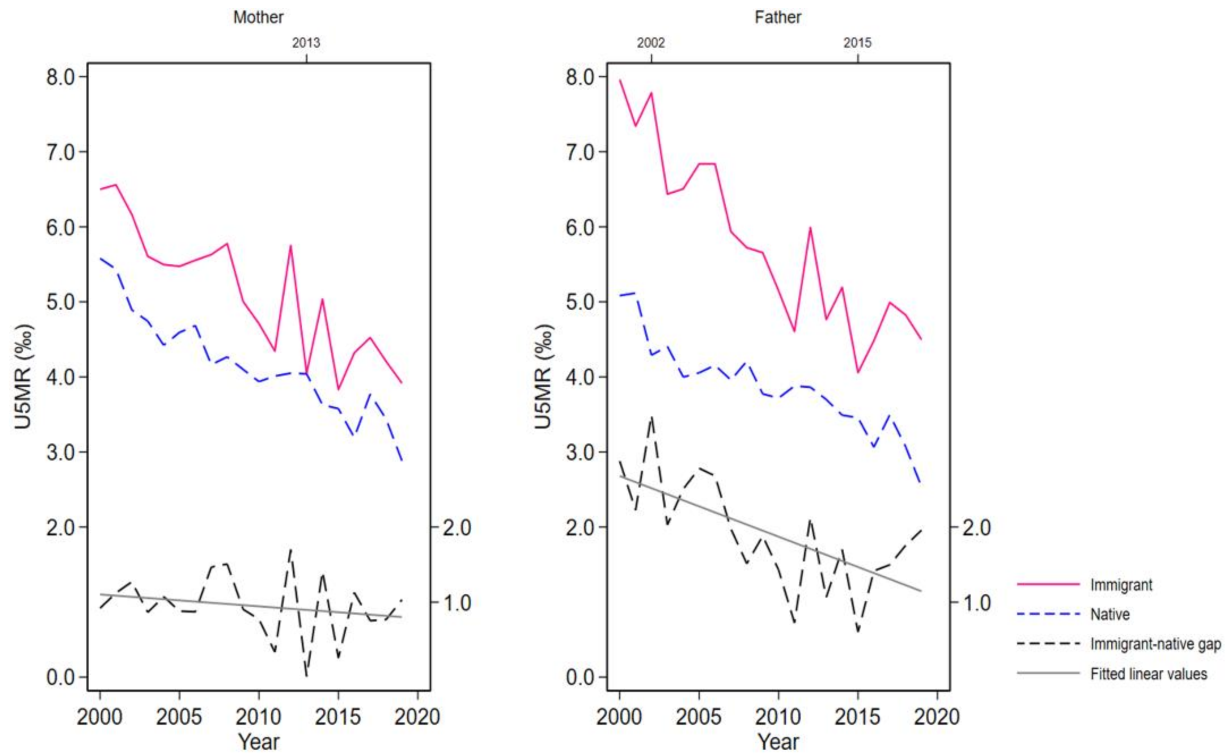
Tab 3 shows that immigrant-born has an excess U5MR, whether the country of birth of their mother or father is considered. However, while the U5MR of immigrant-born measured by the father's country of birth is higher than the same rate for the mother's country of birth, the opposite is true for the U5MR of children born to natives. These disparities between immigrants and natives will be decomposed in the multivariate section.

A bivariate analysis of U5M and each of the mortality risk factors based on migratory status reveals notable disparities that predominantly favor native-born mothers and fathers. Generally, children of native-born individuals have lower U5MR even when stratifying by risk factor. Additionally, it is crucial to highlight that very low birth weight and multiple births increase the mortality rate. Therefore, for each group, the U5MR for the low birth weight category exceeds 260 deaths per 1000 live births, and is at least 14 deaths per 1000 live births for multiple births.

Finally, it should be noted that the effects of all variables, with the exception of marital and SES, are significantly different both between immigrant and native-born, and between father's and mother's origin.

Another descriptive section is devoted to trends in U5M for the two groups, and the variation of the gap between them since 2000, as shown in figure 1.

Fig 1: Trend of U5M according to migratory status and immigrant-native U5M gap



Source: Own calculations based upon Belgian Vital Statistics

When using the mother's country of birth, we observe a higher mortality among immigrant mothers compared to native mothers during the period from 2000 to 2019. These disparities alternate between upward and downward trends. For example, there have been periods of decreasing gap, especially notable in 2013 and 2015.These two years follow a period of increasing mortality gap, most prominently in 2012.This upward trend, which then subsided, continued in 2014 and 2017, while the mortality decreased simultaneously in both groups.

These trends, based on the father's country of birth, exhibit a distinct pattern compared to the previous analysis. They reveal that after a peak in 2001, followed by subsequent increases (although in smaller proportions) in the following years, mortality gap decreased for several years, notably in 2015. However, after 2015, an upward trend emerged, even as the mortality decreased in both groups. A more detailed examination of the graphs indicates wider disparities between immigrant and native when considering the father's country of birth, compared to the mothers. Thus, if the mortality gap between the two groups are smaller, the mortality for both groups is higher. As the gap diminish with consideration of both indicators, the most significant reductions are observed with the father's origin.

Having analyzed the trends in these gaps, what about their regional variations? This is the question the table 4 and the figure 2 help us answer.

Tab 4: Regional differences in immigrant-native U5M gap

Region	Indicator	Immigrant (‰)	Native (‰)	U5M gap
Flanders	Mother	4.83 (4.58-5.09)	3.60 (3.49-3.71)	1.23*** (0.95-1.51)
	Father	5.34 (5.09-5.59)	3.42 (3.31-3.52)	1.92*** (1.65-2.20)
Wallonia	Mother	3.89 (3.58-4.20)	3.57 (3.43-3.71)	0.32 (-0.02-0.67)
	Father	4.97 (4.66-5.28)	3.21 (3.07-3.35)	1.76*** (1.42-2.10)
Brussels- Capital	Mother	4.34 (4.09-4.59)	5.02 (4.73-5.30)	-0.67*** (-1.05 - -0.29)
	Father	4.69 (4.44-4.95)	4.62 (4.33-4.90)	0.07 (-0.31-0.46)

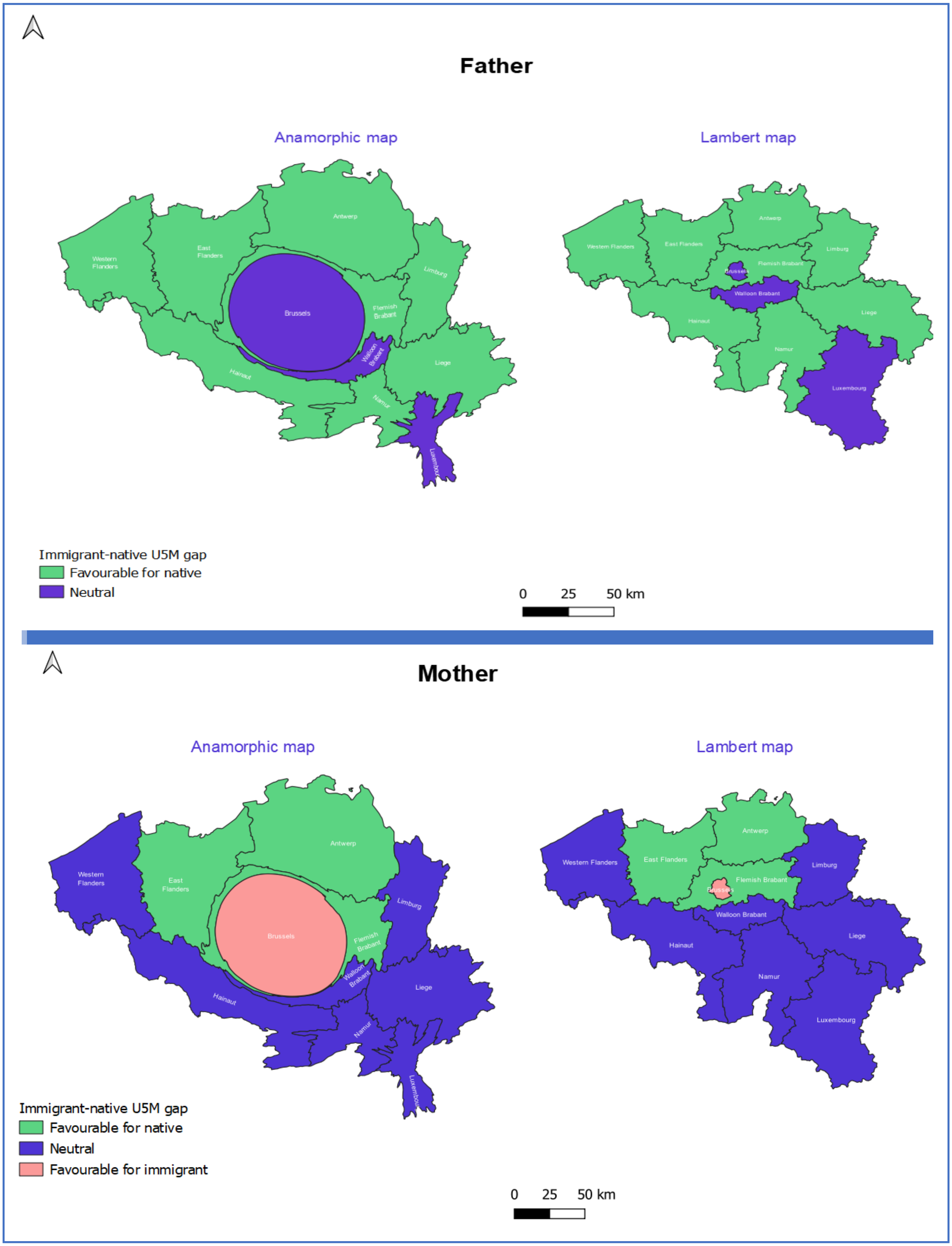
Note: 95% CIs are in parentheses; ***p<0.001.
Source: Own calculations based upon Belgian Vital Statistics 1998-2020.

Tab 4 displays the U5MR according to migratory status in each region and gaps between immigrant and native-born.

When using the mother's origin, there are statistically significant differences between the two groups in Flanders and Brussels. While these differences strongly favor natives in Flanders are less pronounced in Brussels where they favor immigrants. As for the Walloon region, no statistically significant differences were observed.

Based on the father's origin, an advantage in U5M was observed for natives in Flanders and Wallonia, whereas U5M in Brussels is the same, regardless of whether one is born to an immigrant or native father.

Fig 2: Immigrant-native U5M gap at provincial level



Note: In the anamorphic map, the size of the province is modified to be directly proportional to the corresponding number of births. Lambert map preserves local angles, which means that angles between lines of latitude and longitude are represented correctly.

Source: own calculations based upon Belgian Vital Statistics

Fig 2 describes immigrant-native U5M gap at provincial level.

Using the father's origin, it becomes evident that immigrants experience higher U5MR in all Flemish provinces. The same pattern is observed in Walloon provinces, with the exception of Luxembourg, where no statistical difference was found between immigrant and native-born.

Regarding the mother's origin, in Flanders, only the provinces of Antwerp, East Flanders, and Flemish Brabant align with the regional trend, showing the most significant disparity in Flemish Brabant. The remaining provinces, where no statistically significant differences in immigrant-native U5M gap were observed, deviate significantly from the regional trend. In Wallonia, the regional trend is confirmed across all provinces, once again with the same indicator (Appendix, table A.1).

3.2. Decomposition analysis

Tab 5 displays the results of two multivariate decompositions assessing the contribution of each risk factor to the 'composition effect' component of the immigrant-native U5M gap. Estimates are presented per 10,000 live births, instead of 1,000 live births for clearly, given the small numbers.

In this section, only the mother's characteristics are included in the model for control, given the significant correlation between the mother's age and the father's age at infant birth, as well as between the mother's socioeconomic index and that of the father. Additionally, the variables related to the mother are of higher quality.

Tab 5: Multivariate decomposition of immigrant-native U5M gap, contribution of composition effect

	Mother (Immigrant vs native)				Father (Immigrant vs native)			
Risk factors	Gaps		95% CIs		Gaps		95% CIs	
Child sex								
(Female)	0.016		-0.001	0.035	0.030		-0.004	0.064
Birth rank								
(Rank 1)	-1.736	***	-2.236	-1.236	-3.444	***	-4.526	-2.362
Birth Weight								
(Very LBW)	-1.371	***	-1.637	-1.104	2.494	***	1.834	3.154
Type of birth								
(Multiple births)	0.070		-0.113	0.254	0.109		-0.127	0.346
Mother's age	0.738	***	0.530	0.945	0.897	***	0.582	1.212
Calendar Year	1.468	***	1.126	1.810	2.562	***	1.754	3.371
Matrimonial status								
(Parent in union)	0.131	*	0.030	0.233	0.070		-0.270	0.132
Mother's socioeconomic index (1^{st} quartile)	3.624	***	2.393	4.855	3.296	***	1.849	6.592
U5MR difference (per 10,000)	5.23	***	3.53	6.92	15.28	***	13.57	16.99
Explained Component (%)	81.72	***	78.59	87.85	36.42	***	34.98	37.57

Note: Reference categories are in parentheses. ***p<0.001; **p<0.01; *p<0.05.
Source: Own calculations based upon Belgian Vital Statistics and 2001 & 2011 censuses

As a reminder, a positive (negative) coefficient implies a reduction (respectively an increase) in the mortality gap if immigrant-born exhibits the same risk factors of mortality as native-born, assuming the effects of these mortality risk factors among immigrant-born remained unchanged over the period.

The results show that the average number of excess U5M among immigrant is around 5 per 10,000 live births when the mother’s origin is used. This figure rises 15 per 10,000 births when the father’s origin is used; suggesting once again that disparities in U5M are higher with the father's origin. The difference between these two indicators is also reflected by the contribution of the composition effect in the explanation of these mortality gaps which accounts for over 80% for the mother and only 36% for the father. Thus, while the immigrant-native U5M gap is better explained by the variables introduced in the model using the mother's origin, it is not in the father's model.

A detailed analysis of the model, using the mother's origin, shows that the largest difference in under-five mortality between immigrant and native-born is linked to the mother's socioeconomic status. The coefficient of 3.6 (95% CI [2.4-4.9]) indicates a reduction of 3.6 deaths per 10,000 live births in this gap. Rebalancing the very low birth weight of the child between the two groups by reducing it (as it is higher among immigrant) leads to a decrease of one death per 10,000 live births in mortality gap. In addition, equalizing the age of immigrant mothers at infant’s birth with that of native mothers would reduce the mortality gap by around 0.7. Moreover, the increasing disparities in the prevalence of married or cohabiting parents between the two groups is expected to lessen the mortality gap by approximately 0.13 deaths per 10,000 live births. However, the mortality gap can be increased by counterbalancing the effect of the birth rank. Indeed, an increase in this gap of less than 2 deaths per 10,000 live births would be observed if the prevalence of child of rank 1 among children of immigrant women were shifted closer to that of native-born women (that would mean increased fertility), as the latter often have a higher concentration of this mortality risk factor (as indicated in the descriptive analysis). Over the entire period from 1998 to 2020, it's worth noting that the mortality gap decreased by 1.5 (95% CI [1.1-1.8]) deaths per 10,000 live births, as proved by the positive contribution of the "calendar year" variable.

As for the model using the father's origin as an outcome variable, the results are in the same direction but with higher intensity than the previous model. For instance, the socioeconomic index, maternal age, and the prevalence of very low birth weight negatively contribute to the mortality gap. However, their combined effects are more substantial, leading to a reduction in this gap of 7 deaths per 10,000 live births (i.e. the sum of the individual contributions of these three factors), compared to 6 deaths per 10,000 live births with the mother's origin. There are some differences when comparing these two models (mother and father). On one hand, the effect of the prevalence of parents in union is significant only in the mother's model, albeit weakly. On the other hand, it is evident that over the entire period, there is a decrease in the mortality gap when using the father's origin, as observed with the mother, but with a more substantial decrease of 2.6 deaths per 10,000 live births.

Overall, the results from Tab indicate that positive contributions to the composition effect are risk factors that, if equalized, should reduce the immigrant-native U5M gap. The most significant reduction would be achieved by equalizing the mother's socioeconomic index. Conversely, negative contributions would widen this gap, as observed in the prevalence of child of rank 1. It should also be noted that despite a larger mortality gap with the father's origin, the reduction in these gaps over the period was more substantial with this same indicator.

Replicating this analysis for each of region, the following table was obtained, in which only the effect of the 'calendar year' variable is presented.

Tab 6: Multivariate decomposition by region-average reduction in gap

	Mother			Father		
	Flanders	Wallonia	Brussels-Capital	Flanders	Wallonia	Brussels-Capital
	Gap (95% CI)					
Calendar year	1.2*** (0.5-1.8)	1.4*** (1.01-1.82)	-1.5 (-6.4-3.4)	2.2** (0.8-3.6)	4.2** (1.8-6.5)	-0.4 (-3.0-2.2)
% of Explained Component	60.59*** (54.3-63.88)	66.62* (62.12-270.32)	25.62 (-25.57-39.10)	32.62*** (29.26-35.07)	28.59*** (27.95-29.06)	-24.22 (-106.88-24.82)

Note: Reference categories are in parentheses. ***p<0.001; **p<0.01; *p<0.05.
Source: Own calculations based upon Belgian Vital Statistics and 2001 & 2011 censuses

The average reduction in the mortality gap in Flanders and Wallonia is at least one death per 10,000 births when using the mother's origin. As at the national level, the regional decline exceeding two deaths per 10,000 births are more significant when considering the father's origin. However, the mortality gap remained stable in Brussels over the period. It should also be noted that despite a greater disparity in mortality in Flanders, the reduction in these disparities has occurred more significantly in Wallonia.

Discussion and conclusion

The objective of this analysis was to assess disparities in U5M between immigrant and native as well as their variation and to estimate the individual contributions of sociodemographic and socioeconomic mortality risk factors to theses disparities.

In terms of results, the gap measured according to mother's origin is largely explained by the factors considered in the model. This is rare but entirely plausible concerning health inequalities (Rahimi & Hashemi Nazari, 2021). Indeed, the majority of disparities remain often unexplained by the variables in the model, as is the case with our model using the father's origin. Overall, our findings are consistent with previous studies by suggesting a primordial role of sociodemographic and mortality risk factors among which the socioeconomic index ranks at the top, akin to the works of Elder et al. (2016) and Stanek et al.(2021). Indeed, Elder et al. (2016) concluded that the racial or ethnic gaps in infant mortality between white, black, Mexican, Puerto Rican, Asian and Native American mothers in the U.S. were mainly explained by socioeconomic differences measured by marital status, education and age of the mother. Similarly, Stanek et al.(2021) found similar conclusions regarding low birth weight disparities between immigrant and native women in Spain. Given the significance of socioeconomic factors in shaping infant and child mortality inequalities, especially those that are modifiable, income support programs, access to housing, and other social services are widely encouraged in social policies. These measures could mitigate the disadvantages associated with lower socioeconomic status and would be more effective in reducing mortality gap between the two groups. Identifying these measures is an important step, but determining how they can be operationalized is quite another. This step requires further in-depth study and consideration. As for the effect of the prevalence of child of rank 1, whose contribution to mortality disparities has been shown, with an even greater disparity among immigrants, we note that it covers the difference in fertility between immigrants and natives. A higher proportion of child of rank 1 within families is also due to lower fertility rates, indicating both a greater per capita investment per child, and potentially longer intervals between births. This suggests that the lower proportion of first-born children among immigrants may be associated with less investment, attention, or care compared to natives, for whom this investment would be higher.

In addition to these findings, this research highlights the need to consider both parents, especially the father, who is often under-represented in research on infant health inequalities according to migratory origin. The large gap observed with the father's origin is quite edifying. Adverse birth indicators associated with the absence of paternal race or ethnic origin on the birth certificate in previous studies (Ma, 2008; Palatnik et al., 2021; Payne-Sturges et al., 2022) emphasize the importance of the father's impact on infant health. The differences observed with the father's origin might reflect other social constructs that we are not able to capture in this study, as proved by the small portion of the explained effect indicating the influence of others factors related to father's characteristics not considered in the model. Indeed, fathers (particularly immigrants with low SES) are often less involved in maternal and child protection service programs in Europe (WHO Regional Office for Europe, 2007). Wagner et al. (2015), in their study of factors associated with the total duration of breastfeeding in France, identified a link between the presence of the father at the time of the child's birth and a long duration of breastfeeding. What's more, if fathers engage in risky behaviors, this can have a negative impact on the mother's behaviors. (Ma, 2008). This information is not available in our data. Future research should address these questions, explore how father's health behavior may affect children's health depending on migratory origin.

Our results also emphasize the change of these child death inequalities, which decreased between 1998 and 2020. This occurs in the general context of decline in infant mortality in Belgium as in the European countries (UN IGME, 2019), stemming from medical progress and the successful implementation of policies aimed at addressing inequalities. One plausible explanation for such a drop might be the change in the composition of immigrants over time. Indeed, between 2000 and 2020, the country of origin of immigrants has changed, Romania is now in the lead with 15% of immigrants, and Morocco is no longer among the top 4, even if the majority of immigrants remain European (Myria, 2022). However, it is essential to note that if the change in the composition of the immigrant population is not followed by a change in its socio-demographic profile, it is unlikely to have an effect on mortality differentials.

One of the main contributions of this research is to highlight the dichotomies not only in terms of the father's or mother's origin, but also at the regional level. Although the U5MR difference has narrowed in the northern and southern regions, and to a greater extent in Wallonia, the immigrant-native gap remains wider in Flanders. By examining the Belgian health policies, whose responsibilities are divided between the federal state and the regions, we can identify a preliminary explanatory factor. Indeed, policies related to the promotion and prevention of health, as well as maternal and child health services, fall exclusively under the jurisdiction of the regions and linguistic communities. The implementation of these policies may be impeded by language barriers, an essential element in the prenatal, perinatal and post-neonatal care relationship between immigrant mothers and healthcare staff. Despite numerous initiatives such as the use of interpreters and intercultural mediators, language barriers to access and quality of care for immigrants persist in all regions of Belgium (Nierkens et al., 2002; Krystallidou et al., 2020). Given that the Brussels-Capital region is one of the most cosmopolitan in the world, and French is one of the most widely spoken languages globally and the predominant language in Wallonia, these language barriers in the hospital are likely to be more prevalent in Flanders where Dutch is used in public services. A study of the use of healthcare services, including child healthcare among individuals of foreign origin in Flanders showed that only 19% of the clients spoke Dutch sufficiently to be understandable by health care workers (Nierkens et al., 2002). While linguistic proficiency alone may not necessarily imply an enhanced relationship between migrants and healthcare staff, as highlighted in the same study, we posit that the language barrier may help to explain the divergence in results between regions. We also wonder whether child health promotion activities in Flanders target more vulnerable women. Indeed, even though the regulation of compulsory health insurance is a federal responsibility, its implementation can differ in practice, as shown by a report highlighting the systematic denial of care to individuals lacking medical insurance coverage in Antwerp (INAMI et al., 2014). Another explanation lies in the differences in the political climate between regions, particularly with the significant influence of the farright in Flanders. This distinction is important, as Flores (2017) pointed out, anti-immigrant attitudes or behaviors can create discrimination.

We cannot conclude without mentioning one of the limitations of the O-B decomposition technique, which is constrained to two groups. Immigrants are a highly heterogeneous group, and lumping them together into one broad category may hide important disparities. As illustrated by the graph (Appendix, Fig A.1) showing U5MR when mixed categories are considered, additional lessons can be drawn. The same applies to more detailed analyses, considering parents' country or region of origin.

This work concludes with some reflections in the form of inquiries regarding the reduction of mortality gaps and regional differences. If discrimination experienced by immigrants in hospitals and elsewhere, could explain these regional disparities, what is its contribution? Is the decline in the U5MR gap linked to the very liberal naturalization policy (Minsart et al., 2013) following successive reforms facilitating foreigners' access to Belgian citizenship? In-depth studies on regional differences in language barriers, discrimination and naturalization are needed.

References

Algava, E., Bloch, K., & Robert-Bobée, I. (2021). Les familles en 2020 : 25 % de familles monoparentales, 21 % de familles nombreuses. *Insee Focus*, *249*.

Balaj, M., York, H. W., Sripada, K., Besnier, E., Vonen, H. D., Aravkin, A., Friedman, J., Griswold, M., Jensen, M. R., Mohammad, T., Mullany, E. C., Solhaug, S., Sorensen, R., Stonkute, D., Tallaksen, A., Whisnant, J., Zheng, P., Gakidou, E., & Eikemo, T. A. (2021). Parental education and inequalities in child mortality: A global systematic review and meta-analysis. *The Lancet*, *398*(10300), 608-620. https://doi.org/10.1016/S0140-6736(21)00534-1

Ballon, M., Botton, J., Forhan, A., Lauzon-Guillain, B., Melchior, M., El Khoury, F., Nakamura, A., Charles, M. A., Lioret, S., & Heude, B. (2019). Which modifiable prenatal factors mediate the relation between socio-economic position and a child's weight and length at birth? *Maternal & Child Nutrition*, *15*(4), 1-10. https://doi.org/10.1111/mcn.12878

Bergeron-Boucher, M.-P., Canudas-Romo, V., Pascariu, M., & Lindahl-Jacobsen, R. (2018). Modeling and forecasting sex differences in mortality: A sex-ratio approach. *Genus*, *74*(20), 1-28. https://doi.org/10.1186/s41118-018-0044-8

Blinder, A. S. (1973). Wage Discrimination: Reduced Form and Structural Estimates. *The Journal of Human Resources*, *8*(4), 436-455. https://doi.org/10.2307/144855

Bollini, P., Pampallona, S., Wanner, P., & Kupelnick, B. (2009). Pregnancy outcome of migrant women and integration policy: A systematic review of the international literature. *Social Science & Medicine*, *68*(3), 452-461. https://doi.org/10.1016/j.socscimed.2008.10.018

Castro-Martin, T. (2010). Single motherhood and low birthweight in Spain : Narrowing social inequalities in health? *Demographic Research*, *22*(27), 863-890. https://doi.org/10.4054/DemRes.2010.22.27

Cho, R. M. (2011). Effects of welfare reform policies on Mexican immigrants' infant mortality rates. *Social Science Research*, *40*(2), 641-653. https://doi.org/10.1016/j.ssresearch.2010.10.004

Collins, W. J., & Thomasson, M. A. (2002). *Exploring the Racial Gap in Infant Mortality Rates, 1920-1970* (Working Paper 8836). National Bureau of Economic Research. https://doi.org/10.3386/w8836

Courtenay, H., & Gordon, D. (1977). Congenital deformities and chromosomal disorders: Maternal versus paternal age. *Fertility and Sterility*, *28*(8), 888. https://doi.org/10.1016/s0015-0282(16)42748-2

Daalen, K. R. van, Kaiser, J., Kebede, S., Cipriano, G., Maimouni, H., Olumese, E., Chui, A., Kuhn, I., & Oliver-Williams, C. (2022). Racial discrimination and adverse pregnancy outcomes: A systematic review and meta-analysis. *BMJ Global Health*, *7*(8), e009227. https://doi.org/10.1136/bmjgh-2022-009227

Dauvrin, M., Derluyn, I., Coune, I., Verrept, H., & Lorant, V. (2012). Towards fair health policies for migrants and ethnic minorities: The case-study of ETHEALTH in Belgium. *BMC Public Health*, *12*(1), 726. https://doi.org/10.1186/1471-2458-12-726

Debuisson, M. (2001). *The decline of infant mortality in the Belgian districts at the turn of the 20th century*. *XXXI*(3-4), 497-527.

DeSisto, C. L., Hirai, A. H., Collins, J. W., & Rankin, K. M. (2018). Deconstructing a disparity: Explaining excess preterm birth among U.S.-born black women. *Annals of Epidemiology*, *28*(4), 225-230. https://doi.org/10.1016/j.annepidem.2018.01.012

Devos, C., Cordon, A., Lefèvre, M., Obyn, C., Renard, F., Bouckaert, N., Gerkens, S., Maertens de Noordhout, C., Devleesschauwer, B., Haelterman, M., Léonard, C., & Meeus, P. (2019). *Performance du système de santé belge – Rapport 2019 – Synthèse. Health Services Research (HSR). Bruxelles : Centre Fédéral d'Expertise des Soins de Santé (KCE).* (KCE Reports 313B).

Elder, T. E., Goddeeris, J. H., & Haider, S. J. (2016). Racial and Ethnic Infant Mortality Gaps and the Role of Socio-Economic Status. *Labour economics*, *43*, 42-54. https://doi.org/10.1016/j.labeco.2016.04.001

Evans, S., & Alberman, E. (1989). International Collaborative Effort (ICE) on Birthweight; Plurality; and Perinatal and Infant Mortality: II: Comparisons between Birthweight Distributions of Births in Member Countries from 1970 to 1984. *Acta Obstetricia et Gynecologica Scandinavica*, *68*(1), 11-17. https://doi.org/10.3109/00016348909087682

Farré, L. (2016). New evidence on the healthy immigrant effect. *Journal of Population Economics*, *29*(2), 365-394. https://doi.org/10.1007/s00148-015-0578-4

Fiori, F. (2020). Maternal employment and the well-being of children living with a lone mother in Scotland. *Demographic Research*, *43*(57), 1685-1738. https://doi.org/10.4054/DemRes.2020.43.57

Fishman, S. (2020). An extended evaluation of the weathering hypothesis for birthweight. *Demographic Research*, *43*(31), 929-968. https://doi.org/10.4054/DemRes.2020.43.31

Flores, R. D. (2017). Do Anti-Immigrant Laws Shape Public Sentiment? A Study of Arizona's SB 1070 Using Twitter Data. *American Journal of Sociology*, *123*(2), 333-384. https://doi.org/10.1086/692983

Gennuso, K. P., Kindig, D. A., & Givens, M. L. (2019). Joinpoint Trend Analysis of Infant Mortality Disparities in Wisconsin, 1999–2016. *American Journal of Public Health*, *109*(5), 714-718. https://doi.org/10.2105/AJPH.2018.304945

Gillet, E., Saerens, B., Martens, G., & Cammu, H. (2014). Fetal and infant health outcomes among immigrant mothers in Flanders, Belgium. *International Journal of Gynecology & Obstetrics*, *124*(2), 128-133. https://doi.org/10.1016/j.ijgo.2013.07.031

Giurgescu, C., McFarlin, B. L., Lomax, J., Craddock, C., & Albrecht, A. (2011). Racial Discrimination and the Black-White Gap in Adverse Birth Outcomes: A Review. *Journal of Midwifery & Women's Health*, *56*(4), 362-370. https://doi.org/10.1111/j.1542-2011.2011.00034.x

Goovaerts, P., & Xiao, H. (2011). Geographical, temporal and racial disparities in late-stage prostate cancer incidence across Florida: A multiscale joinpoint regression analysis. *International Journal of Health Geographics*, *10*(1), 63. https://doi.org/10.1186/1476-072X-10-63

Gourbin, C., & Wunsch, G. (1999). Paternal age and infant mortality. *Genus*, *55*(1/2), 61-72.

Green, T., & Hamilton, T. (2019). Maternal educational attainment and infant mortality in the United States: Does the gradient vary by race/ethnicity and nativity?

Demographic Research, *41*(25), 713-752. https://doi.org/10.4054/DemRes.2019.41.25
Hercot, D., Mazina, D., Verduyckt, P., & Deguerry, M. (2015). *Naître Bruxellois(e) Indicateurs de santé périnatale des Bruxellois(es) 2000-2012* (Les dossiers de l'Observatoire, p. 1-79) [Observatoire de la santé et du social Bruxelles]. Observatoire de la Santé et du Social, Région de Bruxelles-Capitale Commission communautaire commune.
Heymann, J., Raub, A., & Earle, A. (2011). Creating and Using New Data Sources to Analyze the Relationship between Social Policy and Global Health: The Case of Maternal Leave. *Public Health Reports*, *126*(3_suppl), 127-134. https://doi.org/10.1177/00333549111260S317
Hoffmann, R., Kröger, H., & Pakpahan, E. (2018). Pathways between socioeconomic status and health: Does health selection or social causation dominate in Europe? *Advances in Life Course Research*, *36*, 23-36. https://doi.org/10.1016/j.alcr.2018.02.002
Iceland, J. (2021). US disparities in affluence by household structure, 1959 to 2017. *Demographic Research*, *44*(28), 653-698. https://doi.org/10.4054/DemRes.2021.44.28
INAMI, Kluwer, & Médecins du Monde. (2014). *Livre vert sur l'accès aux soins en Belgique* (Wolters Kluwer Belgium SA). chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://eurotox.org/wp/wp-content/uploads/BE_Livre-vert-sur-l%E2%80%99acc%C3%A8s-au-soin-en-Belgique-2014.pdf [Consulté, le 20/03/2024]
Jadalla, A. A., Hattar, M., & Schubert, C. C. (2015). Acculturation as a Predictor of Health Promoting and Lifestyle Practices of Arab Americans : A Descriptive Study. *Journal of Cultural Diversity*, *22*(1), 15-22.
Janeczko, D., Hołowczuk, M., Orzeł, A., Klatka, B., & Semczuk, A. (2020). Paternal age is affected by genetic abnormalities, perinatal complications and mental health of the offspring. *Biomedical Reports*, *12*(3), 83-88. https://doi.org/10.3892/br.2019.1266
Juárez, S. P., Honkaniemi, H., Dunlavy, A. C., Aldridge, R. W., Barreto, M. L., Katikireddi, S. V., & Rostila, M. (2019). Effects of non-health-targeted policies on migrant health: A systematic review and meta-analysis. *The Lancet Global Health*, *7*(4), e420-e435. https://doi.org/10.1016/S2214-109X(18)30560-6
Kihal-Talantikite, W., Le Nouveau, P., Legendre, P., Zmirou Navier, D., Danzon, A., Carayol, M., & Deguen, S. (2019). Adverse Birth Outcomes as Indicators of Poor Fetal Growth Conditions in a French Newborn Population—A Stratified Analysis by Neighborhood Deprivation Level. *International Journal of Environmental Research and Public Health*, *16*(21), 1-14. https://doi.org/10.3390/ijerph16214069
Korenbrot, C. C., Dudley, R. A., & Greene, J. D. (2000). Changes in Births to Foreign-born Women after Welfare and Immigration Policy Reforms in California. *Maternal and Child Health Journal*, *4*(4), 10.
Krystallidou, D., Vaes, L., Devisch, I., Wens, J., & Pype, P. (2020). Study protocol of OncoTolk : An observational study on communication problems in language-mediated consultations with migrant oncology patients in Flanders (Belgium). *BMJ Open*, *10*(6), e034426. https://doi.org/10.1136/bmjopen-2019-034426

Lam, B., Jamieson, L. M., & Mittinty, M. (2021). Black Lives Matter: A Decomposition of Racial Inequalities in Oral Cancer Screening. *Cancers*, *13*(848), 1-14. https://doi.org/10.3390/cancers13040848

Lefèvre, M., Bouckaert, N., Camberlin, C., Devriese, S., Pincé, H., de Meester, C., Fricheteau, B., & Van de Voorde, C. (2019). *Organisation des maternités en Belgique*. *KCE Reports 323B*. https://doi.org/10.57598/R323BS

Ma, S. (2008). Paternal Race/Ethnicity and Birth Outcomes. *American Journal of Public Health*, *98*(12), 2285-2292. https://doi.org/10.2105/AJPH.2007.117127

Menashe-Oren, A., Bocquier, P., Ginsburg, C., Compaoré, Y., & Collinson, M. (2023). The dynamic role of household structure on under-5 mortality in southern and eastern sub-Saharan Africa. *Demographic Research*, *49*, 249-294. https://www.demographic-research.org/articles/volume/49/11/

Mendoza, F. S. (2009). Health Disparities and Children in Immigrant Families: A Research Agenda. *Pediatrics*, *124*(Supplement 3), S187-S195. https://doi.org/10.1542/peds.2009-1100F

Minsart, A.-F., Englert, Y., & Buekens, P. (2013). Naturalization of immigrants and perinatal mortality. *The European Journal of Public Health*, *23*(2), 269-274. https://doi.org/10.1093/eurpub/cks032

Mitha, A., Foix-L'Hélias, L., Arnaud, C., Marret, S., Vieux, R., Aujard, Y., Thiriez, G., Larroque, B., Cambonie, G., Burguet, A., Boileau, P., Rozé, J. C., Kaminski, M., Truffert, P., & Ancel, P.-Y. (2013). Neonatal Infection and 5-year Neurodevelopmental Outcome of Very Preterm Infants. *Pediatrics*, *132*(2), e372-e380. https://doi.org/10.1542/peds.2012-3979

Monden, C., Pison, G., & Smits, J. (2021). Twin Peaks: More twinning in humans than ever before. *Human Reproduction*, *36*(6), 1666-1673. https://doi.org/10.1093/humrep/deab029

Mustillo, S., Krieger, N., Gunderson, E. P., Sidney, S., McCreath, H., & Kiefe, C. I. (2004). Self-Reported Experiences of Racial Discrimination and Black–White Differences in Preterm and Low-Birthweight Deliveries: The CARDIA Study. *American Journal of Public Health*, *94*(12), 2125-2131. https://doi.org/10.2105/AJPH.94.12.2125

Myria. (2022). *Population et mouvements* (Cahier du rapport annuel 2022; La migration en chiffres et en droit, p. 1-19). [Consulté, le 01/03/2024]

Niel, X. (2011). *Les facteurs explicatifs de la mortalité infantile en France et leur évolution récente. L'apport de l'échantillon démographique permanent.* (Documents de travail - F2011/06 | série des documents de travail F1106 ; Série des documents de travail, p. 1-35). Direction des statistiques démographiques et sociales, Insee. https://www.insee.fr/fr/statistiques/1380997

Nierkens, V., Krumeich, A., de Ridder, R., & van Dongen, M. (2002). The future of intercultural mediation in Belgium. *Patient Education and Counseling*, *46*(4), 253-259. https://doi.org/10.1016/S0738-3991(01)00161-6

Oaxaca, R. (1973). Male-Female Wage Differentials in Urban Labor Markets. *International Economic Review*, *14*(3), 693-709. https://doi.org/10.2307/2525981

Palatnik, A., Garacci, E., Walker, R. J., Ozieh, M. N., Williams, J. S., & Egede, L. E. (2021). The Association of Paternal Race and Ethnicity with Adverse Pregnancy Outcomes in a Contemporary U.S. Cohort. *American journal of perinatology*, *38*(7), 698-706. https://doi.org/10.1055/s-0039-3400995

Payne-Sturges, D. C., Puett, R., & Cory-Slechta, D. A. (2022). Both parents matter : A national-scale analysis of parental race/ethnicity, disparities in prenatal PM2.5 exposures and related impacts on birth outcomes. *Environmental Health*, *21*(1), 47. https://doi.org/10.1186/s12940-022-00856-w

Powers, D. A. (2016). Erosion of Advantage: Decomposing Differences in Infant Mortality Rates Des. *Population Research and Policy Review*, *35*(1), 23-48. https://doi.org/10.1007/s11113-015-9370-0

Racape, J., De Spiegelaere, M., Alexander, S., Dramaix, M., Buekens, P., & Haelterman, E. (2010). High perinatal mortality rate among immigrants in Brussels. *The European Journal of Public Health*, *20*(5), 536-542. https://doi.org/10.1093/eurpub/ckq060

Racape, J., Schoenborn, C., Sow, M., Alexander, S., & De Spiegelaere, M. (2016). Are all immigrant mothers really at risk of low birth weight and perinatal mortality? The crucial role of socio-economic status. *BMC Pregnancy and Chilbirth*, *16*(75), 1-10. https://doi.org/10.1186/s12884-016-0860-9

Rahimi, E., & Hashemi Nazari, S. S. (2021). A detailed explanation and graphical representation of the Blinder-Oaxaca decomposition method with its application in health inequalities. *Emerging Themes in Epidemiology*, *18*(1), 1-15. https://doi.org/10.1186/s12982-021-00100-9

Reichman, N. E., & Teitler, J. O. (2006). Paternal Age as a Risk Factor for Low Birthweight. *American Journal of Public Health*, *96*(5), 862-866. https://doi.org/10.2105/AJPH.2005.066324

Rich-Edwards, J., Krieger, N., Majzoub, J., Zierler, S., Lieberman, E., & Gillman, M. (2001). Maternal experiences of racism and violence as predictors of preterm birth: Rationale and study design. *Paediatric and Perinatal Epidemiology*, *15*(s2), 124-135. https://doi.org/10.1046/j.1365-3016.2001.00013.x

Riswick, T., & Hsieh, Y.-H. (2020). Between rivalry and support: The impact of sibling composition on infant and child mortality in Taiwan, 1906–1945. *Demographic Research*, *42*(21), 615-656. https://doi.org/10.4054/DemRes.2020.42.21

Rosenberg, L., Palmer, J. R., Wise, L. A., Horton, N. J., & Corwin, M. J. (2002). Perceptions of Racial Discrimination and the Risk of Preterm Birth: *Epidemiology*, *13*(6), 646-652. https://doi.org/10.1097/00001648-200211000-00008

Saarela, J., & Finnäs, F. (2014). Infant mortality and ethnicity in an indigenous European population: Novel evidence from the Finnish population register. *Scientific Reports*, *4*(1), Article 1. https://doi.org/10.1038/srep04214

Sanderson, J.-P., Vandeschrick, C., & Eggerickx, T. (2023). *La mesure des inégalités sociales de mortalité : Construction d'un indicateur de positionnement social à l'échelle individuelle à partir des données de recensements belges (1991-2011)* (Document de travail DT 33 (n°33) ; Démographie et société, p. 33). Centre de recherche en démographie/ IACCHOS.

Shorette, K., & Burroway, R. (2022). Consistencies and contradictions: Revisiting the relationship between women's education and infant mortality from a distributional perspective. *Social Science Research*, 1-13. https://doi.org/10.1016/j.ssresearch.2022.102697

Smith-Greenaway, E. (2020). *The child health benefits of parents' education in diverse African families*. https://www.niussp.org/article/the-child-health-benefits-of-parents-education-in-diverse-african-familiesbenefices-de-leducation-des-parents-sur-la-sante-des-enfants-dans-diverses-familles-africaines/?print=print

Sow, M., Schoenborn, C., Spiegelaere, M. D., & Racape, J. (2019). Influence of time since naturalisation on socioeconomic status and low birth weight among immigrants in Belgium. A population-based study. *PLoS ONE*, *14*(8), 11-15. https://doi.org/10.1371/journal. pone.0220856

Sow, M., Spiegelaere, M. D., Sylvestre, M.-P., & Raynault, M.-F. (2021). *Are Newborns of Immigrant Mothers More at Risk of Poorer Perinatal Health Than Those of Natives-born Mothers? One Size Does Not Fit All. A Population-based Study, Montreal, Quebec.* [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-256614/v1

Stanek, M., Requena, M., & del Rey, A. (2021). Impact of Socio-economic Status on Low Birthweight: Decomposing the Differences Between Natives and Immigrants in Spain. *Journal of Immigrant and Minority Health*, *23*(1), 71-78. https://doi.org/10.1007/s10903-020-01027-0

Stanek, M., Requena, M., del Rey, A., & García-Gómez, J. (2020). Beyond the healthy immigrant paradox: Decomposing differences in birthweight among immigrants in Spain. *Globalization and Health*, *16*(1), 87. https://doi.org/10.1186/s12992-020-00612-0

Statbel. (2019). *Structure de la population*. https://statbel.fgov.be/fr/themes/population/structure-de-la-population

Statbel. (2023). Feto-infant mortality. *Mortality, Life expectancy and causes of death*. https://statbel.fgov.be/en/themes/population/mortality-life-expectancy-and-causes-death/feto-infant-mortality

Štípková, M. (2016). Immigrant disadvantage or the healthy immigrant effect? Evidence about low birth weight differences in the Czech Republic. *The European Journal of Public Health*, *26*(4), 662-666. https://doi.org/10.1093/eurpub/ckw029

UN IGME. (2019). *Levels & Trends in Child-Report 2019* (p. 1-52). [Consulté, le 15/01/2021]

UNFPA. (2023). *Maternal Health Analysis of Women and Girls of African Descent in the Americas* (p. 27 p.). https://www.unfpa.org/publications/maternal-health-analysis-women-and-girls-african-descent-americas [Consulté, le 29/07/2023]

Van Leeuw, V., & Leroy, C. (2020). *Santé périnatale en Région bruxelloise* [Centre d'Épidémiologie Périnatale, 2021].

Wagner, S., Kersuzan, C., Gojard, S., Tichit, C., Nicklaus, S., Geay, B., Humeau, P., Thierry, X., Charles, M.-A., Lioret, S., & Lauzon-Guillain, B. (2015). Durée de l'allaitement en France selon les caractéristiques des parents et de la naissance. Résultats de l'étude longitudinale française Elfe, 2011. *Bull Epidémiol Hebd*, *29*, 522-530.

Wallace, M., Khlat, M., & Guillot, M. (2020). Infant mortality among native-born children of immigrants in France, 2008–17: Results from a socio-demographic panel survey. *European Journal of Public Health*, 1-8. https://doi.org/10.1093/eurpub/ckaa186

Watson, T. (2006). Public health investments and the infant mortality gap : Evidence from federal sanitation interventions on U.S. Indian reservations. *Journal of Public Economics*, *90*(8), 1537-1560. https://doi.org/10.1016/j.jpubeco.2005.10.002

WHO Regional Office for Europe. (2007). *Fatherhood and Health outcomes in Europe* (Summary E91129).

Yun, M.-S. (2005). A simple solution to the identification problem in detailed wage decompositions. *Economic Inquiry*, *43*(4), 766-772. https://doi.org/10.1093/ei/cbi053

Zeitlin, J., Mortensen, L., Prunet, C., Macfarlane, A., Hindori-Mohangoo, A. D., Gissler, M., Szamotulska, K., van der Pal, K., Bolumar, F., Andersen, A.-M. N., Ólafsdóttir, H. S., Zhang, W.-H., Blondel, B., Alexander, S., & Euro-Peristat Scientific Committee. (2016). Socioeconomic inequalities in stillbirth rates in Europe: Measuring the gap using routine data from the Euro-Peristat Project. *BMC Pregnancy and Childbirth*, *16*(1), 15. https://doi.org/10.1186/s12884-016-0804-4

Appendix

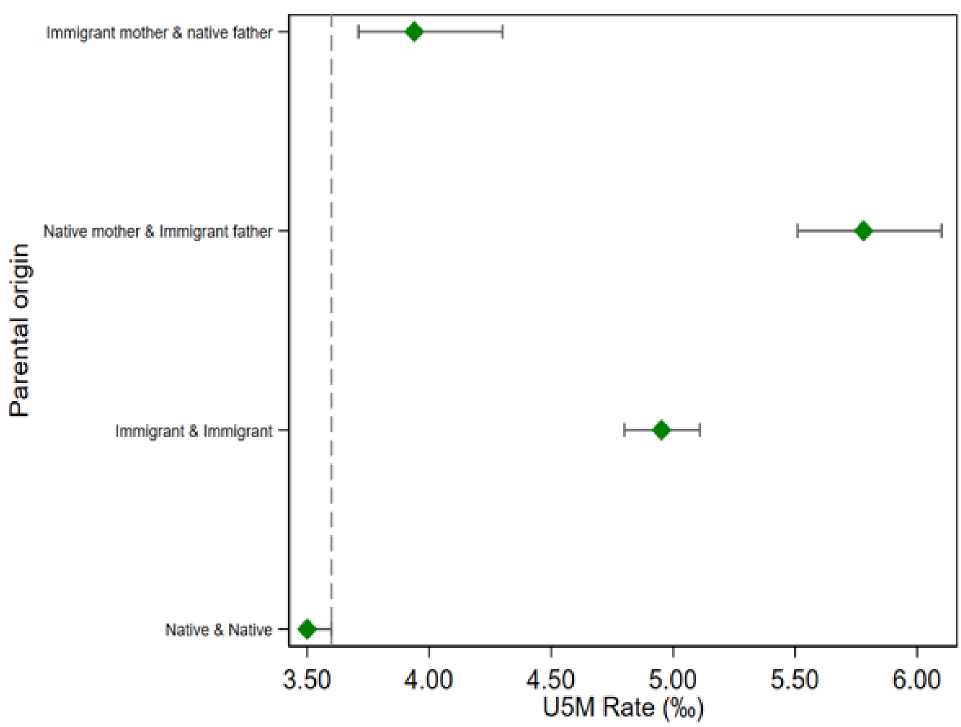
Tab A.1: Provincial differences in immigrant-native U5M gap

	Mother		Father	
Provinces	**Immigrant-native U5M gap**	**95% IC**	**Immigrant-native U5M gap**	**95% IC**
Brussels	-6.74	(-10.54; -2.93)	0.75	(-3.07; 4.56)
Antwerp	16.19	(11.94; 20.44)	19.70	(15.61; 23.80)
Limburg	6.25	(0.29; -12.79)	12.79	(6.06; 19.51)
East Flanders	12.73	(6.42; 19.04)	26.92	(20.48; 33.35)
Flemish Brabant	21.13	(10.81; 31.46)	25.57	(15.46; 35.69)
Western Flanders	3.25	(-4.06; 10.56)	13.03	(5.67; 20.39)
Walloon Brabant	5.87	(-3.60; 15.34)	5.41	(3.61; 14.43)
Hainaut	1.44	(-7.22; 4.34)	15.69	(10.12; 21.25)
Liege	5.43	(-0.35; 11.20)	23.62	(17.73; 29.50)
Luxembourg	0.09	(-11.62; 11.43)	8.76	(-3.22; 20.73)
Namur	10.73	(-0.96; 22.42)	13.01	(2.29; 23.73)

U5M gap calculated per 10,000 live births

Source: Own calculations based upon birth and death certificates 1998–2020

Fig A.1: U5MR (5q0) according to parental origin using mixed categories



Source: Own calculations based upon birth and death certificates 1998–2020