A population-based study on mortality among Belgian immigrants during the first COVID-19 wave in Belgium. Can demographic and socioeconomic indicators explain differential mortality?

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ABSTRACT

Introduction: Belgium has noted a significant excess mortality during the first COVID-19 wave. Research in other countries has shown that people with migrant origin are disproportionally affected. Belgium has an ethnically diverse and increasingly ageing population and is therefore particularly apt to study differential mortality by migrant group during this first wave of COVID-19.
Data and methods: We used nationwide individually-linked data from the Belgian National Register providing sociodemographic indicators and mortality; and the administrative census of 2011 providing indicators of socioeconomic position. Age-standardized all-cause mortality rates (ASMRs) were calculated during the first COVID-19 wave (weeks 11–20 in 2020) and compared with ASMRs during weeks 11–20 in 2019 to calculate excess mortality by migrant origin, age and gender. For both years, relative inequalities were calculated by migrant group using Poisson regression, with and without adjustment for sociodemographic and socioeconomic indicators.
Results: Among the middle-aged, ASMRs revealed increased mortality in all origin groups, with significant excess mortality for Belgians and Sub-Saharan African men. At old age, excess mortality up to 60% was observed for all groups. In relative terms, most male elderly migrant groups showed higher mortality than natives, as opposed to 2019 and to women. Adding the control variables decreased this excess mortality.
Discussion: This study underlined important inequalities in overall and excess mortality in specific migrant communities, especially in men. Tailor-made policy measures and communication strategies should be set-up taking into account the particular risks to which groups are exposed.

Introduction

Belgium has noted a significant excess mortality during the first wave (March 2020 to May 2020) of the COVID-19 pandemic in Europe (Leroy et al., 2020). The Belgian statistical office (Statistics Belgium) reported 30,014 registered deaths in Belgium between March 9, 2020 and May 17, 2020 (weeks 11 to 20); i.e. 8,808 additional deaths compared with the three-year average observed in 2017–2019 in the same weeks (Statistics Belgium). As in Spain, Italy and the United Kingdom, but also the Netherlands, Belgian mortality numbers peaked high; higher than in Norway, Switzerland and Portugal (European Mortality Monito, 2020), for example. However, cross-country mortality comparisons remain difficult and must be interpreted cautiously. Some countries, like

Belgium, reported all deaths from COVID-19 on the national territory, including deaths in residential care centres, whereas other countries did not do so. In sharp contrast with other countries, Belgian practice was furthermore to register all deaths where COVID-19 could possibly be involved as due to COVID-19. Finally, adjustment for relevant demographics was in most countries not possible.

Several studies show wide inequalities within societies. Despite claims that 'we are all in it together', COVID-19 mortality seems to affect some population groups disproportionally (Wright et al., 2020). First of all, medically vulnerable populations show higher mortality figures, including the elderly and people with chronic conditions (Banerjee et al., 2020; Dietz & Santos-Burgoa, 2020; Du et al., 2020; Huang et al., 2020; research group on, 2020). Tragic though this is, this mortality

cannot fully be avoided. Yet, with better prevention of chronic diseases and better chronic health care, it can be acted upon. Secondly, socio-economically vulnerable populations also exhibit higher mortality (Caul, 2020). It seems that COVID-19 exposes the existing fault lines in society and, hence, is likely to amplify the existing inequalities. A recent UK study pinpoints a clear urban-rural divide, with cities being worse off (Caul, 2020). This study also demonstrates that COVID-19 has disproportionally affected the most deprived areas of England. Not only areal deprivation, but also individual deprivation is of high concern: lower socioeconomic groups show higher mortality (Drefahl et al., 2020). Less attention is drawn to differential mortality by migrant group (White & Nafilyan, 2020), which is the focus of this paper.

Research on ethnic inequalities in the UK and the US has shown that African American and other ethnic minorities have been especially affected by the COVID-19 pandemic (van Dorn et al., 2020). They are more vulnerable to contract this disease, but also have more negative outcomes (Bhala et al., 2020; Khunti et al., 2020; Webb Hopper et al., 2020). However, the continental European context, with its focus on first- and second-generation immigrants, might be different. That's why studying this topic in the Belgian COVID high-risk context is of particular interest (de Valk et al., 2011). Moreover, Belgium is one of the forerunners in the transition to an ethnically diverse and increasingly ageing population in Europe. Currently, the proportion of older immigrants in Belgium is larger than that in other traditional European immigration countries, such as Germany or the Netherlands. Hence, Belgium is a very interesting setting to study differential mortality by migrant group during the first wave of the COVID-19 pandemic.

In general, migrants in Belgium, especially from Mediterranean origin, have a more favourable mortality profile compared to the host population and that despite their often lower socioeconomic position (Deboosere & Gadeyne, 2005; Vandenheede et al., 2015). This is in line with the *healthy-migrant effect*, which states that the healthiest individuals are selected for migration, but that this health selection advantage wears off with time. As for other explanations, evidence for the *hypothesis of mortality as a rapid health transition* has been found (Vandenheede et al., 2015). This hypothesis states that the infectious-disease mortality of migrants from less industrialised countries will be high upon arrival and disappear quickly after migration, whilst an increase in chronic-disease mortality does not follow immediately, entailing a migrant mortality advantage. Furthermore, the *salmon-bias hypothesis* – migrants leaving the host country due to illness or imminent mortality – has been shown to be an unlikely explanation of the migrant mortality advantage in Belgium (Vandenheede et al., 2015; Vanthomme & Vandenheede, 2021).

Since COVID-19 is an infectious disease, hitting migrants and host population at the same time, the hypothesis of mortality as a rapid health transition is unlikely to apply. Furthermore, as COVID-19 has been named a *syndemic pandemic* (Bambra et al., 2020), it is also unlikely that migrants will experience a mortality advantage in terms of COVID-19. On the contrary, migrants are most often in the lower socioeconomic strata and are hence, in a disadvantaged position on the one hand, and more vulnerable for having non-communicable diseases that are associated with worse COVID-19 outcomes on the other hand (Bambra et al., 2020). Yet, we could find only one study that looked into explanations for the differential COVID-19 mortality by migrant group (White & Nafilyan, 2020), although many hypotheses have been suggested (Bambra et al., 2020; Bentley, 2020; Guadagno, 2020; Horton, 2020; Marmot & Allen, 2020; What is the impact, 2020). Most hypotheses point at structural and social vulnerabilities as culprits for the observed disparities which can be seen as a form of 'structural violence' (Bentley, 2020). First, migrant groups are most likely to live in the disproportionally affected urban areas. Second, they often hold a lower socioeconomic position. They are often lower educated, which means health messages are likely to convey less easily, also language barriers can occur; they often practice professions that were considered essential during the lockdown associated with the first wave, such as retail work,

public transport jobs and health-care professions; they also have fewer financial means. Third, they often live in more crowded (overcrowded) housing and are more likely to live in multigenerational households (Guadagno, 2020). All these hypotheses suggest that COVID-19 is a syndemic pandemic which does not affect all equally but in which biological and social interactions increase some groups' susceptibility and worsen their health outcomes (Bambra et al., 2020; What is the impact, 2020).

Our data allow to test some of these most common explanations. Therefore, in this study we will assess excess mortality during the first COVID-19 wave in Belgium in migrants and across migrant groups and by demographic indicators and indicators of socioeconomic deprivation. More specifically, we assessed whether 1) the extent of excess mortality during the first COVID-19 wave is different in migrants and across migrant groups, compared with the native Belgian population; and 2) whether a series of demographic and socioeconomic indicators as well as chronic disease prior to COVID-19 might explain this differential excess mortality.

Data and methods

Dataset and study population

We used data provided by Statistics Belgium that consist of individually linked data from 1) the Belgian National Register providing yearly stock files of the total Belgian population, sociodemographic indicators and mortality (FOD Binnenlandse Zaken, 2014); and 2) the administrative census of 2011 providing indicators of socioeconomic position (Statistics Belgium, 2011). For this paper we used the data for 2019 and 2020 on the total population legally residing in Belgium aged 40 years and older.

We have considered mortality during the first COVID-19 wave in Belgium, which was defined as the period between weeks 11–20, thus covering the period between the 9th of March 2020 and the 17th of May 2020. In order to calculate excess mortality during this period, we have compared this mortality with a reference period, i.e. mortality during weeks 11–20 in 2019 (i.e. from March 11th – May 19th).

Variables

Because of the delay in information on causes of death, inequalities in COVID-19 mortality have been approached through excess mortality during the first COVID-19 wave in Belgium as compared to the same calendar period in 2019 (weeks 11–20). The main research goal of this paper was to analyse whether the level of excess mortality in 2020 differed by migrant origin, in other words whether groups with a specific migrant origin were more strongly affected by mortality during the first wave of COVID-19 compared with native Belgians without a migrant origin. Migrant origin was defined using a stepwise procedure, based on both the individual and the parent's country of origin, hereby maximizing the population with migrant roots. If an individual could be linked to her/his parents and the nationality at birth of one of the parents was non-Belgian, this nationality has been used to define migrant origin; If the nationality at birth of both parents was Belgian or if the individual could not be linked to her/his parents, the individual's nationality at birth has been used to define migrant origin; if the individual's nationality at birth was unknown, the individual's current nationality was used. Due to group sizes and number of deaths, we were not able to distinguish first from second-generation migrants in this study. However, we stratified migrant origin by age group, which for a large part reflects the division between first- (65+ years) and second-generation (<65 years) migrants, at least for a large proportion of traditional labour migrants in Belgium (Deboosere & Gadeyne, 2005). We then grouped the country of origin into the following migrant groups: native Belgians; EU-15 (excluding the United Kingdom); other European countries; Turkey; Northern Africa; Sub-Saharan African

(SSA); and other countries. These groups were based on geographical proximity, shared migration history and group size. Turkish migrants were grouped as a single country as it represents one of the largest migrant communities in Belgium but is not representative for the remainder of European or Asian countries due to its specific migration history to Belgium (de Valk et al., 2011).

All analyses were stratified by gender and age group (40–64 years and 65+ years) and adjusted for age (measured continuously). The lower age limit was chosen to ensure a sufficient number of migrants as well as COVID-19 deaths per group. Stratifying is important as previous studies proved that men are more affected than women, and that old-aged people are hit extremely hard by COVID-19 (Di Stadio et al., 2020; Dowd et al., 2020; Drefahl et al., 2020; Sharma et al., 2020; Williamson et al., 2020). To identify factors that might be associated with differences in excess mortality during this first COVID-19 wave, we integrated several indicators of interest in the statistical models. First of all, we included a series of *demographic indicators*. The first one was the *type of household* people live in: with a partner, without a partner, in a collective household (e.g. care homes) or an 'other' type of household (e. g. living together with roommates or with the parents). This indicator served as a proxy indicator of having a 'close social network' but also reflected the possibility of infection transmission within the household. Secondly, we took *population density* into account as COVID-19 seemed to spread more rapidly in densely populated areas (Guadagno, 2020). Population density was calculated at the municipality level and grouped into three categories of equal size, from low (from 24 to 403 inhabitants/km^2) over intermediate (from 406 to 1,051 inhabitants/km^2) to high (from 1,076 to 23,358 inhabitants/km^2) population density. A second series of indicators included in the models were indicators of *socioeconomic position* (SEP), as these are related to migrant origin and may be related to COVID-19 mortality as well. Cultural capital, important to understand and act upon health messages, was measured through *educational attainment*, consisting of having a degree of primary education or less, lower secondary education, upper secondary education and tertiary education. *Income level* was included as indicator of economic capital which may be related to housing conditions and to health care utilization. This indicator was based on the total net taxable income per person and divided into deciles that were categorised as low income (deciles one to four), mid income (five to seven) and high income (eight to ten). As missing values might be not be randomly distributed over migrant origin, these were treated as separate categories, both for educational attainment and income level. To end with, we also included a proxy of *chronic disease* prior to the COVID-19 pandemic. More specifically, individuals were categorised as having a chronic disease when their total taxable income in 2020 mainly consisted of sickness benefits (60% or more). As this indicator was based on income out of labour, it could only be constructed for the population younger than 65 years.

Statistical analyses

To measure excess mortality in migrants and across migrant groups compared with native Belgians and to account for existing sociodemographic and socioeconomic inequalities between migrant communities, different methods have been used. In a first step, excess mortality during the first COVID-19 wave in Belgium has been calculated. We did so by calculating directly age-standardized mortality rates (ASMR) by migrant group, stratified by gender and age group, using the Belgian population of 2020 as the standard population. The ASMRs have been calculated during the observation period (weeks 11–20) in 2020 and during the reference period in 2019. The absolute difference as well as the percentage of change between the ASMRs observed in both years gave an estimation of excess mortality by migrant group, gender and age group. Secondly, to study the role of the sociodemographic and socioeconomic indicators as well as chronic disease in mortality differences in migrants and across migrant groups during the first wave of the pandemic, we have estimated relative inequalities. Age-adjusted mortality rate ratios

have been calculated for the various migrant groups using the native Belgians as reference group by means of Poisson regression using the log of the person-time as the offset. In addition, mortality rate ratios have been calculated by migrant origin, gender and age group, adjusting for demographic indicators, SEP, and chronic disease (only among 40-64-years). The results of the age-adjusted and fully-adjusted models can be found in the text, the results of the model building can be found in the appendix Table A.1, A.2, A.3 and A.4. The significance of the absolute trends over time have been formally tested as explained by Altman & Bland (Altman & Bland, 2003). All analyses have been performed with Stata/SE 16.1.

Results

Mortality differences by migrant group during the first COVID-19 wave and excess mortality compared to a reference period in 2019

Table 1 shows the ASMRs during the first COVID-19 wave by migrant group as well as the difference compared to the reference period in 2019. The ASMRs revealed increased mortality in all origin groups, with significant differences between 2019 and 2020 for Belgian middle-aged men and women (7% and 10% excess mortality) and SSA middle-aged men. For this group, we observed an increase of more than 342 deaths per 100,000 person-years).

Trends were different among the population aged 65 and over, for whom we observed a high excess mortality among all groups ranging from 26% to 60% among men and from 24% to 48% among women. The largest excess mortality among men was observed for men from 'other origin' and from 'other European origin' with an absolute excess of more than 1,000 deaths per 100,000 person-years. Among women, Turkish migrants showed the larges excess with 706 more deaths per 100,000 person-years, followed by women from EU-15 countries. Although the excess mortality among SSA men and women as well as women from 'other origin' was quite high in absolute terms, this was not statistically significant due to small group sizes.

Role of sociodemographic, socioeconomic and health indicators in the differential mortality during the first COVID-19 wave by migrant group

Tables 2–5 show the results of the Poisson regression models by gender and age group, with and without the adjustment for the sociodemographic and socioeconomic variables and additionally for chronic disease for the youngest age group.

The basic regression model (controlled for age) revealed few relative mortality differences in migrants and across migrant groups during the first COVID-19 wave among men aged 40–64 years (Table 2). The only exceptions concerned on the one hand men of Northern African descent with 34% lower mortality than native Belgian men, and on the other hand SSA men with 79% higher mortality. Controlling for sociodemographic and socioeconomic characteristics and chronic disease resulted in an additional significantly lower mortality in men originating from EU-15 countries, other EU-countries and other countries and a non-significant coefficient for SSA men. Overall, these patterns matched with the ones observed in 2019, except for SSA men who had a mortality advantage in 2019, which was no longer the case in 2020. Overall, among middle-aged women, patterns were similar to those observed for men (Table 3). Yet, middle-aged Turkish women also showed a mortality advantage compared to native Belgian women, with 57% lower mortality in the age-adjusted model and 75% lower mortality in the fully-adjusted model. Adding the variables of interest to the basic model resulted, as in men, in additional mortality advantages. As in men, the mortality disadvantage of SSA middle-aged women in the basic model was not observed in 2019, whereas the mortality advantage of Turkish and Northern African women compared to native Belgian women in the basic model had not been observed either in 2019.

For men aged 65+, the pattern was quite different, with higher MRRs

Table 1

Number of deaths, person-years (PY), age-standardized mortality rates (ASMR) per 100,000 person-years and 95% confidence intervals (95% C.I.) by migrant group, age and sex during the first COVID-19 wave in 2020 and excess mortality compared with the same period in 2019.

	2020			Comparison of 2020 and 2019 mortality levels	
	Deaths	PY	ASMR (95% C.I.)	Absolute difference 2020–2019	% change
MEN 40-64					
Belgian	1487	260,066	251.7 (238.9–264.4)	**17.7 (17.2–18.1)**	**7.0%**
EU-15	226	44,240	248.6 (216.2–281.0)	41.0 (38.6–43.5)	16.5%
Other Europe	63	16,637	241.3 (179.1–303.6)	9.8 (8.19–11.6)	4.1%
Turkey	39	7115	339.1 (228.2–450.1)	84.1 (71.6–96.6)	24.8%
North Africa	47	17,751	159.9 (111.5–208.4)	39.5 (32.6–46.5)	24.7%
SSA	50	6840	486.8 (342.9–630.6)	**342.1 (270.6–413.4)**	**70.3%**
Other origin	25	9028	175.2 (103.2–247.2)	38.6 (29.1–48)	22.0%
MEN 65+					
Belgian	10,752	156,327	2052.8 (2017.0–2088.5)	**612.9 (608.2–617.4)**	**29.9%**
EU-15	867	15,488	2068.1 (1933.3–2202.9)	**568.3 (554.1–582.6)**	**27.5%**
Other Europe	164	2673	2505.3 (2128.8–2881.8)	**1049.2 (977.7–825.8)**	**41.9%**
Turkey	75	1054	2518.6 (1942.7–3094.5)	**963.7 (888.9–1038.5)**	**38.3%**
North Africa	170	3424	1692.7 (1429.8–1955.6)	**436.8 (417.6–456)**	**25.8%**
SSA	34	617	2321.7 (1384.2–3259.2)	1271.1 (1080.7–1461.4)	54.7%
Other origin	62	1452	1844.6 (1362.8–2326.5)	**1099.5 (948.1–1250.9)**	**59.6%**
WOMEN 40–64					
Belgian	912	259,646	152.5 (142.6–162.5)	**14.8 (14.3–15.3)**	**9.7%**
EU-15	115	42,259	133.9 (109.4–158.4)	−2.5 (−3.1–2.0)	−1.9%
Other Europe	49	17,896	162.5 (115.1–209.9)	53.4 (45.2–61.7)	32.9%
Turkey	<10	6308	62.5 (15.8–109.2)	−11.4 (−15.8–7.0)	−18.2%
North Africa	25	15,007	92.5 (54.1–130.9)	−10.5 (−13.9–7.1)	−11.4%
SSA	31	7062	276.9 (172.2–381.7)	111.2 (87.4–135.1)	40.2%
Other origin	25	10,763	150.1 (87.4–212.8)	76.5 (57.2–95.7)	51.0%
WOMEN 65+					
Belgian	12,897	202,145	1512.1 (1487.6–1536.5)	**491.0 (487.4–494.6)**	**32.5%**
EU-15	934	16,652	1677.9 (1579.6–1776.1)	**663.8 (646.8–680.7)**	**39.6%**
Other Europe	141	3463	1531.4 (1289.8–1773.0)	**364.6 (341.6–387.6)**	**23.8%**
Turkey	46	1235	1465.8 (1061.7–1870.0)	**705.9 (598.6–813.2)**	**48.2%**
North Africa	119	3331	1168.2 (954.8–1381.7)	**399.4 (380.7–418.1)**	**34.2%**
SSA	37	897	1484.2 (939.3–2029.1)	182.9 (256.7–109)	12.3%
Other origin	36	1546	1040 (702.6–1377.5)	312.8 (274.9–350.9)	30.1%

Results in Bold are significant at the 0.05-level.

than Belgians for most migrant groups (Table 4). These MRRs were statistically significant for Turkish men with 46% higher mortality and non-EU-15 Europeans with 24% higher mortality. These disadvantageous mortality patterns were not observed in 2019. Adjusting for the sociodemographic and socioeconomic characteristics resulted in a decrease of this excess mortality and even a mortality advantage of 19% for Northern African men compared to the male host population. Nevertheless, excess mortality of 28% remained statistically significant for Turkish men in the fully-adjusted model. Women aged 65+ of SSA and EU-15 descent showed an excess mortality of 41% and 12% respectively, which was not observed in 2019 (Table 5). In contrast, women of 'other' origin had a significantly lower mortality in all models, which was also the case in 2019 in the fully-adjusted model. After adding the confounders to the model, the mortality disadvantage of SSA women disappeared.

Discussion

This paper aimed at mapping out mortality differences in migrants and across migrant groups during the first COVID-19 wave in Belgium (in week 11 to week 19 in 2020). Several indicators were calculated, comparing mortality in 2020 to mortality in a reference period (week 11 to week 19 in 2019). Overall, mortality increased in all groups during the first COVID-19 wave in Belgium. Although excess mortality was not always significant, increases should be taken seriously as the total population is included in this study. Striking was the excess mortality in SSA men and women, suffering from very high rates during the first COVID-19 wave. Sub-Saharan Africans were the only community

showing significantly higher MRRs than native Belgians both for men and women at middle age and for women at old age. Interpreting this large MRR is complex and several factors need to be taken into account. SSA communities seemed to be hit by higher mortality rates in other countries as well, such as the USA, related to a higher prevalence of cardiovascular diseases, hypertension and diabetes for instance (Doumas et al., 2020). Our data revealed that excess mortality among these groups was typically related to their socioeconomic and sociodemographic position. Controlling for the comorbidity indicator did not really account for their mortality excess (See Appendix). Striking also was the higher mortality of Turkish old-aged men, holding after control for socioeconomic and -demographic variables, in contrast to Northern Africans who seemed to have a consistently lower mortality among old-aged men. A possible explanation could be related to different levels of language proficiency: Northern Africans are more likely to master at least one of Belgium's national languages (i.e. French), as this is also a commonly used language in many of the Northern African countries, whereas this is not so for Turkish migrants. Linguistic barriers are important as they may be related to limited awareness of recommended prevention measures (Guadagno, 2020). Furthermore, men from non-EU15 European countries showed an excess mortality related to their socioeconomic and sociodemographic profiles, while among women, EU-15 descents showed a slightly higher mortality than the native Belgians.

These patterns likely resulted from a complex interplay between multiple factors. COVID-19 is a syndemic pandemic and our results clearly showed that we 'are not all in it together'. Not only socioeconomic and sociodemographic elements come into play, but also cultural

Table 2

Mortality rate ratios and 95% confidence intervals by migrant group: age- and fully-adjusted models for men aged 40–64 years during the first COVID-19 wave in 2020 compared with the reference period in 2019.

	2020		2019	
	Age-adjusted model	Fully-adjusted model	Age-adjusted model	Fully-adjusted model
Region of origin				
Belgium	ref.	ref.	ref.	ref.
EU-15	0.99	0.75	0.89	0.71
	(0.86–1.14)	(0.64–0.87)	(0.76–1.04)	(0.60–0.84)
Other Europe	0.92	0.60	1.01	0.75
	(0.72–1.19)	(0.45–0.80)	(0.78–1.30)	(0.56–0.99)
Turkey	1.34	0.83	1.04	0.69
	(0.97–1.84)	(0.60–1.16)	(0.71–1.52)	(0.46–1.01)
Northern Africa	0.66	0.42	0.58	0.40
	(0.49–0.88)	(0.31–0.56)	(0.42–0.80)	(0.29–0.57)
Sub-Saharan Africa	1.79	1.19	0.78	0.58
	(1.34–2.38)	(0.88–1.61)	(0.50–1.23)	(0.37–0.92)
Other	0.68	0.46	0.61	0.46
	(0.46–1.01)	(0.30–0.69)	(0.39–0.95)	(0.29–0.72)
Age	1.11	1.10	1.10	1.09
	(1.10–1.12)	(1.09–1.11)	(1.09–1.11)	(1.08–1.10)
Household type				
With partner		ref.		ref.
Without partner		1.98		2.17
		(1.79–2.19)		(1.95–2.41)
Other		1.85		1.59
		(1.56–2.19)		(1.32–1.92)
Collective HH		4.93		3.44
		(3.95–6.15)		(2.64–4.47)
Population density				
Low		ref.		ref.
Intermediate		1.08		1.08
		(0.97–1.21)		(0.97–1.22)
High		1.31		1.07
		(1.17–1.47)		(0.95–1.21)
Educational level				
Primary or less		ref.		ref.
Lower secondary		0.97		0.86
		(0.84–1.13)		(0.74–1.00)
Upper secondary		0.80		0.77
		(0.69–0.93)		(0.66–0.90)
Tertiary education		0.67		0.69
		(0.56–0.80)		(0.58–0.83)
Unknown		0.84		0.74
		(0.70–1.01)		(0.61–0.90)
Income level				
Low		ref.		ref.
Intermediate		0.73		0.83
		(0.65–0.83)		(0.73–0.94)
High		0.56		0.59
		(0.49–0.65)		(0.51–0.68)
Unknown		1.60		1.84
		(1.35–1.90)		(1.52–2.24)
Chronic disease				
No		ref.		ref.
Yes		2.48		2.92
		(2.19–2.80)		(2.57–3.32)

The age-adjusted model contains region of origin and age; The fully-adjusted model contains region of origin, age, sociodemographic and socioeconomic characteristics and chronic disease.

Table 3

Mortality rate ratios and 95% confidence intervals by migrant group: age- and fully-adjusted models for women aged 40–64 years during the first COVID-19 wave in 2020 compared with the reference period in 2019.

	2020		2019	
	Age-adjusted model	Fully-adjusted model	Age-adjusted model	Fully-adjusted model
Region of origin				
Belgium	ref.	ref.	ref.	ref.
EU-15	0.88	0.66	0.99	0.79
	(0.72–1.06)	(0.54–0.82)	(0.81–1.20)	(0.64–0.97)
Other Europe	1.05	0.69	0.81	0.57
	(0.78–1.40)	(0.49–0.97)	(0.57–1.15)	(0.40–0.82)
Turkey	0.43	0.25	0.57	0.35
	(0.20–0.91)	(0.12–0.53)	(0.25–1.14)	(0.18–0.71)
Northern Africa	0.62	0.39	0.75	0.50
	(0.42–0.94)	(0.25–0.59)	(0.50–1.12)	(0.33–0.76)
SSA	1.85	1.14	1.39	0.98
	(1.29–2.65)	(0.78–1.67)	(0.89–2.17)	(0.62–1.55)
Other	0.95	0.67	0.49	0.38
	(0.63–1.41)	(0.44–1.03)	(0.27–0.88)	(0.20–0.70)
Age	1.10	1.09	1.10	1.09
	(1.10–1.12)	(1.08–1.10)	(1.09–1.11)	(1.08–1.10)
Household type				
With partner		ref.		ref.
Without partner		1.80		1.60
		(1.58–2.05)		(1.39–1.83)
Other		2.03		2.28
		(1.60–2.58)		(1.79–2.90)
Collective HH		9.65		5.61
		(7.33–12.71)		(3.94–8.00)
Population density				
Low		ref.		ref.
Intermediate		0.97		1.07
		(0.85–1.12)		(0.92–1.24)
High		1.05		1.12
		(0.90–1.23)		(0.96–1.31)
Educational level				
Primary or less		ref.		ref.
Lower secondary		0.76		1.03
		(0.63–0.92)		(0.84–1.27)
Upper secondary		0.59		0.83
		(0.49–0.72)		(0.67–1.03)
Tertiary		0.64		0.84
		(0.52–0.80)		(0.66–1.06)
Unknown		0.80		1.00
		(0.63–1.03)		(0.76–1.30)
Income level				
Low		ref.		ref.
Intermediate		0.92		0.89
		(0.78–1.07)		(0.75–1.05)
High		0.65		0.68
		(0.52–0.80)		(0.55–0.84)
Unknown		2.23		1.94
		(1.79–2.77)		(1.52–2.49)
Chronic disease				
No		ref.		ref.
Yes		3.07		3.34
		(2.65–3.56)		(2.87–3.89)

The age-adjusted model contains region of origin and age; The fully-adjusted model contains region of origin, age, sociodemographic and socioeconomic characteristics and chronic disease.

traditions and cultural barriers, communication skills, health seeking behaviour, access to health services, precarious job and housing conditions, travelling for leisure and work-related goals, the wider urban context, etc., leading to a higher vulnerability among specific communities to get the disease and to recover or not from the disease. The higher mortality rates in precarious communities during the first COVID-19 wave, especially at old age and among men, were striking, particularly in the light of the well-established healthy migrant effect (mainly in migrants with a shorter duration of stay in Belgium)

(Deboosere & Gadeyne, 2005; Vandenheede et al., 2015).

Relative differences of course depend upon the behaviour of the reference group, the native Belgians. Their mortality profile during the first COVID-19 wave might have deviated from the traditional socio-economic patterning observed in health and mortality, with a higher mortality than usual in higher social classes. Skiing holidays and travelling for leisure and work-related goals – more typical for and affordable in the middle and higher classes – initially played an important role in the spread of COVID-19 in Europe. However, our analyses illustrated

Table 4

Mortality rate ratios and 95% confidence intervals by migrant group: age- and fully-adjusted models for men aged 65+ years during the first COVID-19 wave in 2020 compared with the reference period in 2019.

	2020		2019	
	Age-adjusted model	Fully-adjusted model	Age-adjusted model	Fully-adjusted model
Region of origin				
Belgium	ref.	ref.	ref.	ref.
EU-15	1.04	0.98	1.06	1.01
	(0.97–1.11)	(0.92–1.05)	(0.97–1.15)	(0.93–1.10)
Other Europe	1.24	1.09	1.03	0.95
	(1.06–1.45)	(0.94–1.28)	(0.84–1.27)	(0.77–1.17)
Turkey	1.46	1.28	1.08	0.97
	(1.16–1.83)	(1.02–1.61)	(0.79–1.49)	(0.70–1.32)
Northern Africa	0.88	0.81	0.90	0.82
	(0.76–1.03)	(0.69–0.94)	(0.75–1.09)	(0.68–0.99)
SSA	1.35	1.06	0.79	0.66
	(0.96–1.89)	(0.75–1.48)	(0.46–1.36)	(0.38–1.14)
Other	0.91	0.81	0.56	0.51
	(0.71–1.17)	(0.63–1.04)	(0.38–0.83)	(0.34–0.75)
Age	1.12	1.09	1.12	1.10
	(1.12–1.13)	(1.09–1.10)	(1.11–1.12)	(1.09–1.10)
Household type				
With partner		ref.		ref.
Without partner		1.37		1.30
		(1.31–1.43)		(1.23–1.37)
Other		1.41		1.38
		(1.27–1.57)		(1.22–1.56)
Collective HH		5.50		3.18
		(5.21–5.79)		(2.97–3.42)
Population density				
Low		ref.		ref.
Intermediate		1.03		1.01
		(0.99–1.07)		(0.96–1.07)
High		1.19		1.06
		(1.14–1.25)		(1.01–1.13)
Educational level				
Primary or less		ref.		ref.
Lower secondary		0.91		0.98
		(0.86–0.95)		(0.92–1.04)
Upper secondary		0.89		0.89
		(0.84–0.94)		(0.83–0.95)
Tertiary		0.76		0.80
		(0.72–0.81)		(0.74–0.86)
Unknown		1.03		1.03
		(0.97–1.10)		(0.95–1.11)
Income level				
Low		ref.		ref.
Middle		0.89		0.87
		(0.85–0.92)		(0.83–0.91)
High		0.74		0.75
		(0.70–0.79)		(0.69–0.81)
Unknown		0.85		0.88
		(0.73–1.00)		(0.71–1.09)

The age-adjusted model contains region of origin and age; The fully-adjusted model contains region of origin, age, sociodemographic and socioeconomic characteristics.

Table 5

Mortality rate ratios and 95% confidence intervals by migrant group: age- and fully-adjusted models for women aged 65+ years during the first COVID-19 wave in 2020 compared with the reference period in 2019.

	2020		2019	
	Age-adjusted model	Fully-adjusted model	Age-adjusted model	Fully-adjusted model
Region of origin				
Belgium	ref.	ref.	ref.	ref.
EU-15	1.12	1.09	1.00	0.97
	(1.05–1.20)	(1.02–1.16)	(0.92–1.09)	(0.89–1.06)
Other Europe	0.99	0.90	1.11	1.01
	(0.84–1.17)	(0.76–1.06)	(0.91–1.36)	(0.83–1.23)
Turkey	0.98	0.91	0.85	0.77
	(0.73–1.31)	(0.68–1.22)	(0.58–1.25)	(0.52–1.13)
Northern Africa	0.89	0.83	0.80	0.71
	(0.74–1.08)	(0.68–1.01)	(0.63–1.02)	(0.55–0.92)
SSA	1.41	1.18	1.26	1.06
	(1.02–1.95)	(0.85–1.63)	(0.82–1.93)	(0.69–1.63)
Other	0.69	0.63	0.73	0.67
	(0.50–0.95)	(0.45–0.87)	(0.49–1.09)	(0.44–1.00)
Age	1.14	1.09	1.13	1.10
	(1.14–1.14)	(1.09–1.10)	(1.13–1.14)	(1.09–1.10)
Household type				
With partner		ref.		ref.
Without partner		1.34		1.29
		(1.28–1.42)		(1.21–1.37)
Other		2.13		1.84
		(1.96–2.32)		(1.67–2.04)
Collective HH		5.30		3.71
		(4.98–5.64)		(3.44–3.99)
Population density				
Low		ref.		ref.
Intermediate		1.03		0.98
		(0.99–1.07)		(0.93–1.03)
High		1.13		1.04
		(1.08–1.17)		(0.99–1.09)
Educational level				
Primary or less		ref.		ref.
Lower secondary		0.93		0.88
		(0.89–0.97)		(0.83–0.93)
Upper secondary		0.82		0.84
		(0.77–0.86)		(0.79–0.90)
Tertiary		0.73		0.68
		(0.68–0.78)		(0.62–0.75)
Unknown		0.95		1.00
		(0.90–1.00)		(0.93–1.07)
Income level				
Low		ref.		ref.
Middle		0.95		0.90
		(0.92–0.99)		(0.86–0.94)
High		0.90		0.95
		(0.84–0.96)		(0.88–1.04)
Unknown		0.84		0.80
		(0.72–0.98)		(0.65–0.98)

The age-adjusted model contains region of origin and age; The fully-adjusted model contains region of origin, age, sociodemographic and socioeconomic characteristics.

the dominance of the classic social gradient during the first wave with a higher mortality among lower educated and low-income groups.

The variable that generated the largest differences was type of household, with a huge mortality excess in collective households during the first wave both among men and women; a trend related to the fact that residents of care homes were often not hospitalised during the first COVID-19 wave in Belgium and to the lack of testing capacity and medical staff in these care homes. Another striking result was that population density generated significantly higher mortality differences in 2020 compared to 2019 (except among middle-aged women). This is an important observation, consistent with earlier studies on the spread of infectious diseases in dense areas (Glaeser, 2011). In the light of the composition of the population in care homes, with very few people with

a migrant origin, the higher mortality of specific communities was even more striking.

The vulnerability of middle-aged people with a chronic disease did not really change during the first COVID-19 wave. The variable seemed to be somewhat more determinant in 2019 than in 2020 but the difference between both periods was not significant. Of course, the construction of this variable relied on the declarations in the tax register and not on medical diagnosis. A person was categorised as suffering from chronic morbidity when the share of sickness benefits in his/her total income was equal to 60% or more. This probably captured people suffering from a severe, advanced and limiting disease. Moreover, as the indicator was based on income, it was only available for the population of working age. Our study had several other limitations. It was based on

register data and included the officially registered population in Belgium only, excluding the vulnerable group of undocumented migrants. In addition, although analyses were based on exhaustive data, some of the migrant communities were rather small. Results for these groups should be interpreted with caution, such as the SSA community. In addition, at the time of the analyses, it was impossible to isolate deaths due to COVID-19. Consequently, we had to focus on overall mortality and its excess, comparing mortality during week 11–19 in 2020 with the same weeks in the 2019 reference period. This excess mortality resulted from different counteracting causes of death: the decline of mortality for specific causes – such as traffic accidents – and the increase of other causes of death. There is a clear risk that mortality among non-infected persons has been affected, not in the least due to the fact that planned surgery and other medical consultations have been postponed and due to the reduced capacity to treat other acute conditions (Vandoros, 2020). Even if cause-specific data would be available, such data would need to be handled with caution in the future due to the difficulties in registration of a death as COVID-19 conditional on the testing capacity during the first wave and the interplay between COVID-19 and other causes of death. Furthermore, no data were available on occupation, health seeking behaviour, language barriers, housing density and other determinants of mortality differences.

The strength of our study mainly relates to the exhaustive data allowing for detailed analysis of migrant communities. All deaths in the country were captured in our dataset, including a wide variety of socio-economic and socio-demographic variables that seemed to have played an important role in spreading the COVID-19 virus, such as residency in a care home, type of household, education, income level, chronic conditions and migrant origin. The overall conclusion was that specific groups have been struck hard by COVID-19 already during the first COVID-19 wave in Belgium.

Given that our data applied to the total population in Belgium, this study underlined important inequalities in overall mortality and in mortality excesses in specific communities. Policy makers should keep in mind that specific communities come with specific characteristics and realise that a one for all-policy is not the best choice to make with regard to the syndemic. Specific policy measures and communication strategies should be set up taking into account the particular risks to which specific communities and classes are exposed to.

Ethics approval

This research as well as the data adhere to the ethical code of scientific research in Belgium, see: http://www.belspo.be/belspo/organisation/publ/pub_ostc/Eth_code/ethcode_nl.pdf.

All authors have signed the ethical code.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and material (data transparency)

The analyses are based on data from a census-linked mortality follow-up study and cannot be made available due to privacy issues. Researchers can gain full access to the data by submitting an application to the Privacy Commission Belgium. In order to get permission to use data from the Belgian population register linked to census data an authorization request (in Dutch or French) needs to be submitted to the Belgian Data Protection Authority. The authorization request includes an application form and additional forms regarding data security. The necessary forms for the authorization request can be downloaded from the Data Protection Authority website (https://www.dataprotectionauthority.be). Next to information on the applicant and a list of requested data, the authorization request should specify why the data from the population register are necessary, for which time span data will be stored, and who will have access to the data.

Code availability

(software application or custom code): the codes for the analyses are available upon request (please contact the corresponding author).

Author contributions

KV: Conceptualization, Methodology, Validation, Formal analysis, Writing of the original draft, Writing - Review & Editing, Visualization. SG: Conceptualization, Methodology, Validation, Writing of the original draft, Writing - Review & Editing. PL: Data curation, Writing - Review & Editing. HV: Conceptualization, Methodology, Validation, Writing of the original draft, Writing - Review & Editing.

Declaration of competing interest

The authors declare that there are no conflicts of interest.

Appendix

Table A.1

Mortality rate ratios and 95% confidence intervals by migrant group: model building from age-adjusted to fully-adjusted models for men aged 40–64 years during the first COVID-19 wave in 2020.

	Model 1	Model 2	Model 3	Model 4
Region of origin				
Belgium	ref.	ref.	ref.	ref.
EU-15	0.99 (0.86–1.14)	0.91 (0.79–1.05)	0.75 (0.65–0.88)	0.75 (0.64–0.87)
Other Europe	0.92 (0.72–1.19)	0.80 (0.62–1.03)	0.58 (0.43–0.77)	0.60 (0.45–0.80)
Turkey	1.34 (0.97–1.84)	1.33 (0.96–1.83)	0.88 (0.63–1.22)	0.83 (0.60–1.16)

(*continued on next page*)

Table A.1 (*continued*)

	Model 1	Model 2	Model 3	Model 4
Northern Africa	0.66 (0.49–0.88)	0.59 (0.44–0.79)	0.41 (0.30–0.55)	0.42 (0.31–0.56)
Sub-Saharan Africa	1.79 (1.34–2.38)	1.36 (1.02–1.81)	1.04 (0.77–1.40)	1.19 (0.88–1.61)
Other	0.68 (0.46–1.01)	0.59 (0.40–0.88)	0.42 (0.28–0.63)	0.46 (0.30–0.69)
Age	1.11 (1.10–1.12)	1.11 (1.10–1.12)	1.10 (1.09–1.11)	1.10 (1.09–1.11)
Household type				
With partner		ref.	ref.	ref.
Without partner		2.50 (2.26–2.76)	2.10 (1.90–2.32)	1.98 (1.79–2.19)
Other		2.44 (2.07–2.88)	1.89 (1.60–2.24)	1.85 (1.56–2.19)
Collective HH		11.27 (9.20–13.81)	6.36 (5.08–7.95)	4.93 (3.95–6.15)
Population density				
Low		ref.	ref.	ref.
Intermediate		1.06 (0.95–1.19)	1.09 (0.98–1.22)	1.08 (0.97–1.21)
High		1.35 (1.20–1.51)	1.32 (1.17–1.48)	1.31 (1.17–1.47)
Educational level				
Primary or less			ref.	ref.
Lower secondary			0.95 (0.82–1.10)	0.97 (0.84–1.13)
Upper secondary			0.76 (0.65–0.88)	0.80 (0.69–0.93)
Tertiary education			0.62 (0.52–0.74)	0.67 (0.56–0.80)
Unknown			0.81 (0.67–0.97)	0.84 (0.70–1.01)
Income level				
Low			ref.	ref.
Intermediate			0.61 (0.54–0.68)	0.73 (0.65–0.83)
High			0.41 (0.36–0.47)	0.56 (0.49–0.65)
Unknown			1.11 (0.94–1.30)	1.60 (1.35–1.90)
Chronic disease				
No				ref.
Yes				2.48 (2.19–2.80)

Table A.2

Mortality rate ratios and 95% confidence intervals by migrant group: model building from age-adjusted to fully-adjusted models for women aged 40–64 years during the first COVID-19 wave in 2020.

	Model 1	Model 2	Model 3	Model 4
Region of origin				
Belgium	ref.	ref.	ref.	ref.
EU-15	0.88 (0.72–1.06)	0.82 (0.67–1.00)	0.67 (0.54–0.82)	0.66 (0.54–0.82)
Other Europe	1.05 (0.78–1.40)	0.84 (0.70–1.27)	0.66 (0.47–0.92)	0.69 (0.49–0.97)
Turkey	0.43 (0.20–0.91)	0.43 (0.20–0.91)	0.27 (0.13–0.57)	0.25 (0.12–0.53)
Northern Africa	0.62 (0.42–0.94)	0.58 (0.38–0.87)	0.38 (0.25–0.58)	0.39 (0.25–0.59)
Sub-Saharan Africa	1.85 (1.29–2.65)	1.45 (1.01–2.08)	1.00 (0.69–1.47)	1.14 (0.78–1.67)
Other	0.95 (0.63–1.41)	0.87 (0.58–1.30)	0.61 (0.40–0.93)	0.67 (0.44–1.03)
Age	1.10 (1.10–1.12)	1.10 (1.09–1.11)	1.09 (1.08–1.10)	1.09 (1.08–1.10)
Household type				
With partner		ref.	ref.	ref.
Without partner		2.03 (1.78–2.30)	2.03 (1.78–2.30)	1.80 (1.58–2.05)
Other		2.59 (2.03–3.29)	2.23 (1.76–2.83)	2.03 (1.60–2.58)
Collective HH		21.40 (16.72–27.38)	13.00 (9.77–17.30)	9.65 (7.33–12.71)
Population density				
Low		ref.	ref.	ref.
Intermediate		0.96 (0.83–1.11)	1.00 (0.86–1.14)	0.97 (0.85–1.12)
High		1.08 (0.93–1.25)	1.08 (0.93–1.26)	1.05 (0.90–1.23)
Educational level				
Primary or less			ref.	ref.
Lower secondary			0.76 (0.62–0.91)	0.76 (0.63–0.92)
Upper secondary			0.56 (0.46–0.68)	0.59 (0.49–0.72)
Tertiary education			0.59 (0.48–0.73)	0.64 (0.52–0.80)
Unknown			0.76 (0.60–0.97)	0.80 (0.63–1.03)
Income level				
Low			ref.	ref.
Intermediate			0.73 (0.63–0.86)	0.92 (0.78–1.07)
High			0.45 (0.37–0.55)	0.65 (0.52–0.80)
Unknown			1.39 (1.13–1.71)	2.23 (1.79–2.77)
Chronic disease				
No				ref.
Yes				3.07 (2.65–3.56)

Table A.3
Mortality rate ratios and 95% confidence intervals by migrant group: model building from age-adjusted to fully-adjusted models for men aged 65+ years during the first COVID-19 wave in 2020.

	Model 1	Model 2	Model 3
Region of origin			
Belgium	ref.	ref.	ref.
EU-15	1.04 (0.97–1.11)	1.04 (0.97–1.12)	0.98 (0.92–1.05)
Other Europe	1.24 (1.06–1.45)	1.15 (0.99–1.34)	1.09 (0.94–1.28)
Turkey	1.46 (1.16–1.83)	1.50 (1.19–1.88)	1.28 (1.02–1.61)
Northern Africa	0.88 (0.76–1.03)	0.95 (0.81–1.10)	0.81 (0.69–0.94)
Sub-Saharan Africa	1.35 (0.96–1.89)	1.15 (0.82–1.61)	1.06 (0.75–1.48)
Other	0.91 (0.71–1.17)	0.86 (0.67–1.10)	0.81 (0.63–1.04)
Age	1.12 (1.12–1.13)	1.10 (1.09–1.10)	1.09 (1.09–1.10)
Household type			
With partner		ref.	ref.
Without partner		1.39 (1.33–1.45)	1.37 (1.31–1.43)
Other		1.47 (1.33–1.63)	1.41 (1.27–1.57)
Collective HH		5.70 (5.41–6.01)	5.50 (5.21–5.79)
Population density			
Low		ref.	ref.
Intermediate		1.01 (0.97–1.06)	1.03 (0.99–1.07)
High		1.15 (1.10–1.20)	1.19 (1.14–1.25)
Educational level			
Primary or less			ref.
Lower secondary			0.91 (0.86–0.95)
Upper secondary			0.89 (0.84–0.94)
Tertiary education			0.76 (0.72–0.81)
Unknown			1.03 (0.97–1.10)
Income level			
Low			ref.
Intermediate			0.89 (0.85–0.92)
High			0.74 (0.70–0.79)
Unknown			0.85 (0.73–1.00)

Table A.4
Mortality rate ratios and 95% confidence intervals by migrant group: model building from age-adjusted to fully-adjusted models for women aged 65+ years during the first COVID-19 wave in 2020.

	Model 1	Model 2	Model 3
Region of origin			
Belgium	ref.	ref.	ref.
EU-15	1.12 (1.05–1.20)	1.12 (1.05–1.20)	1.09 (1.02–1.16)
Other Europe	0.99 (0.84–1.17)	0.90 (0.76–1.06)	0.90 (0.76–1.06)
Turkey	0.98 (0.73–1.31)	0.98 (0.73–1.31)	0.91 (0.68–1.22)
Northern Africa	0.89 (0.74–1.08)	0.87 (0.72–1.05)	0.83 (0.68–1.01)
Sub-Saharan Africa	1.41 (1.02–1.95)	1.18 (0.86–1.63)	1.18 (0.85–1.63)
Other	0.69 (0.50–0.95)	0.62 (0.45–0.85)	0.63 (0.45–0.87)
Age	1.14 (1.14–1.14)	1.10 (1.09–1.10)	1.09 (1.09–1.10)
Household type			
With partner		ref.	ref.
Without partner		1.34 (1.27–1.41)	1.34 (1.28–1.42)
Other		2.13 (1.95–2.31)	2.13 (1.96–2.32)
Collective HH		5.30 (4.99–5.64)	5.30 (4.98–5.64)
Population density			
Low		ref.	ref.
Intermediate		1.02 (0.98–1.06)	1.03 (0.99–1.07)
High		1.09 (1.05–1.13)	1.13 (1.08–1.17)
Educational level			
Primary or less			ref.
Lower secondary			0.93 (0.89–0.97)
Upper secondary			0.82 (0.77–0.86)
Tertiary education			0.73 (0.68–0.78)
Unknown			0.95 (0.90–1.00)
Income level			
Low			ref.
Intermediate			0.95 (0.92–0.99)
High			0.90 (0.84–0.96)
Unknown			0.84 (0.72–0.98)

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