The impact of changes in living arrangements on the mortality of older adults: Belgium 1991-2012

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Acknowledgements

This study has received support from the Estonian Science Foundation's R&D project PRG71.

Abstract

BACKGROUND
Previous studies have shown that the distribution of older people in various living arrangements has changed, and that old-age mortality differs by living arrangements. However, the effects of these changes on the total number of deaths have not yet been investigated.

OBJECTIVE
The aim of this study is to differentiate the effects of the change in the distribution of the population and in the mortality risks associated with each type of living arrangement on mortality.

METHODS
Continuous observation of the population 60 years of age and older for the period 1991-2012 based on Belgian national register data provides a unique opportunity to analyse the effects of the change in the distribution of the population and in mortality risks by living arrangements. A simple decomposition method is used to examine to what extent these two changes have influenced mortality.

RESULTS
The distribution of the population by living arrangements changed in both absolute and relative numbers. The age-standardised mortality rates by living arrangements also changed: the situation of those living with their spouse or partner improved while that of individuals living in collective households worsened. The overall effects of the changes on the total number of deaths offset each other, whereas the distribution of the number of deaths by living arrangements displays a large variation.

CONTRIBUTIONS
This study highlights the long-term trends in population and mortality risks by living arrangements in older age. It shows that despite the limited change in the total number of deaths, these two factors had an important and divergent impact on the distribution of the last living arrangement before death.

Keywords
living arrangements, older adults, mortality, long-term trends, second demographic transition.

Introduction

The aim of this study is to examine the effect of recent changes in the distribution of the older population by living arrangements (LA) on total mortality. Continuous improvement in the survival of the older population has occurred in Western societies in recent decades (Rau et al. 2008). Concurrently, family patterns have been influenced by important changes in the framework of the Second Demographic Transition (SDT) (Fokkema and Liefbroer 2008, Lesthaeghe 2014). The decline in fertility and changes in family composition since the 1970s are the main factors underlying the increasing diversification of living arrangements that other researchers have found (Lesthaeghe 1983; 2014, Audenaert 2003). Trends confirm not only the spread of unconventional living arrangements such as unmarried cohabitation, but also a tendency towards more individualistic choices such as single parenthood, childlessness, and the dissolution of marriages – processes that involve younger and older people alike (De Jong Gierveld 2001, 2004; Gaymu et al. 2008; Lesthaeghe 2014; Wagner and Valdés Cifuentes 2014). The results of decisions made earlier in life are reflected in the LA composition of the older population. As a result of the decline in fertility and the emergence of more individualistic LA, older people are less likely to live with a close family member or have children to rely on (McGarry and Schoeni 2000; Gaymu et al. 2008). This has resulted in a relatively large proportion of older people living alone or in collective households, as observed in other Western European countries (Reher and Requena 2018). At the same time, unmarried cohabitation has become increasingly common, and could offset the effect of divorce or de facto separation with regard to LA, as many people are still living with their partner in old age (United Nations 2017). The first situation is linked to the increase in divorces and separations, which also affects the older population, and the second is related to improved longevity (Seltzer and Yahirun 2014). Other changes, such as cohorts' with a higher proportion of married people entering old age, and a decreasing gender gap in life expectancy, have also resulted in an increasing proportion of older adults living with a partner (Gaymu et al 2008, Martikainen et al. 2019; United Nations 2017).

The life expectancy of older people in Western societies has been continuously improving over the last decades (Rau et al. 2008), but differences exist between population groups according to their vulnerability to mortality (Vaupel, Manton and Stallard 1979; Caselli, Vallin and Wunsch 2006). In addition to age and sex, several authors have investigated marital status as a factor in the variation in mortality risks (Martikainen et al. 2005; Murphy, Grundy and Kalogirou 2007). Studies have also suggested that mortality risks in old age may be associated with the type of LA (Davis et al. 1992,1997; Koskinen et al. 2007; Staehelin et al. 2012; Poulain and Herm 2015; Poulain, Dal and Herm 2016). Therefore, the changes observed in the

proportion of the older population by LA are driven not only by the different family and LA patterns of the generations that have recently entered old age, but also by different levels and the evolution of mortality risks by LA. Due to the increase in life expectancy and a decreasing gender gap in mortality, married people are living longer with their spouse before being separated by death, and they have lower risks of dying compared with their contemporaries (Staehelin et al. 2012; Poulain and Herm 2015; Martikainen et al. 2019, Franke and Kulu 2017). The mortality risk for men and women living with their spouse also tends to converge at the oldest ages, which results in relatively more people still living with their spouse in old age, but also implies an increase in widows and widowers living alone at a very high age (Poulain, Dal and Herm 2016, Martikainen et al. 2019). From a different viewpoint, non-marital cohabitation is becoming a more frequent alternative to remarriage even among older people; however, according to Drefahl (2010), it might not have the same positive effect that marriage has on survival. In most Western countries, studies have shown that excess mortality among those who are single tends to increase compared with those who are married (Valkonen, Martikainen and Blomgren 2004). Among other results, recent studies have shown remarkably higher mortality rates for older people living in institutions that provide care for the aged. This excess mortality has been increasing relative to other LA in recent decades, and could plausibly be explained by selectivity in nursing-home entry (Grundy 2011; Herm, Poulain and Anson 2014).

The mechanisms by which mortality risks are associated with LA in old age are still not well known, and the findings contain some contradictions. This is partly because it is difficult to identify causal links between LA and mortality risk, as LA in old age are quite dynamic (Feng et al. 2017). For example, the presence of the spouse or partner, who is the closest and most available caregiver, supports survival and reduces the need for formal care, e.g., entry into a nursing home (Chappell 1991; Antonucci and Ajrouch 2007; Freedman, Cornman and Carr 2014). Accordingly, the increase in persons living with their spouse or partner is associated with a decrease in total mortality. However, all marriages and partnerships end with the death of the spouse or partner, or divorce, which inevitably changes the LA of the survivor, and most LA after bereavement or divorce are associated with a higher mortality risk (Herm, Anson and Poulain 2016). A crucial question concerns the distribution of the last LA before death among those who no longer have a spouse or partner.

The prevalence of co-residence with a potential caregiver indicates the type of care that might be needed for older adults. Accordingly, the final LA is the most relevant to policy development, as the last years before death are associated with the highest need for care (Gaymu et al. 2008). This is one of the reasons underlying the keen interest in investigating the LA of older people (Grundy 2008). Several researchers have studied the place of death in old age (e.g., Houttekier et al. 2011); however, this information does not enable a reliable assessment of the care needs of the elderly to be made, because the place of death does not necessarily indicate the type of care needed during the period preceding death.

In summary, multiple factors have contributed to the change in the composition of the population of older people by LA. Some of these changes are the consequences of life events that occur at older ages, while others are driven by those that take place earlier in life. Simultaneous shifts have occurred in LA and mortality improvement. Obviously, the net effect is a blend of changes in behaviour, choice (possibly involuntary) of LA, and developments in mortality. Examining the net effect of changes in mortality related to LA in light of changes in the distribution of population by LA and changes in mortality risk for each type of LA, is therefore both pertinent and timely. In this context, the question arises as to whether and how much the change in the distribution of the population by LA, and the change in LA-specific

mortality risks are reflected in the number of deaths in each LA in old age, and, more globally, in the evolution of the total number of deaths. Therefore, we distinguish the net impact of the change in the size of the population by LA from the LA-specific mortality risk. We may assume that a sizeable reduction in mortality risk for most LA might be outweighed by the substantial increase of the population in LA in which the mortality risk is relatively higher. Accordingly, it might be that a possible increase in the total number of deaths may be at least partly attributed to an increase of the population in LA that are less favourable or even detrimental to survival.

This study identifies in which ways and to what extent the improvement in LA-specific mortality combined with the dynamics of LA composition at older ages is linked to changes in total mortality of older adults. As such, this study makes an innovative contribution to the existing literature on the association between living arrangements and mortality. Moreover, the results of this study have important policy implications, as trends in LA shed light on the dynamics of the availability of informal care, and help to assess the evolution of needs for care in old age.

Data, methods and typology of living arrangements

Belgian data from the continuous population register are used to assess the impact of LA trends on the total number of deaths and its distribution by last LA before death. The same data have been used in previous studies of the association between LA and mortality of the older Belgian population (Herm, Poulain and Anson 2014; Herm, Anson and Poulain 2016; Poulain and Herm 2015; Poulain, Dal and Herm 2016). These data enable the LA of individuals aged 60 years and older to be tracked on a yearly basis from 1991 to 2012 inclusive. Examining a period of more than twenty years allows the emergence of new types of living arrangements among older adults to be discerned, as well as changes in the age composition of the population by LA. Simultaneously, it makes it possible to determine the effect of these changes on the total mortality outcome in old age.

The administrative population register captures the changes in LA of each individual as well as the date of death. It is therefore possible to identify the final LA, where the need for care is highest (Gaymu et al. 2008). Based on these data, changes in the distribution of the population by LA as of the first of January of each year and annual LA-age-specific mortality rates are computed and analysed. The exhaustive administrative database includes all individuals aged 60 years and older, which prevents problems related to sampling, non-response, or missing data.

The target population is comprised of 2.06 million people aged 60 years and over on 1 January 1991, and an additional 2.48 million people who reached the age of 60 during that period. During the observation period 1.97 million deaths were registered, and 2.57 million people aged 60 years and over were still alive on 31 December 2012. For the sake of simplicity, we exclude a small number of international migrants, both emigrants and immigrants, which constitutes no more than 1.6% of the population. Those who died at the end of the year are considered to have been alive in the country on 31 December of that year, as the limited number of people who emigrated abroad are excluded from the analysis.

The LA typology used in this analysis takes into account the type of household, relationship with the reference person, and marital status. The following groups of LA are distinguished:

1. Individuals living with others in a private household:

    2a. Individuals living with their spouse;

2b. Unmarried individuals cohabiting with a partner;

2c. Individuals living with someone who is neither their spouse nor cohabiting partner;

2. Individuals living alone;

3. Individuals living in a collective household (mainly care homes for the elderly).

We further distinguish individuals living alone or in a collective household by marital status: never married, widowed, divorced, or married but living separately. Individuals living with their spouse or partner may also have others living in the household. The choice of typology is dictated by the potential support that might be expected from a cohabiting partner or spouse.

LA-specific mortality rates are calculated by dividing the number of deaths occurring in any given year by each year of age and sex according to the individual's LA on 1 January of each year. We decompose the change in the total number of deaths in two ways: by considering the change in population distribution by LA and the change in mortality risk for each LA. A mobile average of three years is used to avoid a possible bias from one specific year. The formulas used for this decomposition are presented in Annex 1. The first decomposition is based on absolute figures; it takes into account the effect of the change of population size in each LA compared with the change in the LA-specific mortality risk. Because the main drivers of the change in the total number of deaths are an increase in the size of the total population, with larger cohorts entering the 60+ group, and the global improvement in mortality risks, we perform a second decomposition. Based on relative figures, this process considers the relative change in the population structure by LA and the relative change in LA-specific mortality risks compared with the overall change across all LA. Strictly speaking, the results of the second exercise can be viewed as independent of the overall changes in the population size and mortality risks.

Results

Change in the total number of deaths among the older population

A comparison of the average number of deaths for 1991-1993 with the average for 2010–2012 shows that the total number of deaths among those aged 60 years and over slightly increased in Belgium over the two-decade period of observation (2.6% for men, from 42,606 to 43,691, and 4.8% for women, from 46,449 to 48,670, Table 2). If only the size of the cohorts had increased, and the mortality rates observed in 1991–1993 had remained the same, the increase in the total number of deaths would be significant (48.2 % for men and 34.8% for women). During that period a sizeable reduction in mortality risks occurred among the whole older-age population, which could be responsible for the decrease in the total number of deaths (45.6% for men and 30.0% for women, if the size of the population is kept constant as in the average for 1991–1993). These two counterbalancing trends resulted in a slight increase in the total number of deaths towards the end of observation period as shown above.

Changes in the living arrangements of the older population

The number of men aged 60 years and older increased by one third from 1991–1993 to 2010–2012, and the number of women by one fifth (Table 1). Older people living with a partner, married or unmarried, became more numerous. Among those living alone or in collective LA, a notable increase occurred in the number who were divorced or separated, as well as in the

number of widows and widowers in collective LA. The relative increase in the number of divorced and separated individuals was the most substantial – almost threefold for both men and women living alone or in collective LA. However, the trend was not even across all LA. Fewer men and women were living with someone other than their partner at the close of the observation period. The number of widowed women living alone decreased slightly, as did the number of never-married women living alone or in collective LA. The decrease among those living alone was rather small, but the number of never-married women living in collective LA had decreased by one third by the end of the observation period. In light of the decreasing trend in the number of never-married women living alone or in collective LA, it is interesting to note that the number of never-married men in both LA increased somewhat during the observation period.

Table 1. Belgian population aged 60+ by living arrangements and gender, 1991-1993 and 2010-2012.

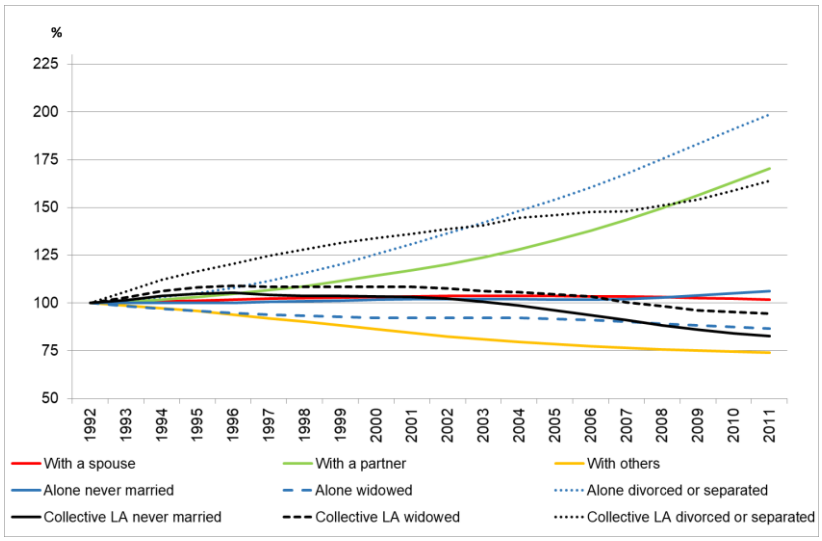
	Number				Percentage			
	Men		Women		Men		Women	
Living arrangements	1991-1993	2010-2012	1991-1993	2010-2012	1991-1993	2010-2012	1991-1993	2010-2012
With spouse	520 768	676 241	455 417	603 233	59.6	60.6	37.5	42.6
With partner	21 884	47 601	21 862	39 661	2.5	4.3	1.8	2.8
With others	177 208	167 658	255 145	216 398	20.3	15.0	21.0	15.3
Alone never married	29 744	40 351	40 067	38 124	3.4	3.6	3.3	2.7
Alone widowed	75 150	83 219	337 574	337 662	8.6	7.5	27.8	23.9
Alone divorced or separated	29 362	74 542	37 458	99 304	3.4	6.7	3.1	7.0
Collective LA never married	7 670	8 104	22 395	15 080	0.9	0.7	1.8	1.1
Collective LA widowed	7 506	9 058	41 167	55 132	0.9	0.8	3.4	3.9
Collective LA divorced or separated	4 119	8 626	4 816	9 824	0.5	0.8	0.4	0.7
All living arrangements	**873 410**	**1 115 400**	**1 215 901**	**1 414 419**	**100**	**100**	**100**	**100**

The changes in the proportion of individuals in each LA were uneven over the period 1991-2012 as detailed in Figure 1. The increase in the percentage of men living with their spouse was minimal, while the percentage of women in this LA increased significantly. The proportion of men and women cohabiting with a partner increased exponentially – by 70% for men and 60% for women in 2010-2012 compared with the early 1990s. On the contrary, a decrease was observed in the proportion of the population living with others, which indicates that these LA became less prevalent among both men and women. Whereas the proportion of women living alone remained unchanged for the total population, a redistribution occurred within this LA that resulted in a smaller percentage of those who were widowed or never married, and an increase in divorced or separated individuals. The percentage of men living alone who had never been married also increased. Nevertheless, only the proportion of divorced or separated increased significantly among the latter group. In fact, the percentage of men and women who were

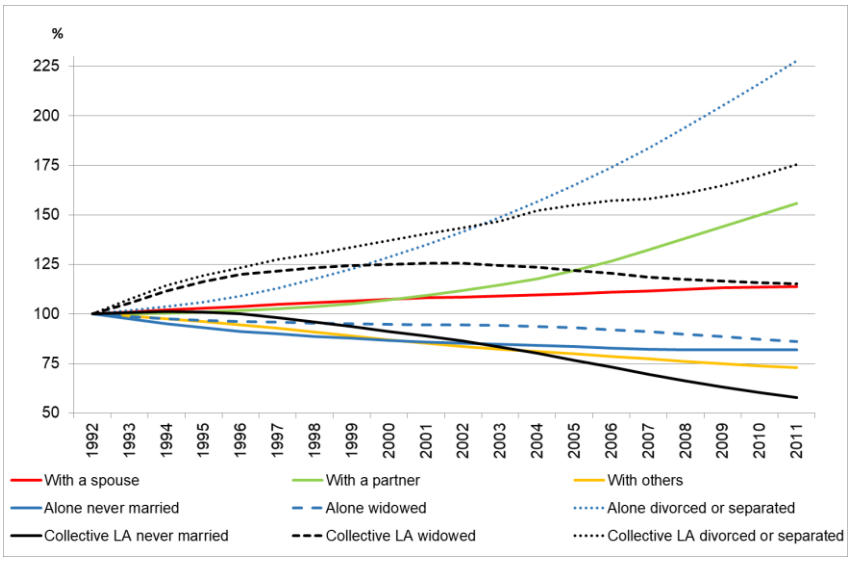
divorced or separated and living alone exhibited the strongest increase relative to all other LA, while the percentage of both sexes who were widowed and living alone decreased. During the observation period, a dual trend appeared among those living in collective LA. On the one hand, the percentage of people in collective LA increased sharply during the first years of the 1990s, but the absolute numbers stabilised at the beginning of the 21st century, and subsequently decreased towards the end of the observation period.

Figure 1. Change in the distribution of the population aged 60+ by living arrangements, 1992–2011 (three-year mobile average, 1991-1993 = 100)

Men



Women



The association between living arrangements and mortality risks

The LA-specific mortality rates for the population aged 60 years and older standardised on the age structure of the total population are displayed in Figure 2. Women exhibited lower mortality in all LA, and the lowest mortality was observed among both men and women living with their

spouse. The mortality risk for women living alone, regardless of marital status, was only slightly higher. For men, living with their spouse, partner or others is clearly more conducive to survival than living alone. For both sexes, cohabiting with a non-married partner is associated with a 10% higher mortality risk than living with their spouse. For women, living with others who are not their spouse or partner is associated with a mortality risk more than 25% higher relative to living with their spouse, but that risk is less than 20% for men. The gender gap is narrowest among those living with their spouse or living with others who are not their spouse or partner. The mortality rates among those living in collective LA are more than three times higher, with the exception of the never-married, especially women, for whom the mortality risk is lowest among those in this type of LA.

Figure 2. Age-standardised mortality rates for the population aged 60+ by living arrangements, average for 1991–2012

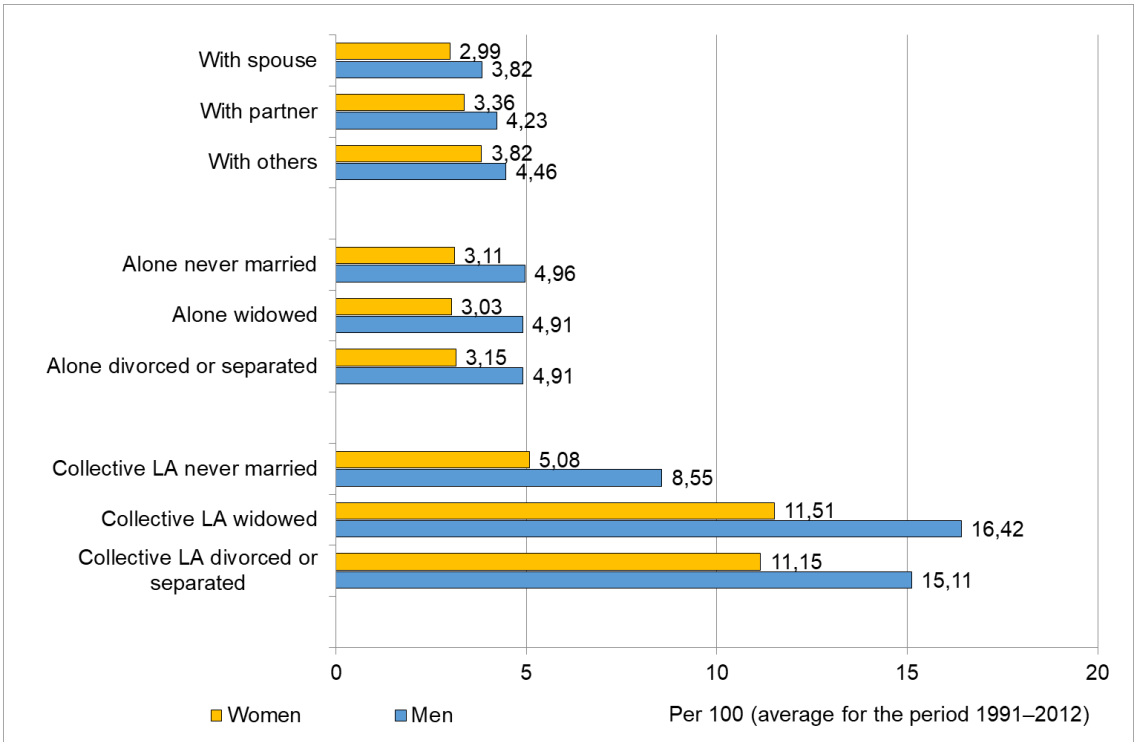
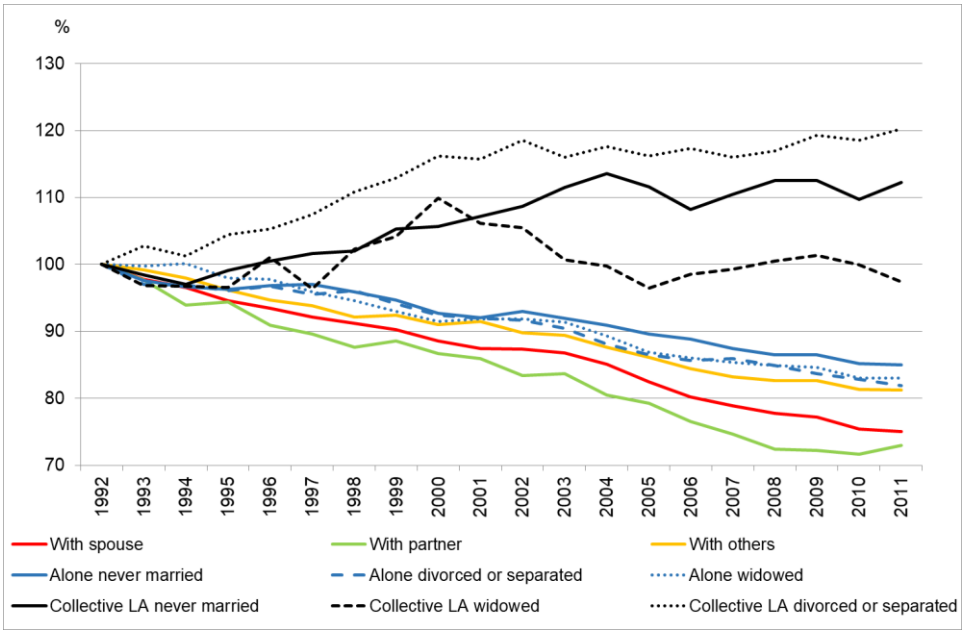


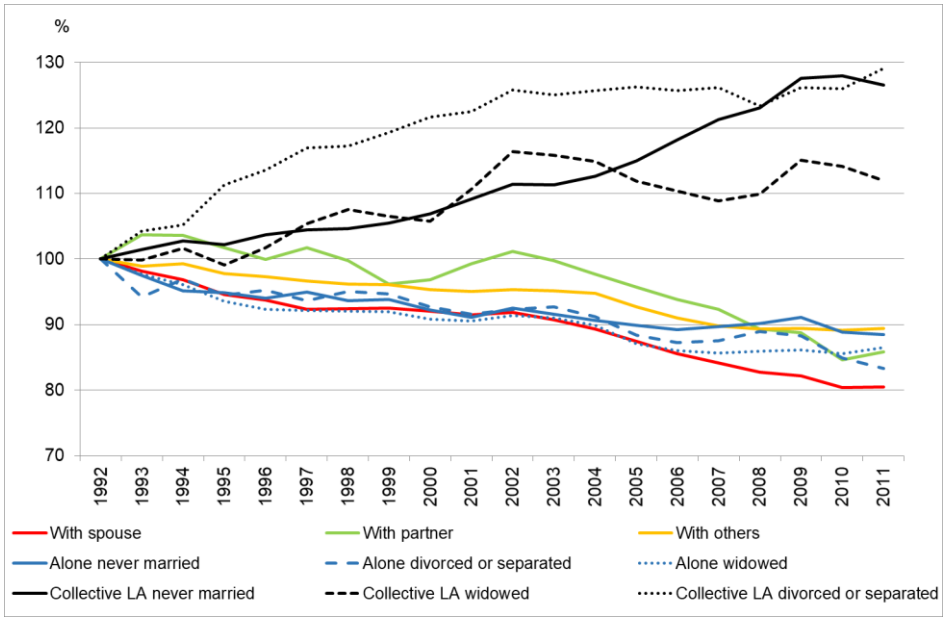
Figure 3 displays the trends in LA-specific mortality risks for men and women; the change in the three-year mobile-average age-standardised mortality rates is shown for each LA over the observation period, relative to 1991-1993. The relative mortality risks decreased linearly for both men and women living in private households. The maximal reduction was found for women living with their spouse and for men living with their partner or spouse. The reduction was somewhat smaller among those living alone or with others who were not their spouse or partner. In contrast, the mortality risks among those in collective LA showed an increase.

Figure 3. Change of age-standardised mortality rates of the population aged 60+ by living arrangements, 1992–2011 (three-year mobile average; 1991-1993 = 100)

Men



Women



The impact of changes in population size and mortality rates by LA on the number of deaths

The impact of changes related to LA is assessed by distinguishing two components of the change in the number of deaths in each LA in absolute and relative terms. The calculations used to differentiate these impacts, which are displayed in Table 2, were performed for each year of age, sex and LA, according to the formula presented in Annex 1. The first component measures

the impact of the change in population by LA (Table 2, Column C), and the second considers the effect of the change in mortality rates by LA (Column D). As expected, the change in the size of the population contributed to an increase in the number of deaths in all LA except for women living with others or who were never married and living in a collective household. On the contrary, the improvement in mortality contributed to a decrease in the number of deaths in all LA except for those who were divorced or separated living in collective LA.

Apart from the remarkable increase in the total population aged 60 years and over and the large decrease in the mortality rates of this population, the impact of the changes related to LA is assessed in the second decomposition in relative terms. The first component measures the impact of the relative change in the structure of the population by LA (Column E), and the second gauges the effect of the relative change in mortality rates by LA (Column F).

Table 2. Decomposition of the difference between numbers of deaths by sex and living arrangements among the population aged 60+, 1991-1993 and 2010–2012

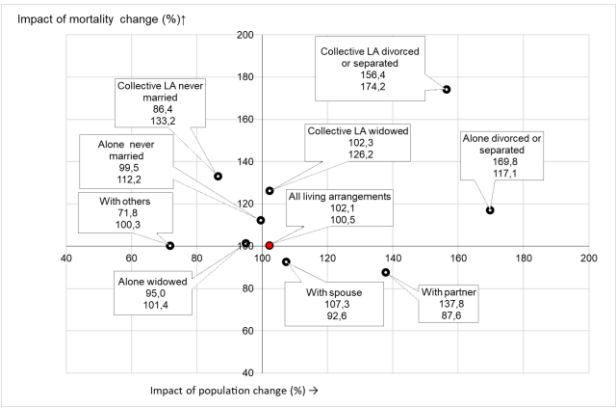
Living arrangements	Observed number of deaths			Difference due to absolute changes in		Difference due to relative changes in	
	Average for 1991-1993	Average for 2010-2012	Change in number of deaths	population size	mortality risk	population size	mortality risk
Men	A	B	B-A	C	D	E	F
With spouse	21180	21155	-25	12555	-12580	1552	-1576
With partner	1123	1410	287	1185	-899	425	-139
With others	7553	5448	-2105	336	-2441	-2127	22
Alone never married	1486	1660	174	714	-540	-8	182
Alone widowed	6335	6110	-225	1903	-2128	-316	91
Alone divorced or separated	1371	2562	1191	2146	-954	957	234
Collective LA never married	771	922	151	164	-13	-105	256
Collective LA widowed	1962	2522	560	569	-9	46	514
Collective LA divorced or separated	825	1902	1077	951	126	465	612
All living arrangements	**42606**	**43691**	**1085**	**20523**	**-19438**	**889**	**196**
Women	A	B	B-A	C	D	E	F
With spouse	8219	8972	753	5804	-5051	1923	-1170
With partner	579	697	118	422	-304	162	-44
With others	10799	7803	-2996	-624	-2372	-2962	-34
Alone never married	1401	1134	-267	79	-346	-275	8
Alone widowed	14603	13833	-770	4528	-5298	72	-842

Alone divorced or separated	976	1797	821	1448	-627	826	-5
Collective LA never married	1605	1486	-119	-54	-65	-349	230
Collective LA widowed	7593	11362	3769	3778	-9	1743	2026
Collective LA divorced or separated	674	1586	912	798	114	452	460
All living arrangements	**46449**	**48670**	**2221**	**16179**	**-13958**	**1592**	**629**

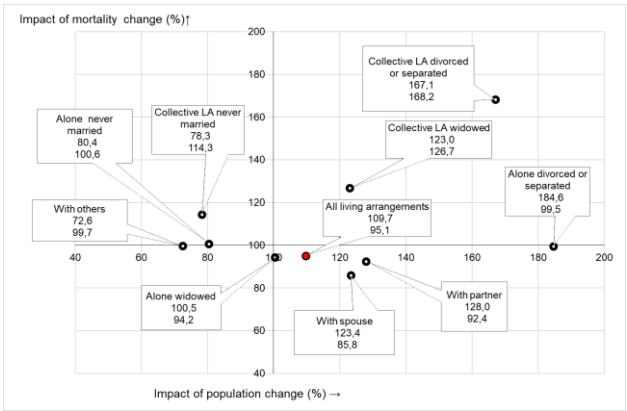
The contribution of these two relative changes in population size and mortality rates to the total number of deaths differs between LA, as displayed in Figure 4. The horizontal and vertical lines mark the respective impacts of the relative change in the size of the population and mortality rates. LA that are above the horizontal line contribute to the increase, and those below the line to the decrease in the number of deaths due to the relative increase or decrease in the mortality rates for that LA. The LA left of the vertical line contribute to the decrease, and those to the right are associated with the increase, in the number of deaths due to the relative growth or decline in the size of the population in that LA.

Figure 4. Relative impact of the relative changes in the population structure and mortality rates by LA on the change in the total number of deaths by LA

Men



Women



The larger impact on those living with others relates to those who are not living with their spouse or partner: more than 2000 less for both men and women due to the relative decrease in their population. The increase among men living with their spouse is due to the relative increase in their population, and is offset by a reduction linked to the decrease in mortality risks. For women living with their spouse, the effect of the relative increase in population was paramount. The relative increase among men and women living with their partner contributed to the increase in the number of deaths in this LA, which was somewhat offset by the relative reduction in their mortality risk. Among those living alone, the impact of the relative change in population increased the number of deaths significantly for those who were divorced or separated. Concurrently, the relative reduction in mortality risk contributed to the decrease in deaths among widows but not among widowers. The lessening mortality risk among all three marital status groups in collective LA contributed to the increase in the number of deaths of both men and women, and the change in the size of the population had a similar effect, except for those who were never married.

Discussion

In the context of population ageing the older Belgian population has grown remarkably since 1991, and further growth is projected (Van den Bosch et al. 2011). Our study showed, as expected, that the number of older people increased in most LA, but differences were observed between LA in both absolute and relative terms. The more sizeable absolute increase applied to both men and women living with their spouse, but was relatively larger for men. The second group ranked in terms of absolute growth included divorced or separated individuals living alone. The number of people living with their partner also increased in absolute numbers, and the relative increase was among the highest in private households, after those who were divorced or separated and living alone. The number of people living with their spouse increased mainly due to improved survival of both men and women, and also due to the reduced gender gap in mortality, as found by Keilman and Christiansen (2010). The relatively rapid increase in the proportion of the population who were divorced or separated and living alone or only with their partner indicates a tendency towards the emergence of more independent and ‘modern’ LA at older as well as younger ages, which can be viewed as a consequence of the SDT (Lesthaeghe 2014). Never-married women became less numerous among those living alone, but also in collective LA; no significant change was observed for never-married men. The decrease among never-married women is due to the fact that female cohorts arriving at older age had a higher proportion of members who were married. The only LA that experienced a decrease in both absolute and relative numbers was that of ‘living with others than their spouse or partner’. This also reflects a change in family patterns and the emergence of more individualistic LA, whereby older people are less likely to live with a close family member (McGarry and Schoeni 2000; Gaymu et al. 2008). A remarkable relative increase was observed among people living in collective LA, which confirms that most people who reach a very high age spend their last years in a nursing or residential care home (Evans et al. 2014; Poulain and Herm 2015). The composition of older people in collective living arrangements changed in terms of marital status, reflecting developments among the general population in line with the SDT (Lesthaeghe 2014). Nevertheless, recent trends point to a stagnation in the number of persons in collective LA. The contributing factors are that people are living longer together as a couple, that they prefer to stay in their own home, and that there are limited spaces in nursing homes (Van den Bosch et al. 2011).

Mortality risks varied between LA, with the lowest mortality observed among older people living with their spouse; this group also had the smallest gender gap, which is in agreement with the findings of other researchers (Staehelin et al. 2012; Martikainen et al. 2019; Franke and Kulu 2017). On the contrary, individuals in collective LA experienced higher mortality than those in private LA, as also found by Grundy (2011). Our findings reveal that women living alone and in collective LA survived substantially longer than men in the same types of LA. The direct comparison of private and collective LA by marital status provides new insight into the analysis of mortality by LA. Trends observed over more than two decades are also informative, revealing an increasing divergence in mortality between private and collective LA. Other research to date has not made use of a unique database to examine these trends comparatively. Those living with their spouse or partner are showing the most significant improvement in mortality, with a substantial gender difference: the narrowing gap in mortality between these LA is more evident among men than women. This trend merits deeper investigation within the framework of the SDT, and in line with the study by Drefahl (2012), which suggests that living with one's partner might not have the same positive effect that marriage has on survival. With regard to those in collective LA, especially nursing homes, increasingly higher mortality could be associated with more advanced age and poorer health status at the time of entry.

The trend in the total number of deaths among the older Belgian population showed a slight increase during the two decades of the study. As everywhere in Western societies, the size of the older cohorts of the Belgian population increased, whereas the mortality risks at older ages decreased. These two changes offset each other and resulted in only a limited increase in the number of deaths; however, they affected each LA differently. In fact, according to the statement by Pezzin, Pollac and Schone (2013), '*changing marital patterns and increased complexity in family life have adverse effects on late- life health outcomes',* we were expecting to find an increase in the total number of deaths due to the change in the distribution of the population by LA. On the contrary, we found that the total number of deaths among older people was relatively stable. However, considerable changes occurred in the number of deaths by final LA. This reinforced the importance of LA-related changes, but the question remained as to which of these two factors – trends in the population by LA or changes in the mortality risk by LA – had the larger impact on the number of deaths in old age for each LA. The results presented in this study show large differences between LA. The number of deaths was stable among men living with their spouse but not among women. For women, the increase linked to the growth of the population at risk surpassed the decrease that was due to the reduction in the mortality risk. The number of deaths dropped significantly among both sexes living with others who were not their spouse or partner. On the contrary, the number of deaths among those living alone increased. This accords with previous findings from most Western countries that mortality among those who are single tends to increase compared with those who are married (Valkonen, Martikainen and Blomgren 2004). The main driver of the increase in the number of deaths in collective LA is the increase in the associated mortality risk, whereas the increase in deaths among those who were divorced or separated living alone or with others who were not their spouse or partner may be attributed to the increase in the population at risk. Our results are in line with the findings of Houttekier et al. (2011), who identified a growing trend towards excess mortality among the population that died in nursing homes or at home while living alone, whereas the number of deaths in hospitals decreased. However, these results are difficult to compare, as the place of death is not necessarily the last LA. A positive impact was conclusively observed in the increase of the proportion of those living with their spouse or partner – the most favourable LA for survival – but this effect was diminished by the large increase in the number of divorced or separated individuals living alone or in collective LA, among whom the relative

mortality risk increased. However, even if these two factors largely offset each other, they affected the distribution of the final LA, which is highly relevant to the development of policies regarding the care of older people.

Discernible trends in the population and mortality of older people associated with LA over the more than two decades analysed in this study shed light on the major challenges that policy-makers face in terms of creating the conditions for respectable ageing and death. The outcome of this study highlights the need for policies that support older people's living as long as possible in their home in private LA, and that adopt a gender-specific perspective, since older men and women differ with regard to their last LA. Whereas older people living in private LA are more numerous, the type of care they require is not same as that provided in nursing homes. One's care needs are mainly derived from one's health status, but they also depend on the type of LA, and on whether or not there is a potential caregiver in the household. Although there is a growing tendency for older people to live with their spouse or partner, who is the customary caregiver (Gaymu et al. 2008), these spouses or partners also age and may not be able to cope with the care requirements (Freedman, Cornman and Carr 2014). Therefore, informal caregivers, particularly older individuals who care for another older person at home, need effective support, which is the most pressing policy challenge in the near future. People living alone in their home typically require ad hoc formal care during the last years of life, particularly when support from children is irregular or missing. For example, studies have shown that divorced or separated parents, particularly fathers, are less likely than those who are widowed to receive care from their children (Kalmijn and Saraceno 2008). For the same reason, informal care may not be available for those who live with their partner. Deeper investigation is needed with regard to the latter LA, as it is not yet clear whether living with a partner is equivalent to living with a spouse (Drefahl 2010). The larger number of deaths occurring in collective LA reflects the ageing of the population and epidemiological changes (Kalseth and Theisen 2017), and shows that the need for formal care increases significantly towards the end of life. The demand for nursing homes for those at higher ages and in poorer health is escalating, with the result that death is occurring sooner after entry, and that there is a more rapid turnover in the nursing home population. Nursing homes are becoming the main locus of end-of-life care, and it is foreseen that most people will die in that type of LA (Houttekier et al. 2011). Therefore, providing sufficient skilled medical resources in nursing homes to meet the end-of-life care preferences and needs of patients, as well as ensuring efficient support to older adults living at home, are both essential. In summary, the results of this study call for improvements in both formal and informal care, which is in line with a previous analysis of LA in older age (Audenaert 2003).

In addition to the novelty of the results described above, the strength of this investigation is also related to the use of a unique and detailed administrative database that enables population records to be linked with death records, and to identify final LA. Some limitations associated with the accuracy of the data do exist, especially with regard to delayed registration of place of residence when such residence is expected to be temporary. This primarily concerns those living in nursing homes but also to some extent those living with their partner (Lodewijckx and Deboosere 2011). Therefore, the number of people living in these LA may be underestimated. The fact that the final LA was recorded on 1 January and not on the date of death might also introduce a limited bias: mortality in collective LA might be underestimated, as those entering a nursing home shortly before death are counted as living in their previous private arrangements, as registered on 1 January. Nevertheless, neither bias should affect our conclusion that an increasing number of persons are in collective LA and have a relatively higher mortality risk.

Many studies have confirmed that living with one's spouse is beneficial; however, recent research on marriage and health has shown that its protective effect may be weakening due to the deinstitutionalisation of marriage (Tumin 2018). Such alterations in social norms and attitudes might also affect other LA. Therefore, further study of trends in LA and their association with mortality among older people would be useful. These changes could have implications for social welfare, as the legal systems might not recognise new types of LA early enough to ensure adequate support for vulnerable people (Sánchez Gassen and Perelli-Harris 2015). The use of socio-cultural information, including education, former occupation, and perception of health status, might provide additional insights into this investigation, as would qualitative surveys describing the care needs and potential caregivers in various types of LA. Those who are single, whether living alone or in collective LA, would also be an interesting topic of research, as this category includes people with different social backgrounds and preferences, who are completely reliant on formal care when they become dependent.

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ANNEX 1. Decomposition method

Mortality rates are calculated by dividing the number of deaths occurring in a given year in each LA by sex and year of age on 1 January of that year:

m (x,t,s,LA) =d(x,t,s,LA)/p(x,t,s,LA) where

d is the number of deaths occurring among the population aged (x) in a given LA on 1 January at age t for men and women separately (s),

p is the number of persons aged (x) in a given LA on 1 January at the age of t for men and women separately (s).

We use a simple method to decompose the change in the total number of deaths by each year of age and sex for a given LA 1991-1993 (t=1) and 2010-2012 (t=2). A three-year mobile average is used to prevent our results from being biased by one specific year.

The two components of the decomposition (Table 2, Columns C and D) are shown in the following formula:

d2-d1=(m2*p2- m1*p1)

=p2(m2- m1*p1/p2)

=p2(m2-m1+m1-m1*p1/p2)

=p2(m2-m1)+p2*m1(1- p1/p2)

=p2(m2-m1)+m1(p2- p1)

The difference in the total number of deaths for a given LA by each year of age and sex is decomposed in the first component, which expresses the impact of the change in the mortality rate, and in the second, the change in the size of the population at risk. The total change is equal to the sum of these two components. For the sake of simplification, the results calculated for each year of age are combined for the total population aged 60 years and above. In order to compare the impact associated with each LA we also compute the relative changes by using the average number of deaths that occurred in 1991-1993 as the reference.

With regard to the relative numbers (Table 2, Columns E and F), ***m***2 and ***p***2 are as follows:

m2 is the relative value of the mortality rate of a given LA compared with the same mortality rate for the total population of that age and sex

p2 is the relative segment of the population in that LA compared with the total population of that age and sex in all LA

d2-d1 = m2*p2*M2*P2/(M2*P2) – m1*p1*M1*P1/(M1*P1)

= ***m***2*p2*M2*P2- ***m***1*p1*M1*P1

= ***m***2*p2*D2- ***m***1*p1*D1

= p2*D2 * (***m***2*- ***m***1*p1*D1/ (p2*D2))

= p2*D2 * (***m***2*- ***m***1+ ***m***1 - ***m***1*p1*D1/ (p2*D2)

= p2*D2 * (***m***2*- ***m***1) + ***m***1*(p2*D2 -p1*D1)

The difference in the total number of deaths for a given LA by each year of age and sex is decomposed in the first component, which expresses the impact of the change in the mortality rate, and in the second, which conveys the difference in the relative structure by LA.