Int J Public Health (2013) 58:825–835
DOI 10.1007/s00038-013-0478-x

ORIGINAL ARTICLE

Evolution of educational inequalities in mortality among young adults in an urban setting

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Received: 18 December 2012 / Revised: 8 May 2013 / Accepted: 27 May 2013 / Published online: 22 June 2013

Abstract
Objectives To gain insight into the evolution in educational inequalities in adolescent and young adult all-cause and cause-specific mortality in the urban setting of the Brussels-Capital Region.
Methods Data were derived from record linkage between the censuses of 1991 and 2001 and register data on all-cause and cause-specific mortality and emigration in the respective periods of 1st October 1991 to 1st January 1996 and 1st October 2001 to 1st January 2006. Both directly and indirectly standardised mortality rates and the relative index of inequality (RII) were computed.
Results Mortality rates among adolescents and young adults have dropped significantly, especially infections and traffic accidents. However, educational inequalities among men have slightly increased: men with a maximum primary education are four times more likely to die than those who are higher educated [RII = 4.09 (2.78–6.03)]. Among women, no social gradient is observed in either period, but a clear split between the lowest educated and other educational groups is apparent in the 2000s.
Conclusions There is a positive evolution towards lower mortality among adolescents and young adults, but educational inequalities remain a public health concern.

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Keywords Mortality · Causes of death · Education · Adolescents and young adults · Social inequalities · Follow-up study

Résumé
Objectifs Établir un aperçu de l'évolution de l'inégalité selon le niveau d'instruction dans la mortalité générale et par cause des adolescents et des jeunes adultes dans les zones urbaines de la Région de Bruxelles-Capitale.
Méthodes Les données proviennent d'un couplage entre les recensements de 1991 et de 2001 avec les données du Registre Nationale sur la mortalité (générale et par cause) et sur l'émigration des périodes 01/10/1991-01/01/1996 et 01/10/2001-01/01/2006. Nous avons utilisés les taux de mortalité standardisés (directs et indirects) et l'indice relatif d'inégalité (RII)
Résultats Les taux de mortalité des adolescents et des jeunes adultes ont nettement baissé. Les incidences des infections et des accidents de la circulation ont particulièrement diminué. Cependant, les inégalités selon le niveau d'instruction chez les hommes ont légèrement augmenté: la mortalité des hommes avec niveau d'études primaires ou moins est quatre fois plus élevée que la mortalité des plus instruits (RII = 4,09 [2,78 à 6,03]). Chez les femmes, nous n'avons observé aucun gradient social dans aucune des périodes étudiées, mais un net clivage entre les groupes moins instruits et le reste des femmes apparait dans les années 2000.
Conclusion Il y a une évolution vers une plus faible mortalité chez les adolescents et les jeunes adultes, mais l'inégalité selon le niveau d'instruction restent une préoccupation de santé publique.

Mots clés Mortalité générale · Mortalité par cause · Education · Adolescents et jeunes adultes · Inégalités sociales · Formation complémentaire

Introduction

Mortality of adolescents and young adults is a topic that has often fallen beneath the radar of epidemiological and public health research. Young persons are considered to be in one of the healthiest stages of their lives (Blum 2009), thus directing attention to other, more troubling stages, earlier and especially later in life. Yet, health and mortality of adolescents and young adults is of particular interest for both research and policy. Lifestyles adopted in these stages may have a significant impact later in life (Due et al. 2011). Healthy patterns established in adolescence may benefit health later in life, as much as risky behaviour, such as drinking, smoking and unsafe sex, may have a negative impact (van Lenthe et al. 2009).

The *objective* of this paper is to explore socioeconomic differences in all-cause and cause-specific mortality among adolescents and young adults living in the Brussels-Capital Region (BCR) in the periods 1991–1996 and 2001–2006. More specifically, we wish to gain insight into differences in mortality according to own educational level, and how these differences may change over time.

It is widely documented that mortality patterns are not spread evenly in the population (Kunst and Mackenbach 1994; Marmot 2004). An important contributor to differences in mortality is *socioeconomic position* (SEP) (Mackenbach and Kunst 1997; Phelan et al. 2004). Although a socioeconomic gradient is apparent in many diseases in adulthood, research looking into socioeconomic inequalities in adolescents and young adults shows inconsistent results. West and Sweeting (2004) posit that there is social equalisation in youth. They ascribe health differences mainly to youth culture rather than social origin. According to this theory, peers and school environment are more important in explaining different health statuses or behaviours than socioeconomic background. Studies using parental SEP measures indeed mostly find rather small differences (Remes, Martikainen and Valkonen 2010; Richter et al. 2009), but research using the SEP of the adolescents or young adults themselves demonstrates persistent social inequalities (Koivusilta, Rimpela and Kuatiainen 2006). As a measure of early-life SEP, educational attainment may be particularly suited to gain insight into the transition period young people live in (Galobardes, Lynch and Smith 2007).

Although all-cause mortality has declined in all age groups over the last decades, health improvements have not availed as much to adolescents as to children (Viner et al. 2011). In some European countries, young-adult mortality has even increased or at best remained stable (Borrell et al. 2001). A better understanding of the mechanisms behind these patterns can be gained from decomposing all-cause mortality and probing into cause-specific mortality (Remes et al. 2010). The leading cause of death among young adults in low- as well as in high-income countries is injury related: unintentional (traffic accidents, poisoning, falls), intentional (such as homicide) as well as self-inflicted injuries (suicide) are common (Borrell et al. 2001; Krug, Sharma and Lozano 2000; Sethi et al. 2007). Cancers are another main cause of death among the young. Although cancer mortality decreased in the last quarter of the century, adolescents and young adults did not benefit as much from therapeutic advances as other age groups (Bleyer, Viny and Barr 2006). Until recently, infectious disease mortality such as AIDS was also quite common among young adults (Gore et al. 2011).

Methods

Study location and design

The BCR is centrally located in Belgium. It is a segmented city, socially as well as culturally (Jacobs and Rea 2007). With a median age of 37.8 years, the BCR has a relatively young population compared to the other Belgian regions (Deboosere et al. 2009). The city is characterised by a complex interplay of processes of prosperity and poverty, polarisation and integration, and exclusion and inclusion (Baeten 2001), which are the main challenges many European cities face (EU Regional Policy 2011). The social diversification is especially manifest among the younger age groups. A relatively high percentage of Brussels' youth grows up and stays in poverty, drops out of school and lives in worse health and living environments than their Flemish and Walloon peers (De Spiegelaere et al. 2009). The BCR is thus an interesting case to disentangle social inequalities among young persons over time.

The available data set provides exhaustive information on the official population living in the BCR. Data are derived from record linkage between the Belgian censuses of 1991 and 2001 and emigration and mortality data of the BCR. In a first stage, a direct link has been established between the respective censuses and register data of all deaths and emigrations in the periods 1st October 1991 to 1st January 1996 and 1st October 2001 to 1st January 2006. In a second stage, cause-specific mortality data have been added using anonymous individual linkage with death certificates. This database is a unique source of information, including survival status, migration, causes of death and background characteristics of the officially registered population in BCR. The study population, aged 15–34 years at the time of the censuses, consists of 279,465 persons in 1991 and 283,688 in 2001. For the purpose of the study, both adolescents (aged 15–24 years) and young adults (aged 25–34 years) have been included in the

analysis, as there is a lag time between certain environmental exposure and behavioural initiation (e.g. bad sanitation or drug use) and subsequent mortality.

Variables

Educational level

The highest educational level obtained is coded into four groups according to the ISCED classification (UNESCO 2011): (1) no/primary education (ISCED level 0–1), (2) lower secondary education (level 2), (3) higher secondary education (level 3 + 4) and (4) higher education (level 5+). For those who were studying at the time of the census, their current educational level is used. There are 17.9 % persons with missing information in 1991 and 15.8 % in 2001. These are included as separate categories in the analyses.

All-cause mortality

In the period 1991–1996, 2.5 % of all deaths ($N = 1{,}168$) took place among adolescents or young adults. In the period of 2001–2006, this was 1.7 % of all deaths ($N = 724$). Not all of these deaths could be linked to the death certificates: 8.8 % was unlinked ($N = 96$) in 1991–1996 and 15.2 % ($N = 110$) in 2001–2006. This percentage increases with increasing time between the census date and the mortality date. These are not unusual percentages as a large share of the study population moves frequently in this period of life span, and most of the unlinked deaths are largely due to migration to other Belgian regions or abroad. Additional information [indirectly standardised mortality ratios (SMRs)] of the unlinked deaths according to educational level can be found in "Appendix 1".

Causes of death

Deaths are grouped into the four most common causes of death among adolescents and young adults (Table 1), with external causes further divided into motor vehicle accidents (MVAs), deaths due to substance abuse (drugs/alcohol), suicides, assaults and other injuries. For 1991–1996 the International Classification of Diseases 9th revision (ICD-9) and for 2001–2006 the 10th revision (ICD-10) were used. Research has demonstrated that comparability between these classifications is sufficient for external causes of death and for large groups of causes (Anderson et al. 2001). The group of infectious diseases was extended with 22 deaths in 1991–1995 and 5 deaths in 2001–2005. These were not defined as infectious according to the international classification of diseases, but were identified as such in consultation with the Brussels-Capital Health and Social Observatory. These extra added deaths consist mostly of respiratory diseases of which an infection is the underlying cause.

Analysis

To compare *all-cause mortality* between different educational groups and sex, *age-standardised mortality rates*

Table 1 Comparison of the international classification of diseases, revisions 9 and 10 for the main causes of death

	International classification of diseases	
	Revision 9	Revision 10
Infectious diseases		
Main infections	001–139	A00–B99
Underlying cause is infection	320–323; 421; 460–466; 475; 480–481; 485–487; 513; 566–567; 680–684; 686	G00; G0420; G05–G07; I301; I3300; I400; J06–J18, J20–J22, J36, J3900, J3910, J85–86, K61, K6500, L00–L08
Neoplasms	140–239	C00–D48
Other diseases and medical conditions	240–291; 293–302; 306–799	D49–F9; F17; F20–R99
(Excl. causes of death specified elsewhere)		
External causes		
MVA[a]	E810–E829	V01–V79, V892
Substance abuse	292; 303–305; E850-855, E858, E860, E935, E937–940	F10–F16; F18–F19; X40–X49; Y10–Y14; Y16
Suicide	E950–E959	X60–X84; Y87.0
Assault	E960–969	X85–Y09
Other external causes	Rest E800–E999	Rest V01–Y98

[a] Motor vehicle accidents

(ASMRs) have been computed, using the Brussels' general population in 2001 as standard population. As numbers of deaths are small, *indirectly standardised rates* have been used for the analysis of *cause-specific mortality*. The standard rates used were age specific for the total male population of adolescents and young adults in 2001. To analyse educational differences in cause-specific mortality, SMRs were computed, standardised to the stratum-specific rates of those with a higher secondary diploma. The choice of the standard was prompted by it being the most stable educational group in size in both 1991 and 2001. SMRs were calculated period specifically, and for men and women separately. Hence, caution is needed when comparing SMRs over time. The main objective of presenting these SMRs is to get insight into the association between educational level and cause-specific mortality during both periods.

To measure the change of social inequalities over time, the *relative index of inequality* (RII) is used. This index is a commonly used measure in comparative inequality research (Kunst, Bos and Mackenbach 2001) and presents an accurate picture of socioeconomic inequalities in health (Wagstaff, Paci and Van Doorslaer 1991). The RII takes into account the population size and the relative socioeconomic position of groups, and is thus an ideal tool for comparative purposes. It refers to the risk of dying at the bottom relative to the top of the educational hierarchy. A large RII reflects large mortality differences between the low and high positions in society, while at the same time taking into account intermediate social positions. All analyses were carried out with STATA SE 12.1 and presented for men and women separately.

Results

All-cause mortality

There is a significant drop in all-cause mortality between the first half of the 1990s and the first half of the 2000s. The ASMR for men is 41.9 [39.0–44.7] (per 100,000 PY) in the period 1991–1996, compared to 24.9 [22.7–27.0] in 2001–2006 (Table 2). Mortality rates are almost halved in all educational groups, but somewhat more among the higher educated than among the others. Consequently, a social gradient is apparent in both time periods, with a slight increase in the 2000s. Differences between the lowest and highest educational levels are reflected in the RII, showing inequalities that remain high over time: an RII of 3.07 [2.33–4.06] in 1991–1996 and 4.09 [2.78–6.03] in 2001–2006. Men with maximum primary education have approximately a four times higher risk of dying than those with a higher educational degree in the 2000s. The slight

Table 2 Age-standardised all-cause mortality rates (ASMRs) and the relative index of inequality (RII), separately for men and women and period, according to educational level of the Brussels-Capital Region (Belgium)

	1991–1996			2001–2006		
	PY[a]	ASMR	Deaths	PY[a]	ASMR	Deaths
Men						
No/primary	79,889	67.4 [56.5–78.2]	182	35,091	34.4 [23.7–45.1]	43
Lower secondary	71,452	48.5 [39.7–57.3]	118	99,077	30.5 [24.4–36.6]	99
Higher secondary	185,437	40.1 [34.5–45.7]	230	157,725	24.8 [20.4–29.3]	129
Higher education	135,911	28.2 [22.0–34.3]	125	192,331	12.8 [9.6–16.0]	81
Missing	98,961	46.4 [39.2–53.7]	165	91,735	44.4 [37.1–51.7]	143
Total	571,650	41.9 [39.0–44.7]	820	575,959	24.9 [22.7–27.0]	495
		RII = 3.07*** [2.33–4.06]			RII = 4.09*** [2.78–6.03]	
Women						
No/primary	82,419	24.4 [17.4–31.5]	67	36,938	21.1 [13.2–29.0]	30
Lower secondary	59,269	19.5 [13.3–25.6]	39	87,416	9.0 [5.5–12.5]	26
Higher secondary	180,527	20.0 [16.0–24.0]	108	147,801	10.1 [7.1–13.2]	50
Higher education	159,147	11.8 [7.9–15.7]	55	225,089	9.3 [7.1–11.5]	73
Missing	92,318	23.6 [18.4–28.9]	79	81,607	17.4 [12.5–22.2]	50
Total	573,680	17.8 [15.9–19.6]	348	578,851	11.5 [10.1–13.0]	229
RII not relevant						

Standard population: Brussels' population 2001 Census

Source: Belgian Census and Death Certificates of 1991–1996 and 2001–2006

*** Significant at the 0.001 level

[a] Person years

[b] As there is no linear relationship between education and mortality among women, the calculation of an RII is not relevant

Table 3 Indirectly standardised mortality rates (ISMRs) for the main causes of death per 100,000 person years, separately for men and women and period, of the Brussels-Capital Region (Belgium)

	1991–1996		2001–2006	
	ISMR	Deaths	ISMR	Deaths
Men				
External causes	85.6 [78.2–93.6]	489	49.1 [43.6–55.2]	283
MVA[a]	21.2 [17.6–25.3]	123	8.3 [6.1–11.1]	48
Substance abuse	9.3 [6.9–12.2]	52	8.2 [6.0-10.9]	47
Suicide	31.7 [27.2–36.6]	182	19.6 [16.2–23.6]	113
Assault	6.4 [4.5–8.8]	37	5.4 [3.7–7.6]	31
Other external causes	17.0 [13.8–20.8]	95	7.6 [5.5–10.3]	44
Infectious diseases	18.7 [15.3–22.6]	104	1.6 [0.7–3.0]	9
Cancers	7.6 [5.5–10.3]	44	6.3 [4.4–8.7]	36
Other diseases and medical conditions	20.9 [17.3–25.1]	116	14.8 [11.8–18.3]	85
Women				
External causes	24.0 [20.2–28.4]	138	15.7 [12.6–19.3]	91
MVA[a]	5.3 [3.6–7.6]	31	2.1 [1.1–3.6]	12
Substance abuse	1.8 [0.8–3.3]	10	2.3 [1.2–3.9]	13
Suicide	9.5 [7.2–12.4]	55	7.6 [5.2–9.7]	43
Assault	1.9 [0.9–3.4]	11	2.2 [1.2–3.8]	13
Other external causes	5.5 [3.8–7.8]	31	1.8 [0.8–3.2]	10
Infectious diseases	5.7 [3.9–8.1]	32	3.2 [1.9–5.0]	18
Cancers	10.1 [7.6–13.0]	58	9.0 [6.7–11.8]	52
Other diseases and medical conditions	16.3 [13.1–20.0]	91	7.4 [5.3–10.0]	42

ISMRs are standardised to the stratum-specific rates of the total male population of 15–34 years in 2001, for each cause of death separately

Source: Belgian Census and Death Certificates of 1991–1996 and 2001–2006

[a] Motor vehicle accidents

but non-significant difference between the two periods is due to a larger drop in mortality rates among the highest educated in the 2000s.

The pattern among women is markedly different from that among men. First of all, mortality rates do not differ as much between the two periods as they do among men: from 17.8 [15.9–19.6] to 11.5 [10.1–13.0]. Of importance is that the rates of women in the 1990s were already very low. The mortality rates of intermediate educational levels have further dropped in the observed time span. Secondly, no clear gradient can be observed in either period. In 1991–1996, significant differences are discerned between the highest and lowest educational level. Rates among lower and higher secondary educated groups are in between, but overlap. In 2001–2006, there is a clear split between the lowest educated and all other educational groups. As there is no linear relation between educational level and mortality among women, the RII is not relevant to capture these differences over time and is therefore left out of Table 2.

Cause-specific mortality

In 1991–1996 premature mortality among young men is dominated by external causes (Table 3). More than half of these external causes are suicides and MVAs. In 2001–2006, suicide mortality is still the leading cause of death, but mortality due to MVA has been halved (ASMR = 8.3 [6.1–11.1] compared to 21.2 [17.6–25.3] in 1991–1996) and is now comparable in frequency to deaths caused by substance abuse. The number of deaths due to substance abuse and assaults has not changed much over time. The most striking difference is the tremendous drop in mortality from infectious diseases in 2001–2006 compared to 1991–1996. While infections accounted for almost 15 % of all deaths in the first period, they have become rare in the second period (less than 5 %). Among women, the mortality pattern is not predominated by external causes. Deaths from diseases and medical conditions, other than cancers or infections, are the most prevailing in 1991–1996, whereas mortality from cancer, other diseases and medical conditions, and suicides are most common in 2001–2006. In comparison with men, deaths from suicide, infectious diseases, substance abuse and assaults are much less frequent among women.

Table 4 depicts the cause-specific SMRs according to educational level for young men in both time periods. In the 1990s as well as in the 2000s, clear gradients in deaths from other diseases and medical conditions, and substance abuse are observed. However, most mortality patterns have changed (slightly) over time. The gradient in suicide mortality disappears in the 2000s, as the lowest educated men have a mortality risk that is comparable to higher secondary educated men. As for MVA mortality, higher educated persons have a lower risk of dying in the 1990s, a difference that is almost levelled out in the 2000s due to a low numbers of deaths. The pattern for cancers is different

Table 4 Cause-specific standardised mortality ratios (SMRs) according to educational level for men in the two periods (Data Brussels-Capital Region (Belgium) Census and Death Records of 1991–1996 and 2001–2006)

	1991–1996		2001–2006	
	SMR	Deaths	SMR	Deaths
External causes				
MVA[a]				
No/primary	0.87 [0.54–1.33]	21	1.42 [0.29–4.14]	3
Lower secondary	0.80 [0.46–1.27]	17	1.82 [0.97–3.12]	13
Higher secondary	1.00	55	1.00	12
Higher education	0.35 [0.18–0.54]	15	0.38 [0.29–1.33]	8
Missing	0.51 [0.31–0.79]	15	1.75 [0.90–3.05]	12
Substance abuse				
No/primary	1.56 [0.75–2.87]	10	2.86 [1.15–5.89]	7
Lower secondary	2.20 [1.10–3.93]	11	1.52 [0.70–2.89]	9
Higher secondary	1.00	11	1.00	9
Higher education	0.37 [0.10–0.94]	4	0.35 [0.08–0.82]	5
Missing	1.55 [0.91–2.49]	16	2.69 [1.57–4.30]	17
Suicide				
No/primary	1.97 [1.42–2.66]	42	0.93 [0.34–2.02]	6
Lower secondary	1.72 [1.16–2.45]	30	1.30 [0.82–1.95]	23
Higher secondary	1.00	42	1.00	28
Higher education	0.86 [0.59–1.22]	31	0.67 [0.42–0.98]	24
Missing	1.47 [1.04–2.03]	37	1.88 [1.28–2.65]	32
Assault and other external causes				
No/primary	1.75 [1.20–2.845]	33	0.57 [0.16–1.47]	4
Lower secondary	0.93 [0.52–1.54]	15	0.67 [0.35–1.18]	12
Higher secondary	1.00	40	1.00	28
Higher education	0.39 [0.20–0.68]	12	0.10 [0.03–0.24]	4
Missing	1.41 [0.96–1.98]	32	1.44 [0.95–2.10]	27
Diseases and medical conditions				
Infections				
No/primary	1.95 [1.33–2.77]	31	/	1
Lower secondary	1.20 [0.66–2.01]	14		0
Higher secondary	1.00	24		4
Higher education	0.67 [0.39–1.08]	17		0
Missing	0.97 [0.57–1.53]	18		4
Cancers				
No/primary	1.00 [0.40–2.06]	7	5.31 [1.72–12.00]	5
Lower secondary	1.15 [0.42–2.50]	6	4.78 [2.61–8.02]	14
Higher secondary	1.00	11	1.00	5
Higher education	1.24 [0.68–2.09]	14	1.09 [0.44–2.24]	7
Missing	0.73 [0.27–1.59]	6	2.10 [0.68–4.91]	5
Other				
No/primary	1.40 [0.89–2.10]	23	1.66 [0.83–2.98]	11
Lower secondary	1.33 [0.77–2.13]	17	1.03 [0.60–1.64]	17
Higher secondary	1.00	28	1.00	25
Higher education	0.64 [0.38–1.02]	18	0.33 [0.16–0.58]	11
Missing	1.51 [1.02–2.15]	30	1.46 [0.93–2.19]	21

Source: Belgian Census and Death Certificates of 1991–1996 and 2001–2006

[a] Motor vehicle accidents

/ Too few cases to present the SMRs

in both periods. No inequalities appear in 1991–1996, but a significantly higher cancer mortality among the lower educated is observed in 2001–2006. Deaths due to infectious diseases are almost non-existent in the period 2001–2006. Therefore, no educational distribution is shown in Table 4 for this cause.

Table 5 Cause-specific standardised mortality ratios (SMRs) according to educational level for women in the two periods of the Brussels-Capital Region (Belgium)

	1991–1996		2001–2006	
	ASMR	Deaths	ASMR	Deaths
External causes (excl. suicide)				
No/primary	1.54 [0.91–2.44]	18	1.96 [0.64–4.57]	5
Lower secondary	1.27 [0.63–2.27]	11	0.53 [0.11–1.54]	3
Higher secondary	1.00	27	1.00	10
Higher education	0.39 [0.18–0.74]	9	1.08 [0.65–1.69]	19
Missing	1.43 [0.80–2.12]	18	1.85 [0.92–3.30]	11
Suicide				
No/primary	0.66 [0.24–1.44]	6	0.88 [0.17–2.46]	3
Lower secondary	0.87 [0.28–2.04]	5	0.71 [0.23–1.66]	5
Higher secondary	1.00	16	1.00	11
Higher education	0.91 [0.52–1.48]	16	0.86 [0.51–1.35]	18
Missing	1.21 [0.62–2.10]	12	0.82 [0.30–1.79]	6
Infections				
No/primary	1.65 [0.71–3.26]	8	/	4
Lower secondary	1.18[0.24–3.44]	3		4
Higher secondary	1.00	6		1
Higher education	0.36 [0.07–1.04]	3		2
Missing	2.53 [1.31–4.42]	12		7
Cancer				
No/primary	1.19 [0.67–1.96]	15	1.01 [0.27–2.58]	4
Lower secondary	1.18 [0.57–2.32]	8	0.23 [0.03–0.83]	2
Higher secondary	1.00	16	1.00	14
Higher education	0.50 [0.24–0.93]	10	1.03 [0.66–1.53]	24
Missing	0.76 [0.35–1.45]	9	1.06 [0.46–2.09]	8
Other diseases and medical conditions				
No/primary	0.80 [0.46–1.28]	17	8.30 [3.98–15.00]	10
Lower secondary	0.70 [0.32–1.33]	9	3.36 [1.68–6.02]	11
Higher secondary	1.00	34	1.00	6
Higher education	0.32 [0.17–0.56]	12	0.39 [0.08–1.13]	3
Missing	0.88 [0.53–1.37]	19	4.14 [2.14–7.24]	12

Source: Belgian Census and Death Certificates of 1991–1996 and 2001–2006

/ Too few cases to present the SMRs

Table 5 presents educational differences in cause-specific mortality among women in both periods. As mentioned before, the mortality pattern is quite different in women compared to men, especially in 2001–2006 where only the lowest educated seem to differ from the other educational groups. The only persistent gradient is the one in mortality from other diseases and medical conditions, with higher mortality risks among the lowest educated. While the higher educated had a lower risk of dying due to external causes other than suicides in 1991–1996, the difference in 2001–2006 is more pronounced between the lowest educated and the other educational groups. For all other main causes of death, those with higher education have comparable mortality rates as the higher secondary educated. While cancer mortality was lower among higher educated women in 1991, no such difference could be observed in 2001. For suicides no clear pattern was found in either period.

Discussion

Between the beginning of the 1990s and the 2000s, mortality among adolescents and young adults living in the BCR has dropped substantially. In less than two decades, mortality rates have almost halved among men. This is in contrast to research in Southern European cities that suggests a reverse trend (Borrell et al. 2001). Among women, mortality rates were already quite low in the 1990s and decreased further in the 2000s. The most striking difference over time is the near extinction of deaths caused by infections. This trend is observed in other cities as well, and is largely due to better medication to control HIV, which leads to a prolonged life and lower infectious disease mortality at an early age (Palella et al. 1998).

Another positive evolution that took place in this time span is the rise in educational level. The percentage of those with maximum primary education has fallen

dramatically, while a higher share of adolescents and young adults is enrolled in secondary and higher education. Educational inequalities remain among men, although only significantly pronounced between the lowest and highest level of education. Those with at most primary education are four times more likely to die than those who are higher educated. This finding is in line with findings from research in other European cities in the late 1990s (Cesaroni et al. 2006) and in different states of the USA in the beginning of the twenty-first century (Ma et al. 2012) in which lower premature mortality, but higher or stable social inequalities, were observed. Among women, we discern a different pattern: no graded relation between educational level and mortality, but a split between the lowest educated and other educational groups in the 2000s.

Inequalities among men

Social inequalities in all-cause mortality among men are reflected in several external causes of death, such as substance abuse and other fatal accidents, as well as in other diseases and medical conditions such as cardiovascular disease. Social gradients in external causes are found in other studies (Borrell et al. 2002) and are especially common among young-adult men (Sethi et al. 2007). They represent a high burden to public health, measured in both potential life-years lost and costs to society (Cubbin and Smith 2002). Our comparisons over time show that policy implementations may have a high return on a rather short term. Attention to reducing road accidents received much attention in Belgium since the year 2000 (Casteels and Scheers 2008). The major drop in fatal traffic accidents may, at least in part, be the result of intensive campaigns aiming at controlling the wearing of seat belts, speeding and drunken driving, in combination with the construction of safer and better roads. The absence of a gradient in MVA mortality in 2001–2006 shows that everyone has benefited from these actions. However, mortality data do not offer the possibility of examining non-fatal accidents, in which social inequalities may remain evident (Hasselberg and Laflamme 2008).

Another research has demonstrated that social differences in suicide mortality among men are highest between ages 25–44 years (Mäki 2010). Yet data from the beginning of the 2000s show low suicide mortality in both the highest and lowest educational groups. A review of Cubbin and Smith (2002) indicated mixed results, especially according to country, which may reflect cultural differences. The young population of the BCR is characterised by a large share of persons with a foreign origin, which increased in 2001 (58.8 %) compared to 1991 (44.6 %). A forthcoming article of De Grande (2013) zooms in on these cause-specific mortality differences between nationality groups.

Cancer mortality at young ages does not show as much social differentiation as at older ages, since the spectrum of cancer sites is different and overall more at random than at older ages (Bleyer et al. 2006). However, research on cancer mortality among adolescents and young adults is very limited (Bleyer et al. 2006) and the higher mortality risks found among lower educated men in 2001–2006 could be connected to several factors. As the number of deaths is few, it is however not possible to probe into this pattern.

No social gradient among women

Previous studies have also pointed to differences in the magnitude of social inequalities between men and women (e.g. Koskinen and Martelin 1994; Saurel-Cubizolles et al. 2009). This observation is usually explained by gender differences in cause-specific mortality patterns. The causes of death with the largest social gradients (external causes, cardiovascular disease) tend to be more common among adult men (Koskinen and Martelin 1994). In adulthood, social gradients in external deaths among women are observed as well, but as the relative contribution to total mortality is much lower, the gradient is not apparent in the overall mortality pattern. Even in adolescence and early adulthood, which are phases predominated by external causes of death, the cause-of-death pattern among men is much more dominated by external causes than among women. The only clear gradient among women is apparent in other diseases and medical conditions. To make the situation even more complex, social inequalities are not only lower among women, but also reflect a dichotomy between the lowest educated and other educational groups. A possible explanation is that other factors are important to control for, such as employment status and/or marital status (Koskinen and Martelin 1994). To study this relation properly, we need to exclude adolescents (15–24 years) from our study population, as, in contrast to young adults, most of them are still studying and live in the parental home. We also need mortality data over a longer time span to interpret these controls correctly, which is not evident with a low number of deaths. This was out of scope for this paper, but will be studied in the future with recently available mortality data up to 2009.

Strengths and limitations

One of the strengths of this paper is that its results are based on reliable and exhaustive data. The use of record-linked mortality data, linking death certificates with census data, overcomes the well-known numerator–denominator bias (Valkonen 1993) and shows a more accurate picture of social inequalities than unlinked data (Shkolnikov et al. 2007). As the data cover almost the entire population of Brussels—95 % of the population returned the census

questionnaire—its results are highly valuable to policy makers of the BCR.

Another unique feature of this paper is its focus on premature mortality from adolescence till early adulthood. As Marmot (2009) points out, interventions need to start early in the life course and more research is needed to provide insight into the mechanisms of social inequalities. Most research focuses solely on childhood and adolescence (Polinder et al. 2010; Remes et al. 2010) or on premature mortality until the age of 65 years (Cesaroni et al. 2006; Ma et al. 2012). The burden of external causes is however highest before the age of 40 and is, as mentioned earlier, a high cost to society (Cubbin and Smith 2002). Insight into the cause-of-death pattern of young persons can raise awareness of certain health problems and can be the basis for intervention strategies (e.g. lowering substance abuse or assaults) and health promotion strategies (e.g. education as a healthy start in life).

A limitation of this study is that it focuses on mortality differences only. It does not tell the whole story of adolescent and young-adult health. Research on injuries has shown that there are differences in the magnitude of inequalities between fatal and non-fatal injuries (Cubbin and Smith 2002). This paper presents a clear drop in mortality from injuries. Reports from the Belgian Institute for Road Safety however points towards the remaining high cost of non-fatal MVA to society (Casteels and Scheers 2008). Its relation with SES is however not studied in Belgium at population scale. In other countries, mixed results concerning the relation between non-fatal injury and SES were found (Cubbin and Smith 2002). Population-based data on non-fatal injuries are still quite scarce, even in Western European countries (Krug et al. 2000). These kinds of data are needed to complete our information on health of adolescents and young adults. Collecting hospital data or data on disability and rehabilitation could be an important complement to the available census data.

Another data issue relates to missing information, namely on the unlinked causes of death and education. However, we believe this has only a limited impact on the results presented here. A random pattern in the unlinked deaths in 2001–2006 was found, with no significant differences according to sex, educational level, age or nationality of origin. In 1991–1996, an overrepresentation of men and persons of Maghreb origin was discerned, but the percentage of unlinked deaths in this period was rather small (less than 10 %). The missing values on education imply in most cases a selective group that does not differ significantly from the lower educated groups, which may introduce a conservative bias in our results.

Conclusions

The most striking observations of this paper are the tremendous drop in mortality among adolescent and young-adult men between the beginning of the 1990 and 2000s, and the different pattern of inequalities in mortality between young men and women. The mortality decline in men is largely due to a significant decrease in fatal infections, suicide and MVA mortality, indicating the possible positive influence of road safety policy implementations on the latter. Mortality among women was already low in the 1990s. No gradient could be observed in either period, but social inequalities remain between the lowest educational group and the other educational levels. For the main part, this gender difference can be explained by a different cause-of-death pattern, but other influencing factors need to be studied as well.

Acknowledgments This study was funded by Innoviris with the *Prospective Research for Brussels* programme, an initiative of the government of the Brussels-Capital Region. We are thankful to the Brussels-Capital Health and Social Observatory for their methodological help and interesting discussions of the results. Also, many thanks go to Sylvie Gadeyne for her ever-inspiring comments.

Appendix 1

See Table 6.

Table 6 Indirectly standardised mortality ratios (SMRs) of unlinked deaths according to educational level and by sex in the two periods of the Brussels-Capital Region (Belgium)

	Men				Women			
	1991–1996		2001–2006		1991–1996		2001–2006	
	SMR	Deaths	SMR	Deaths	SMR	Deaths	SMR	Deaths
No/primary	1.97 [1.10–3.25]	15	1.50 [0.55–3.26]	6	0.80 [0.17–2.34]	3	1.56 [0.32–4.56]	3
Lower secondary	1.14 [0.49–2.25]	8	0.97 [0.48–1.74]	11	1.07 [0.22–3.12]	3	0.60 [0.07–2.18]	2
Higher secondary	1.00	19	1.00	18	1.00	9	1.00	5
Higher educated	0.97 [0.53–1.63]	14	1.02 [0.64–1.54]	22	0.61 [0.20–1.42]	5	0.85 [0.41–1.56]	10
Missing	1.20 [0.60–2.14]	11	2.40 [1.55–3.55]	25	2.02 [0.92–3.83]	9	1.54 [0.57–3.35]	6

Source: Belgian census and death records of 1991–1996 and 2001–2006

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