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ORIGINAL ARTICLE

Ethnic differences in diabetes-related mortality in the Brussels-Capital Region (2001–05): the role of socioeconomic position

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Abstract
Objectives To examine if and to what extent ethnic differences in diabetes-related mortality are associated with differences in education and housing status.
Methods The data consist of a cohort study linking the 2001 census to emigration and mortality data for the period 2001–05. The study population comprises all Belgian and North African inhabitants of the Brussels-Capital Region (BCR) aged 25–74. Age-standardized mortality rates (ASMRs) (direct standardization) and mortality rate ratios (MRRS) (Poisson regression) are computed.
Results North Africans have a higher diabetes-related mortality compared to Belgians. The ASMRs for North African and Belgian women are 54.8 (95% confidence interval (CI) 31.5–78.2) and 23.8 (95% CI 20.3–27.3), respectively. These differences in diabetes-related mortality largely disappear when differences in education are taken into account. The MRRs for North African versus Belgian origin drop from 1.62 (95% CI 1.11–2.37) to 1.19 (95% CI 0.73–1.93) in men and from 3.35 (95% CI 2.08–5.41) to 1.88 (95% CI 0.95–3.69) in women.
Conclusions Differences in education play an important part in the excess diabetes-related mortality among North Africans in the BCR.

Keywords Ethnicity · Socioeconomic position · Education · Housing status · Inequality · Diabetes-related mortality

Introduction

It has long been recognized that diabetes incidence and its prevalence vary between ethnic groups. In the 1950s, a high occurrence of diabetes was reported among the Pima Indians (Cohen 1954). Ethnic variations in diabetes morbidity have been well documented since (Bennett et al. 1971; Carter et al. 1996; Uitewaal et al. 2004). To account for these differences, physiological, socioeconomic, environmental, behavioral, and genetic explanations have been put forward (Abate and Chandalia 2001; Carter et al. 1996; Cruickshank et al. 2001). Recent studies furthermore note ethnic diversity in metabolic control (Kristensen et al. 2007; Munoko and Hermans 2008; Riffi and Devroey 2008). As both diabetes incidence and glycemic regulation differ according to ethnicity, diabetes mortality rates are also likely to vary between ethnic groups. While research on ethnic differentials in diabetes mortality is rather sparse, studies that have been conducted have found higher diabetes mortality among certain ethnic groups (Mather et al. 1998; Vandenheede et al. (under review)). High diabetes mortality rates are, for example, observed in people of North African descent compared to people of European descent (Vandenheede et al. (under review)).

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The reasons for ethnic differences in diabetes mortality are not yet clear, but differences in diabetes risk factors (socioeconomic position, lifestyle, genetics, etc.), diabetes prevalence, metabolic control and access to and quality of health care may all play an important part (Fischbacher et al. 2009; Kristensen et al. 2007; Munoko and Hermans 2008; Vandenheede et al. (under review)). This study focuses on one of these possible explanations, namely ethnic variations in socioeconomic position (SEP). People of North African origin in Belgium generally have a disadvantaged SEP compared to native Belgians. They are often poorer, have less education and are more likely to live in adverse neighbourhoods (Phalet et al. 2007). Moreover, an inverse association between SEP and diabetes mortality has been reported (Espelt et al. 2008; Miech et al. 2009). It is therefore hypothesized that the high diabetes-related mortality among people of North African origin may partially be explained by their unfavorable socioeconomic profile. More specifically, the objective of this study is to examine to what extent differences in diabetes-related mortality between North Africans and Belgians in the Brussels-Capital Region (BCR) may be due to differences in education and housing status between these groups.

Methods

Design and study population

The setting of this research is the BCR. This metropolitan region has the highest percentage of immigrants in Belgium. At the moment of the 2001 census, 48.3% of the population of the BCR was of foreign origin (Willaert 2010). The population of North African origin was most represented (14.6%). The BCR is therefore particularly suited to study variations between the people of North African and Belgian origin.

Data are derived from an anonymous record linkage between the Belgian 2001 census and emigration and mortality register data (2001–05). The study population comprises the Belgian and North African men and women aged 25–74 living in the BCR at the time of the census ($N = 375{,}259$). The lower age limit is 25 years as diabetes-related mortality at ages younger than 25 is rare ($N = 1$). Above 74 years of age the number of people of North African origin is very small ($N = 771$; 1.0%).

Variables

Mortality from diabetes is defined by the International Classification of Diseases version 10 (ICD-10 codes E10-E14). To capture the actual burden of diabetes, both death certificates with diabetes as an underlying cause of death and with diabetes as one of the causes of death (any mention of diabetes) are analyzed.

Information on the independent variables—age, ethnic origin, sex, education, and housing status—is provided by the 2001 census. The variable age is included as a categorical variable (5-year age bands) in the direct standardization analyses and as a continuous variable in the Poisson regression analyses. North African ethnicity is defined as being of North African origin. If either current nationality or nationality of birth is Algerian, Egyptian, Libyan, Moroccan or Tunisian, people are then considered as being a part of the North African community. Indicators for SEP are education and housing status. Education is categorized according to the International Standard Classification of Education (ISCED). The educational levels included in the analyses are: pre-primary, primary, lower secondary, upper secondary and tertiary education (UNESCO 2006). The variable housing status is based on information regarding tenure status as well as housing quality. This variable consists of six categories (low-, mid- and high-quality tenants and low-, mid- and high-quality owners) and is measured at household level. A dwelling is classified as a low-quality house, when large repairs are necessary; as a mid-quality house, if no large repairs are needed, there is central heating and the surface area is >35 m^2; and as a high-quality house, if mid-quality conditions are fulfilled and the surface area is >85 m^2 (Deboosere and Willaert 2004).

Data analysis

Ethnic variations in education and housing status are examined using Chi-square tests of independence. To map out differences in diabetes mortality by ethnicity, age-standardized mortality rates (ASMRs) are computed, using the general population of the BCR as standard. Relative differences in diabetes-related mortality by SEP indicators and ethnicity are examined using Poisson regression models. To get a clearer picture of the actual burden of diabetes, analyses are conducted for diabetes as one of the causes of death. All analyses are age-adjusted, sex-specific and performed using Stata 11. People with missing values on education and/or housing status are excluded from the analyses ($N = 75{,}422$; 20%).

To challenge the robustness of the findings, a series of sensitivity analyses is conducted. First, Poisson regression analyses are carried out using nationality of birth or current nationality as indicators of ethnicity. Second, sensitivity analyses are performed with different categorizations of SEP measures. Third, two alternative approaches for working with missing values are tested: listwise deletion and multiple imputation (number of imputations = 20) (Acock 2005; Royston 2004; Spratt et al. 2010).

Results

Ethnic differences in socioeconomic factors

Table 1 shows that North African men and women generally have a lower educational level compared to Belgian men and women. For example, 35% of the women of North African origin have at most a degree of pre-primary education versus 3% of the Belgian women. There are furthermore striking differences in housing status between the Belgians and North Africans, with North Africans more often being tenants and living in low-quality dwellings.

The burden of diabetes-related mortality

In the period 2001–05, 64 men and 40 women died of diabetes as an underlying cause of death. The number of deaths due to diabetes as one of the causes of death is more than five times higher (344 deaths among men and 207 among women) (Table 2). Consequently, if only diabetes as an underlying cause of death is taken into account, then the burden of diabetes is severely underestimated. Of these 551 death certificates with mention of diabetes, 117 (21%) report ischemic heart disease (ICD-10 codes I20-I25) and 36 (7%) mention cerebrovascular disease (ICD-10 codes I60-I69) as one of the causes of death (results not shown).

Table 2 also describes ASMRs by sex and ethnic origin. In both men and women, people of North African origin have higher diabetes mortality compared to people of Belgian origin. Differences are particularly pronounced, when diabetes as one of the causes of death is taken into consideration. For example, among women, the ASMR for North African women amounts to 54.8/100,000 (95% CI 31.5–78.2), whereas the ASMR for Belgian women is 23.8/100,000 (95% CI 20.3–27.3).

Association between socioeconomic indicators and diabetes-related mortality

Relative differences in diabetes-related mortality by education and housing status are presented in Table 3.

Overall, an inverse association between both SEP indicators and diabetes-related mortality is observed. In men, mortality rates increase as education decreases; whereas for housing status there seems to be a dichotomy between tenants and low-quality owners on the one hand and mid- and high-quality owners on the other hand. In women, inverse gradients in diabetes-related mortality by education and housing status are discerned.

Ethnic differences in diabetes-related mortality

Figure 1 depicts age-adjusted diabetes mortality rate ratios (MRRs) for ethnic origin. Diabetes as one of the causes of death is the dependent variable. All models are age-adjusted. Model 1 is only adjusted for age, model 2 also includes education, model 3 housing status and model 4 takes both SEP indicators into account.

Ethnic differences in diabetes-related mortality are larger in women than in men. The age-adjusted diabetes

Table 1 Distribution of education and housing status according to sex and ethnic origin in the Brussels-Capital Region (Data Belgian 2001 census)

	Men			Women		
	Belgian origin (N^a (%))	North African origin (N^a (%))	p value[b]	Belgian origin (N^a (%))	North African origin (N^a (%))	p value[b]
Education			<0.0001			<0.0001
Pre-primary	3,428 (2.6)	6,819 (22.7)		4,126 (2.8)	8,664 (34.6)	
Primary	13,995 (10.8)	3,764 (12.6)		17,088 (11.4)	3,180 (12.7)	
Lower secondary	27,768 (21.4)	6,618 (22.1)		33,866 (22.7)	5,045 (20.2)	
Upper secondary	27,860 (21.5)	6,497 (21.7)		32,346 (21.7)	4,531 (18.1)	
Tertiary	56,737 (43.7)	6,282 (20.9)		61,924 (41.4)	3,588 (14.4)	
Housing status			<0.0001			<0.0001
Low-quality tenant	24,656 (19.9)	11,459 (40.0)		24,486 (17.5)	8,026 (33.6)	
Mid-quality tenant	20,336 (16.5)	4,439 (15.5)		24,292 (17.3)	3,954 (16.5)	
High-quality tenant	13,306 (10.8)	2,098 (7.3)		15,300 (10.9)	2,172 (9.1)	
Low-quality owner	12,418 (10.0)	4,311 (15.1)		14,071 (10.1)	3,946 (16.5)	
Mid-quality owner	17,852 (14.4)	2,439 (8.5)		21,873 (15.6)	2,235 (9.3)	
High-quality owner	35,087 (28.4)	3,900 (13.6)		40,093 (28.6)	3,588 (15.0)	

[a] N number of people

[b] Chi-square tests are used to compare people of Belgian and North African origin

Table 2 Number of diabetes deaths and age-standardized mortality rates (per 100,000) by sex and ethnic origin (Brussels-Capital Region (2001–2005)

	Diabetes as an underlying cause of death		Diabetes as one of the causes of death	
	N	ASMR (95% CI)	*N*	ASMRb (95% CI)
Men				
Overall	64	10.7 (8.1–13.3)	344	57.2 (51.2– 63.2)
Ethnic origin				
Belgian	56	10.7 (7.9–13.5)	291	54.4 (48.2–60.7)
North African	8	13.6 (3.3–23.9)	53	89.3 (62.9–115.7)
Women				
Overall	40	5.1 (3.5–6.7)	207	25.8 (22.3–29.4)
Ethnic origin				
Belgian	32	4.4 (2.8–5.9)	181	23.8 (20.3–27.3)
North African	8	16.4 (4.2–28.6)	26	54.8 (31.5–78.2)

N number of people, *ASMR* age-standardized mortality rate, *CI* confidence interval

Table 3 Age-adjusted diabetes mortality rate ratios (and 95% confidence intervals) for education and housing status (Brussels-Capital Region (2001–2005); men and women separately)

	Age-adjusted diabetes MRRs (diabetes as one of the causes of death)			
	Men		Women	
	Model 1	Model 2	Model 1	Model 2
Education				
Pre-primary	2.55 (1.68–3.88)		7.51 (3.53–15.95)	
Primary	1.95 (1.32–2.87)		6.42 (3.15–13.10)	
Lower secondary	2.11 (1.48–3.00)		3.27 (1.58–6.75)	
Upper secondary	1.26 (0.82–1.92)		2.98 (1.40–6.39)	
Tertiary (ref.)	1.00		1.00	
Housing status				
Low-quality tenant		1.68 (1.15–2.45)		5.08 (2.90–8.89)
Mid-quality tenant		1.98 (1.34–2.93)		3.41 (1.86–6.25)
High-quality tenant		1.82 (1.11–2.97)		2.22 (0.98–5.03)
Low-quality owner		1.66 (1.11–2.49)		3.25 (1.75–6.04)
Mid-quality owner		0.85 (0.54–1.35)		2.14 (1.14–4.04)
High quality owner (ref.)		1.00		1.00

MRRs mortality rate ratios, *ref.* reference

MRRs amount to 3.35 (95% CI 2.08–5.41) in women and 1.62 (95% CI 1.11–2.37) in men. However, in both men and women the overall pattern is the same. North Africans have higher diabetes-related mortality compared to Belgians (model 1) and the greater part of this excess mortality seems to be associated with their lower educational attainment (model 2). When education is included in the analyses, more than 60% of the excess diabetes-related mortality among North Africans is explained. In men, MRRs for North African versus Belgian origin drop from 1.62 (95% CI 1.11–2.37) to 1.19 (95% CI 0.73–1.93). In women, a decline in MRRs from 3.35 (95% CI 2.08–5.41) to 1.88 (95% CI 0.95–3.69) is observed. If the mortality analyses are adjusted for housing status, then MRRs also attenuate (model 3), but the higher diabetes-related mortality among North Africans appears to be largely accounted for by education (model 2 vs. model 4).

Sensitivity analyses are also performed. First, mortality analyses using different operational definitions of either ethnicity or education or housing status result in similar findings. Second, the different ways of dealing with missing values—listwise deletion and multiple imputation—indicate that our results are fairly robust. For example, a multiple imputation analysis with both SEP indicators as independent variables (comparable to model 4) gives MRRs of 1.34 (95% CI 0.95–1.92) for men and 1.85 (95% CI 1.09–3.12) for women.

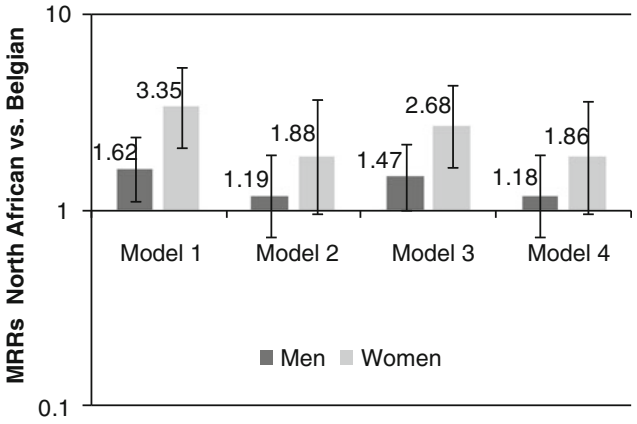

Fig. 1 Age-adjusted diabetes mortality rate ratios (and 95% confidence intervals) for ethnic origin (Brussels-Capital Region 2001–05; men and women separately). All models are age-adjusted. Model 1 includes age and ethnic origin. Model 2 is also adjusted for education, model 3 for housing status and model 4 for both education and housing status

Discussion

The present study shows higher diabetes-related mortality among North Africans compared to Belgians in the BCR. Particularly, a high MRR is observed among North African women. These ethnic differences in diabetes-related mortality are largely accounted for by education.

Methodological issues

Data are obtained from a census-linked mortality follow-up study. The link with the census guarantees a high level of accuracy of socioeconomic information. The direct individual link between census and register data furthermore minimizes numerator–denominator bias (Deboosere and Gadeyne 2005).

A potential source of bias is under-registration of North African residents either in the population census or in the mortality register. However, it is expected that under-registration of people of North African origin in the census is negligibly small. Due to return migration (especially at older ages), under-registration of North Africans in the mortality register may be more substantial, introducing a conservative bias (Ringbäck-Weitoft et al. 1999). Even so, as only 2.9% of the people of North African origin aged 25–74 and living in the BCR at the moment of the 2001 census emigrated, this under-registration of deaths is probably minor.

In the Poisson regression analyses, diabetes as one of the causes of death is used as the dependent variable. As diabetes mellitus is often part of a complex clinical picture, in which the disease is not directly linked to the decease, diabetes is often not registered as the underlying cause of death but as one of the contributing causes. Hence, when using the underlying cause of death as reference (a common practice in epidemiological studies), the burden of diabetes is severely underestimated. Conducting analyses with "diabetes as one of the causes" as the dependent variable enables us to get a more accurate estimation of the actual burden of diabetes-related mortality in the BCR. However, this probably still is an under-estimation of the true diabetes burden (Thomason et al. 2005). To the extent that the reporting of diabetes on death certificates differs between Belgians and North Africans, cross-ethnic comparisons of diabetes-related mortality may be difficult to establish. Yet, the fact that our results mirror findings from prevalence and severity data—showing a high diabetes burden among Moroccans living in Belgium (Riffi and Devroey 2008; Vandenheede and Deboosere 2009)—suggests that ethnic variations in diabetes mortality are not only due to differential registration practices but also reflect actual differences in both diabetes prevalence and severity.

As the SEP indicators (education and housing status) may have differential validity across different ethnic groups, adjusting the analyses for SEP may be problematic (Davey Smith 2000; Smaje 1996). However, due to the sparseness of the data, a further categorization of North Africans according to SEP groups is not feasible. Hence, examining differential effects of SEP indicators in North Africans versus Belgians is not an option. Controlling for SEP is a valuable alternative, as it enables us to disentangle the respective influences of education/housing status and ethnicity on diabetes-related mortality.

The use of multiple SEP indicators (education and housing status) allows us to encompass different dimensions of SEP. The variable education mainly attempts to capture the knowledge-related assets of a person, such as the ability to acquire and handle information, and is often considered as a measure of early life SEP. Housing status on the other hand mostly measures material circumstances. It gives an indication of a person's accumulated wealth through life (Galobardes et al. 2006a, b). However, since only two indicators of SEP are considered, there may still be residual confounding by unmeasured socioeconomic circumstances.

A final methodological consideration worthy of mention is that no distinction between type 1 and 2 diabetes is made. As more than 50% of the death certificates reporting on diabetes have code 'E14' i.e. unspecified diabetes, it is not feasible to distinguish between type 1 and 2 diabetes. Practically, it would not alter the results in a significant way, since 85–90% of all people with diabetes have type 2 diabetes.

Interpretation

Our results indicate that there are substantial differences in diabetes-related mortality between North Africans and Belgians in the BCR. The observed excess diabetes-related mortality among people of North African origin may (to some extent) be attributable to differences between North Africans and Belgians in diabetes risk factors, diabetes prevalence, glycemic regulation and access to and quality of health care (Fischbacher et al. 2009; Kristensen et al. 2007; Munoko and Hermans 2008; Vandenheede et al. (under review)). As mentioned earlier, a higher diabetes prevalence and severity among people of Moroccan origin has been found in Belgium (Riffi and Devroey 2008; Vandenheede and Deboosere 2009). In 35- to 74-year-old men of Belgian and Moroccan origin, a prevalence of 5.0 and 6.5% was observed; whereas in women the diabetes prevalence amounted to 4.3% in Belgian and 11.9% in Moroccan women (Data Belgian Health Interview Surveys 1997–2001–2004). Data from the prevalence study furthermore indicate that the excess burden of diabetes among Moroccans is strongly associated with lifestyle factors (obesity and a lack of physical activity) and educational attainment (Vandenheede and Deboosere 2009). The severity study shows a worse metabolic control and a higher occurrence of complications among both female and male patients of Moroccan origin (Riffi and Devroey 2008).

Although ethnic differences in diabetes-related mortality are observed in both men and women, relative differences by ethnicity are larger among women, thereby again echoing findings from the diabetes prevalence study (Vandenheede and Deboosere 2009).

In the BCR, differences in SEP between North Africans and Belgians play an important part in understanding differences in diabetes-related mortality between these groups. Adjusting the mortality analyses for education explains more than 60% of the excess diabetes-related mortality among North Africans. Differences in housing status also account for some of the ethnic variation in diabetes-related mortality. However, if the mortality analyses are already adjusted for education, then the inclusion of housing status in the analyses does not explain any of the remaining excess diabetes-related mortality among North Africans. These findings suggest that knowledge-related assets, such as healthy lifestyle behaviors, health perceptions and willingness to seek health information, may be more important contributors to ethnic differences in diabetes-related mortality than material conditions. However, the influence of education on diabetes-related mortality is complex. The education–diabetes mortality association may in part be the result of the fact that the well-educated generally have a higher occupational class. Moreover, other mediating mechanisms, such as (non-adequate control of) diabetes risk factors, metabolic control and access to and quality of health care, may play a role (Skalická et al. 2009; Oort van et al. 2005; Torssander and Erikson 2010).

Conclusion

This study indicates that people of North African origin in the BCR have higher diabetes-related mortality rates than people of Belgian origin and that these ethnic differences are largely accounted for by differences in education. These findings suggest that public health policies addressing ethnic differences in diabetes may benefit from focusing on diabetes knowledge, health perceptions, healthy lifestyle, etc. Moreover, as education is such an important contributor to (ethnic) differences in diabetes-related (mortality), enduring efforts should be made to improve the educational profile of the population as a whole and of ethnic minorities in particular.

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Conflict of interest The authors declare that they have no competing interests.

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