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ORIGINAL ARTICLE

Educational disparities in mortality among patients with type 2 diabetes in the Netherlands (ZODIAC-23)

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ABSTRACT

Background: Relative mortality differences between educational level in mortality have been reported among diabetic as well as among non-diabetic subjects in Europe, but data on absolute differences are lacking. We studied the effect of educational disparities on mortality in a Dutch prospective cohort of type 2 diabetes mellitus (T2DM) patients.
Methods: This study was part of the ZODIAC study, a prospective observational study of patients with T2DM. Data on educational level were first collected on 19 May 1998, and from this date on, 858 patients were included in 1998; educational level was known for 656 patients. Vital status was assessed in 2009. The relationship between mortality and educational level was studied using a Cox proportional hazard model, the relative index of inequality (RII), slope index of inequality (SII) and the population attributable risk (PAR). Educational level was divided into four categories; the highest educational level was used as reference.
Results: After a median follow-up time of 9.7 years, 365 out of 858 patients had died. The hazard ratio of primary education for total mortality was 3.02 (95% CI 1.44-6.34). The RII was 2.85 (95% CI 1.21-6.67), the absolute difference in the risk for mortality (SII) was 384 deaths (95% CI 49-719) per 10,000 follow-up years. PAR for patients with the lowest level of education was 51.4%.
Conclusions: A low educational level had a higher impact on mortality than having a macrovascular complication. Given the substantial differences in mortality between educational levels in T2DM, more understanding of underlying (modifiable) mechanisms is necessary.

KEYWORDS

Educational disparities, type 2 diabetes, mortality

INTRODUCTION

In many countries, socioeconomic position and educational level are inversely related to unhealthy behaviour and to lesser access to high quality care. Socioeconomic position (SEP) refers to an individual's position within a hierarchical social structure and is influenced by many social, societal, and economic factors, such as educational level, income, or wealth. Social disparities in mortality can theoretically be expected to be amplified among patients with diabetes, compared with those without diabetes.[1-5]
In Europe, socioeconomic disparities and educational disparities in mortality have been reported among diabetic as well as among non-diabetic subjects.[6-10] Mortality differences between social classes have always been present in the general population; but it was not until the 1990s that widening socioeconomic mortality disparities were also observed among diabetic patients.[8,9]
Most data on SEP and educational disparities and the relationship with mortality are based on cross-sectional data, retrospective data or record linkage studies,[8,10,11] making it difficult to determine the exact impact of educational level on the risk for mortality. Furthermore, all previous studies performed in Europe looked at relative measures. Two large record linkage studies found that the effects of social economic position (SEP) and educational level on survival were weaker in people with diabetes than in the general population.[8,11] Eastern European countries

have higher relative disparities in mortality by SEP.[10] A recent study performed in the US looked at both relative as well as absolute educational disparities in mortality in patients with type 2 diabetes mellitus (T2DM).[12] And although the relative effects of educational disparities on mortality were weaker in adults with diabetes, the absolute impact on mortality was far greater in adults with diabetes. Given the increasing burden of T2DM and the observed increase in social and educational inequalities in the prevalence of T2DM and its complications, further efforts to quantify these effects are urgently needed.[13] The aim of this study was to estimate relative and absolute educational disparities in mortality in a Dutch cohort of adults with T2DM.

MATERIALS AND METHODS

Study population

This study was part of the ZODIAC (Zwolle Outpatient Diabetes project Integrating Available Care) study.[14] In this project, general practitioners are assisted in their care of T2DM patients by hospital-based nurses specialised in diabetes. At baseline, patients with a very short life expectancy (including patients with active cancer) or insufficient cognitive abilities were excluded from this study. ZODIAC started in January 1998, but data on educational level were not collected until 19 May 1998. From this date on, 858 patients were included in 1998, and educational level was known for 656 (76%) patients. Vital status was recorded in January 2009. The ZODIAC study was approved by the medical ethics committee (reference number 03.0316).

Educational level was divided into four categories: primary education, lower secondary education, higher secondary education and tertiary education (bachelor's degree or higher). We categorised patients who went to high school into two groups (lower secondary education and higher secondary education) in accordance to the Dutch school system. Working status was classified as employed (yes) or unemployed (no).

Statistical methods

The effects of relative educational disparities on total mortality were measured using Cox regression models, tertiary education was used as the reference group. We used two different models. In model 1, age and gender were included as possible confounders. In model 2, we adjusted for age, gender, body mass index (BMI), smoking status (smoker/non-smoker), macrovascular complications (yes/no), diabetes duration and working status. We selected these confounders based on their possible relationship with both education as well as mortality.

Furthermore, the relative index of inequality (RII) and the slope index of inequality (SII) for assessment of educational disparities in mortality were used. Both the RII and the SII are generally accepted measures for assessing relative and absolute mortality risk.[15]

Although the interpretation of hazard ratios (HRs) is straightforward, the interpretation of the impact of educational level on mortality by comparing HRs across various groups is hampered by differences in the distribution, by factors such as for example smoking. Measures such as the RII and the SII can overcome this problem.[15,16] Educational level is transformed into a continuous measure in which the rank of education is calculated as the mean proportion of the population having a higher level of education.[16] The RII is the ratio between the estimated mortality prevalence among persons at rank 1 (the lowest education level) and rank 0 (the highest level). In other words, the RII is the predicted ratio of mortality at the two extremes of the educational scale. The RII was calculated with the use of binary logistic regression analysis. The SII measures absolute differences in rates (e.g., in deaths per 100,000 person-years) between the lowest and the highest ends of the educational scale. The SII is the predicted difference in mortality rates between the two extremes of the educational scale.

The SII is computed as the slope of the regression of mortality on the indicator of relative educational position in a generalised linear model using the identity link. Confidence intervals of RII and SII were estimated using a bootstrap procedure.

Based on the hazard ratios of the analyses with educational level as a categorical variable, we also calculated the population attributable risk percentage (PAR%) for all-cause mortality.[17] In our analyses, the PAR% can be interpreted as the percentage by which mortality rates could be reduced if the risk factor of interest was eliminated. PAR% can be calculated by using the following formula: *prevalence of risk factor among decedents x [(HR-1) / HR]*. The PAR% was also calculated for macrovascular complications. Statistical analyses were performed using SPSS version 15.0 and Stata 11.

RESULTS

Baseline data are presented in *table 1*. After a median follow-up time of 9.7 years, 365 out of 858 patients had died. The absolute mortality rate was 441 deaths per 10,000 follow-up years.

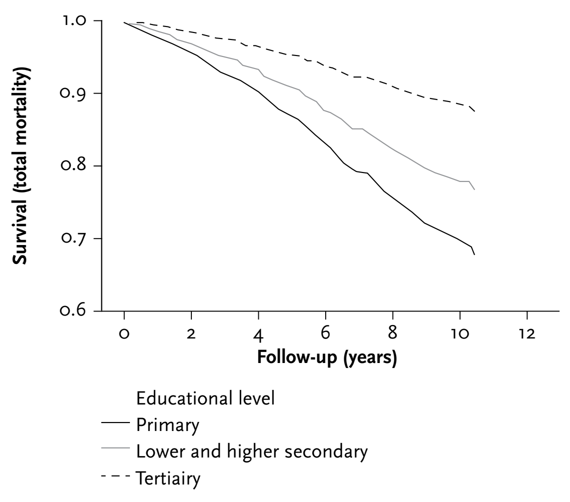
The HRs of primary education, lower secondary education and higher secondary education, compared with tertiary education, for total mortality were 2.53 (95% CI 1.23-5.19), 1.74 (95% CI 0.81-3.72), and 2.31 (95% CI 0.84-6.39), respectively, as calculated with model 1. Using model 2, HRs for total mortality were 3.02 (95% CI 1.44-6.34), 2.01 (95% CI 0.93-4.37), and 2.59 (95% CI 0.92-7.28), respectively. Also see *figure 1*.

Table 1. *Baseline characteristics*

Characteristic	Total *n=858*	Deceased patients *n=365*	Surviving patients *n=493*
Age (years)	67.8 (11.7)	75.4 (8.7)	62.3 (10.8) ***
Female (%)	58.0	55.9	59.6
Diabetes duration (years)	6.0 (3-11)	7.5 (4-13)	5.0(2-9)***
Smoking (%)	21.0	17.3	23.7*
BMI (kg/m^2)	28.9 (4.9)	28.4 (5.0)	29.4 (4.7)**
Systolic blood pressure (mmHg)	152 (25)	154 (27)	151 (24.)
HbA1c (%)	7.5 (1.3)	7.4 (1.3)	7.4 (1.2)
Total cholesterol/HDL	5.3 (1.6)	5.2 (1.6)	5.4 (1.5)
Macrovascular complications (%)	35.8	50.4	24.9***
% Primary school (N)	68.1 (447)	76.9 (186)	63.0 (261)
% Lower secondary education (N)	23.0 (151)	16.9 (41)	26.6 (110)
% Secondary education (N)	3.2 (21)	2.9 (7)	3.4 (14)
% Tertiary education (N)	5.6 (37)	3.3 (8)	7.0 (29)
Working status	13.6	4.8	18.9***
Age >75 years (%)	27.9	53.5	9.3***

Data are presented as means SD for normally distributed data and median with interquartile range for non-normally distributed data or %. *P<0.05, **P<0.01, ***P<0.001 for differences between deceased and survived patients. The sum of patients in the different education categories does not correspond to 858 due to missing data.

Figure 1. *Survival curve for total mortality (model 2) according to the different educational levels*



Total mortality risk was nearly three times higher in T2DM patients with the lowest versus the highest position on the education scale (RII of 2.85, 95% CI 1.21-6.67). The absolute difference in the risk for total mortality between T2DM patients with the lowest versus the highest position on the educational scale, as measured with the SII, was 384 deaths (95%CI 49-719) per 10,000 follow-up years. The PAR for total mortality for patients with the lowest level of education was 51.4% (as calculated with the HR from model 2).

DISCUSSION

Disparities in educational level were related to substantial differences in mortality risk. In relative terms, the mortality risk after ten years was almost three times higher in the lowest educational level group compared with patients with the highest educational level. The impact of a low educational level was far greater than having a macrovascular complication. The population attributable risk (PAR) can give insight into the contribution of a risk factor to total mortality. The PAR of having a low educational level was 51%. Notably, the PAR of having a macrovascular complication was 25%. In absolute terms, patients with the lowest educational level suffered the greatest mortality burden with an absolute difference of 384 deaths per 10,000 follow-up years. The absolute increase in mortality is even more striking when compared with the absolute expected number of deaths in healthy subjects from the general population with a mean age of 68 years: 139 deaths per 10,000 follow-up (data available at www.cbs.nl).

Our study confirms the large absolute educational disparities in mortality in patients with T2DM, as observed in a recent study from the US.[12] Even after correction for important behavioural factors such as BMI, working status and smoking status, there remained a high contribution of having a low educational level to total mortality. The slope index of inequality in the US study was 503 deaths (95% CI 302-697) per 10,000 follow-up years compared with 384 deaths (95% CI 49-719) in our study. Whilst the US study adjusted for age, gender, race and survey year in their Cox proportional hazard analyses, we also adjusted for working status and clinical variables reflecting unhealthy behaviour, in this case smoking and BMI.

Health behaviour and BMI explain only partly the association between socioeconomic status and educational level and incidence of T2DM.[13] The factors that explain the higher mortality in patients with lower educational levels are probably related, at least for a large part, to differences in unmeasured healthy behavioural factors, for example exercise, eating habits and health seeking behaviour.[18,19] But also access to care, financial coverage of care, quality of care, and even different communication styles of the physician have been implicated to influence health behaviour.[20,21] We acknowledge that it would be very interesting to investigate these underlying factors in future studies. However, these data were not available in the ZODIAC study. Our study was specifically designed to estimate the contribution of educational disparities on total

mortality and not for studying the underlying mechanisms explaining this difference.
Several different indicators of SEP have been used in previous studies, including the amount of education, employment grade, income and indices based on residential area characteristics. For example in the US, educational level is most often used as a proxy for SEP.[22] Fortunately, different socioeconomic indicators show strong mutual associations.[23] However, the associations between health and the different socioeconomic indicators could have different implications and causes. For example, the educational level achieved by an individual patient in our cohort could have been influenced by other socioeconomic factors, such as family income and school costs at the time of starting his or her education. Whether, and to what extent, the relationship between educational level and mortality will be applicable to next generations needs to be determined.
There were more limitations to our study. Because of the small sample size the confidence intervals of our results were wide. Therefore, our results should be interpreted with caution. Secondly, selection bias could not be excluded, since data on educational level were not available for one quarter of the participants in the original ZODIAC study. For this reason, we calculated the hazard ratio for missing values on education for total mortality (HR= 1.25, 95% CI 1.04–1.50, adjusted for age, gender, BMI, smoking status, macrovascular complications, and diabetes duration), an outcome that even suggests an underestimation of the relationship observed. Also, the HR for mortality in patients with lower secondary education was lower than patients with higher secondary education; however, CIs overlapped substantially. We also did not correct for race or ethnicity, although most of our cohort (>98%) were Caucasians and the relative risks were comparable with other European studies.[8,11] Neither did we make a formal comparison with the Dutch population because in the ZODIAC study these data are not available. Although we adjusted for working status, no information was available on income level or working status before retirement. Furthermore, the *a priori* selected variables for model 2 and their role as confounders can be debated. As the differences between the HRs between model 1 and 2 were small, the impact of this potential methodological problem will probably be small.
Although regarded as more appropriate, previous studies did not use RII and SII.[15,16] Other strengths are its prospective design, the follow-up period of ten years, and the number of clinical variables available in the ZODIAC study.

In conclusion, we were not able to confirm the 'reassuring' small effect of educational level on mortality in diabetes patients.[9,11] As a matter of fact, relative as well as absolute risks were high in patients with T2DM with a low educational level. A low educational level had a higher impact on mortality than having a macrovascular complication. Further investigation should focus on modifiable factors that underlie these inequalities.

Conflicts of interest: none

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