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Intermediation of behavioural and biological risk factors in relation between educational level and mortality among middle-aged Kaunas population

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Background. Educational differences have been assessed as explanations for health behaviour and all-cause and CVD mortality. In Lithuania, in the years 2000–2007, mortality increased from 1406 to 1620 deaths / 100000 / year for men and from 654 to 744 deaths / 100000 / year for women (1). Health behaviour may have a potential role in explaining the relation between risk factors and education.

The objective of the study was to examine the extent to which health behaviour and biological risk factors can account for relative differences in all-cause and CVD mortality by educational level among middle-aged population.

Materials and methods. In 1983–1992, three independent surveys were carried out in random samples of men and women aged 35–64, involving 5403 persons. The mean response rate was 65.1%. Behavioural and biological risk factors were defined within the framework of the WHO MONICA study. A total of 1320 individuals died from all causes and 654 from CVD. The Cox proportional hazards model was used to evaluate the risk of all-cause and CVD mortality.

Results. The prognostic value of behavioural factors (risk ratio, RR) in the low-educated group as compared with high for mortality from all causes was RR = 1.36 (95% CI, 1.16–1.59) and from CVD RR = 1.25 (95% CI, 1.35–2.00). The risk of biological factors and all-causes mortality in the low-educated group as compared with high was assessed as RR = 1.54 (95% CI, 1.30–1.83) and from CVD as RR = 1.42 (95% CI, 1.12–1.81).

Conclusions. Mortality from all causes and CVD among the middle-aged population was higher in the low-educates group. The population strategy in the low-educated group should be encouraged to reduce the behavioural and biological risk factors.

Key words: middle-aged population, biological risk factors, behavioural risk factors

INTRODUCTION

Most studies on educational differences and cause-specific mortality have focused on three groups of explanatory factors – material, behavioral and psychosocial – in an attempt to explain educational inequalities in mortality (2, 3). These types of factors are the key of causation theory in which educational inequalities in mortality are explained by a different distribution of determinants of health across educational groups (4). Behavioural factors that might be distributed unequally across educational groups include smoking, alcohol consumption, physical activity, dietary habits. The material factors of educational inequalities in mortality include housing conditions, employment status and income. A substantial contribution to explaining educational inequalities in mortality is made by psychosocial and stress-related factors such as life events, the lack of social support. All these types of factors are interrelated, indicating that some mechanisms work through others rather than independently from each other (5). Material factors may affect mortality either directly or indirectly via behavioural and via psychosocial factors. Psychosocial factors may also exert a direct and indirect effect through behavioural factors. Biological risk factors, such as blood pressure, serum cholesterol or glucose intolerance, are influenced by one's behaviour and may be intervened by behavioural modifications. Accordingly, behavioural risk factors account for biological risk factors.

The aim of this study was to examine the prognostic value of health behaviour and biological risk factors in all-

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cause and CVD mortality depending on the educational level in middle-aged population in 1983–2007.

MATERIALS AND METHODS

In the framework of the WHO Multinational Monitoring of Trends and Determinants in Cardiovascular Disease (MONICA) study (6), in the Kaunas city in 1983–1992 three different random samples of subjects aged 35–64 years were selected and examined (N = 5403). The samples were stratified by age and sex. The mean response rate was 65.1%. Approval from the regional Ethics Committee was obtained. All three cohorts were followed up by the official Kaunas city mortality register. Mortality data for the samples of Kaunas men and women aged 35–64 years for the period 1983–2007 were extracted. All death cases were registered every month from the beginning of each survey until 1 January 2008. Two groups of death cases were analysed in this study: group 1 – death from all causes (001-E999 – codes of the 9th revision of the International Classification of Diseases (ICD) (until 1 January 1997), and A00-Z99 – codes of the 10th ICD (after 1 January 1997); group 2 comprised deaths from CVD (390–458 – codes of the 9th ICD and I00–I99 – codes of the 10th ICD).

All respondents were divided into three categories by educational level: university degree (high level), higher and intermediate vocational school, secondary school (intermediate level), lower secondary and primary school (low level). The following behavioural factors were assessed: smoking, excessive alcohol consumption, low leisure time physical activity, overweight, obesity, self-rated health. Subjects who smoked at least one cigarette per day were considered as regular smokers. Alcohol consumption was assessed by answers of study participants to questionnaire questions about the frequency of usual consumption and amounts of alcoholic beverages (beer, wine or spirits). Excessive (high) alcohol consumption was determined in case when the frequency of alcohol consumption was indicated as once a week, several times a week or every day. Low physical activity was determined in case when the mean time spent in the leisure time in winter and summer on walking, moderate and hard work, gardening and other physical activities was less than 10 hours a week. The WHO criteria were used to determine overweight by body mass index (BMI 25.0–29.9 kg/m^2) and obesity (BMI 30.0 kg/m^2 or more) (WHO, 1998) (7). Self-rated health was determined from answering the question: how would you rate your health? The answers were classified as good, fair and poor. Biological risk factors were divided into two categories: hypertension and hypercholesterolemia. High arterial hypertension (AH) was assessed as systolic blood pressure 140 mm Hg or more and / or diastolic blood pressure 90 mm Hg or more, or normal blood pressure (<140 / 90 mm Hg), if the person had been taking antihypertensive drugs the last two weeks. Serum cholesterol level was measured from a venous blood sample and determined by the enzymatic method (8). Serum total cholesterol level of 5.0 mmol/l or more was classified as hypercholesterolemia (8). Diabetes mellitus was determined from a positive answer to the question: "Has a doctor ever told you that you have diabetes?" and / or glucose level 11.1 mmol/l or more 2 hour after glucose load (75 g). Glucose level was determined with an individual glucometer. By means of a standard G. Rose questionnaire and ECG coding using the Minnesota code (MC), ischemic heart disease (IHD) was diagnosed when one or more of the following IHD forms were determined: 1) previous myocardial infarction (MC 1–1, 1–2 and / or documented myocardial infarction); 2) angina pectoris by G. Rose questionnaire; 3) ischemic ECG changes (one or more following MC 1–3; 4–1, 2, 3; 5–1, 2,3 ; 6–1, 2; 7–1, 8–3). The history of stroke was based on the answer to the question: "Has a doctor ever told you that you had a stroke?" Previous stroke cases were verified by the stroke register.

Statistical analysis

The estimates of relative risk (RR) and 95% confidence intervals (CI) of all-cause and CVD mortality by education level and by single behavioural and biological factors, adjusted for confounders (age and sex) were based on the multivariate Cox proportional hazard models. All variables were coded as dummy variables. Factors that were statistically significantly related to all-cause or CVD mortality and varied by education level were added to models with educational level and confounders. The percent change in relative risk for educational groups after addition of each factor (behavioural or biological) was then evaluated separately for all-cause and CVD mortality. The final models contained education level, confounders, and both behavioural and biological factors. The data from the first, second and third MONICA surveys were pooled and used in the models as one data set. The variable "survey" was used in the models to determine the possible differences among the surveys.

A two-tailed P value of $P < 0.05$ was considered statistically significant. The age structure of European population aged 35–64 was used as a standard for standardization of all analysed rates (9). Statistical analysis was performed using the statistical software package SPSS 15.0 for Windows.

RESULTS

Table 1 presents characteristics of the follow-up data by educational level among subjects aged 35–64 years. There were 1320 (24.4%) deaths from all causes and 654 (12.1%) deaths from CVD in the study cohort (n = 5403) during 1983–2007. Results showed a higher risk of all-cause mortality and mortality from CVD in lower secondary as well as higher and intermediate education groups compared with the university education group. The highest percentages of deaths from all causes and deaths from CVD were detected in the lowest educational group (34.8% and 17.8%, respectively).

Table 1. **Risk of all-cause and CVD mortality by educational level among Kaunas middle-aged population, 1983–2007**

Educational level	Respondents, n	Respondents, %	Deaths, n	Deaths, %	Relative risk* (95% CI)
All-cause mortality					
1. University	1341	24.8	216	16.1	1.00
2. Higher and intermediate vocational school, intermediate secondary school	2112	39.1	425	20.1	1.31 (1.11–1.55)
3. Lower secondary and primary school	1950	36.1	679	34.8	1.61 (1.38–1.88)
Total	5403	100	1320	24.4	
Mortality from CVD					
1. University	1341	24.8	108	8.1	1.00
2. Higher and intermediate vocational school, intermediate secondary school	2112	39.1	200	9.4	1.22 (1.00–1.54)
3. Lower secondary and primary school	1950	36.1	346	17.8	1.50 (1.20–1.87)
Total	5403	100	654	12.1	

* Adjusted for age and gender; CI – confidence interval; CVD – cardiovascular diseases.

Table 2. **Prevalence (%) of behavioural and biological risk factors by educational level**

	Educational level		
	High (1) N = 1341	Intermediate (2) N = 2112	Low (3) N = 1950
Behavioural factors			
Smoking	14.9	22.3***	20.7***
Excesive alcohol consumption	10.9	13.2*	14.2**
Low leisure time physical activity	44.5	51.3**	55.3***
Overweight	47.3	43.2*	39.1***
Obesity	22.1	31.8***	42.6***
Poor self-rated health	62.7	69.6***	75.1***
Biological risk factors			
Hypertension	42.6	47.7**	60.1***
Hypercholesterolemia	82.4	83.4	85.4*
IHD	10.7	12.5	18.9***
Diabetes	0.9	1.5	3.6***
Stroke	0.6	0.6	1.4*

Educational level: (1) university; (2) higher and intermediate vocational school, intermediate secondary school; (3) lower secondary and primary school.

IHD – ischemic heart disease.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ as compared to high educational level.

Differences in the prevalence of behavioural and biological risk factors by educational level are presented in Table 2. When estimating behavioural risk factors (smoking, excessive alcohol consumption, low physical activity, etc.) and health indicators (hypertension, hypercholesterolemia, diabetes, IHD and previous stroke), the highest prevalence was also assessed in the lowest educational group, except in overweight (47.3% and 39.1%, $p < 0.001$). After adjusting for age and gender, an independent effect of behavioural and biological risk factors on the risk of all-cause and cardiovascular mortality was (Table 3). For current smokers, the risk to die from any cause was by 79% and from CVD by 64% higher as compared to never or former smokers. High alcohol consumption was associated with a higher risk of all-cause mortality (RR = 1.18, $p < 0.05$). Low physical activity was also a significant factor in determin-

Table 3. **Behavioural and biological risk factors for all-cause mortality and mortality from CVD among middle-aged Kaunas population, 1983–2007**

	All-cause mortality	Mortality from CVD
	RR (95% CI)	RR (95% CI)
Behavioural factors		
Smoking		
never or former smoker	1.00	1.00
smoker	1.79 (1.56–2.05)	1.64 (1.35–2.00)
Alcohol consumption		
moderate	1.00	1.00
high	1.18 (1.01–1.37)	1.11 (0.86–1.38)
Physical activity		
high	1.00	1.00
low	1.30 (1.17–1.46)	1.52 (1.30–1.79)
BMI		
<25 kg/m^2	1.00	1.00
25.0–29.9 kg/m^2	0.91 (0.79–1.06)	1.08 (0.86–1.35)
> = 30.0 kg/m^2	1.17 (1.00–1.36)	1.52 (1.21–1.90)
Self-rated health		
good	1.00	1.00
fair	1.05 (0.84–1.32)	1.18 (0.85–1.66)
poor	1.38 (1.14–1.68)	1.55 (1.16–2.08)
Biological risk factors		
Arterial hypertension		
no		1.00
yes	1.00	
Hypercholesterolemia	1.31 (1.16–1.49)	1.71 (1.42–2.07)
< = 5.0 mmol/l	1.00	1.00
5.0–6.5 mmol/l	0.84 (0.71–1.00)	0.72 (0.56–0.92)
> = 6.5 mmol/l	0.94 (0.79–1.13)	1.02 (0.80–1.31)
IHD		
no	1.00	1.00
yes	1.63 (1.41–1.88)	2.11 (1.75–2.55)
Diabetes		
no	1.00	1.00
yes	2.18 (1.67–2.85)	2.11 (1.47–3.03)
Stroke		
no	1.00	1.00
yes	1.77 (1.16–2.70)	2.72 (1.69–4.37)

RR – relative risk, CI – confidence interval, CVD – cardiovascular diseases.

Adjusted for age and gender.

Table 4. **Behavioural and biological risk factors in association with educational level and all-cause and CVD mortality among middle-aged population, 1983–2007**

Educational level	Confounders (Model 1): RR (95% CI)	Confounders + behavioural factors (Model 2): RR (95% CI)	Confounders + biological factors (Model 3): RR (95% CI)	Confounders + behavioural and biological factors (Model 4): RR (95% CI)
All-cause mortality				
High	1.00	1.00	1.00	1.00
Intermediate	1.31 (1.11–1.55)	1.16 (0.98–1.37)	1.22 (1.02–1.46)	1.10 (0.92–1.32)
Low	1.61 (1.38–1.88)	1.36 (1.16–1.59)	1.54 (1.30–1.83)	1.33 (1.17–1.51)
Mortality from CVD				
High	1.00	1.00	1.00	1.00
Intermediate	1.22 (0.97–1.54)	1.07 (0.85–1.36)	1.08 (0.84–1.39)	0.98 (0.76–1.27)
Low	1.50 (1.20–1.87)	1.25 (1.35–2.00)	1.42 (1.12–1.81)	1.22 (0.96–1.56)

RR – relative risk, CI – confidence interval.

ing the risk of death from all the analysed causes. Obese responders were at a higher risk to die from any cause (RR = 1.17, $p < 0.05$) and from CVD (RR = 1.52, $p < 0.05$) as compared to subjects with a normal body mass. Poor self-rated health increased the risk of death from all causes and from CVD by 38% and 55%, respectively, as compared to good self-rated health. Arterial hypertension, IHD and previous stroke were statistically significant conditions increasing the risk of all-cause and CVD mortality. Diabetes increased the risk of death from all causes 2.18-fold and from CVD 2.11-fold.

Table 4 presents the direct effect of behavioural and biological risk factors compared with the independent effect of educational inequalities on mortality from all causes and from CVD. The relative risk of behavioural factors in the low-educated group as compared to the high educational level from all-cause mortality was estimated as RR = 1.36 (95% CI 1.16–1.59) and mortality from CVD as RR = 1.25 (95% CI 1.35–2.00). The direct effect of biological factors on mortality from all causes in the low-educated group as compared with the high-educate subjects was assessed as RR = 1.54 (95% CI 1.30–1.83), and from CVD the mortality was RR = 1.42 (95% CI 1.12–1.81). The impact of behavioural and biological factors in the low educated group as compared to the high-educated group in all-cause mortality was statistically significant, but in CVD mortality no statistically significant effect was estimated.

DISCUSSION

In our study, the education level showed a graded association with all-cause and CVD mortality in middle-aged men and women. The relative differences by education level were slightly greater in all-cause mortality than in CVD mortality. The results based on routine mortality statistics and census data for 1989 and 2001 for the entire Lithuanian population demonstrated that increasing inequalities in mortality by education occurred due to the declining mortality rate in people with higher education and an increasing mortality rate in people with a low level of education (10, 11). Increasing life expectancy was assessed among persons with higher education, and conversely, decreasing life expectancy was related with a low level of education. CVD were responsible for the greatest number of years lost in life expectancy by all educational categories. In Estonia, educational differences in mortality were increasing from 1989 to 2000, and over a 10-year period life expectancy improved for graduates and worsened for those with the lowest education (12). The impact of post-communist transition on mortality in Eastern Europe as compared to Western European countries has been widely demonstrated. Although educational inequalities in mortality in Eastern Europe were as high as in the West in the early 1990s, in around 2000 the educational inequalities in mortality were considerably greater in the eastern parts (13, 14).

In our study, smoking, physical inactivity, poor self-rated health, obesity and high alcohol consumption were the most important health behaviours related to educational differences in total mortality and mortality from CVD. In most of previous studies (15–17), smoking has had a negative effect on mortality, but other health behaviours showed mixed results. Trends in smoking in nine European countries by education revealed that smoking differed in educational groups. In country-specific analyses, elementary educated British men and women and elementary educated Italian men showed greater declines in smoking than their more educated counterparts (18, 19). Persons who drink occasionally or former drinkers are more likely to have chronic health problems compared to men who abstain from alcohol (19, 20). Former drinkers have the poorest functional health (20). Physical activity contributes to a better health, whereas inactivity worsens the health indices such as blood

pressure, blood lipids, and body weight. Overweight, for both men and women, is more likely to be a chronic health problem, and underweight or obese persons have a higher level of distress compared to those with optimal weight (21). During the 20-year follow-up, the probability of death from all-causes and CVD among men with poor self-rated health as compared to very good was statistically significantly lower (22). Our results showed arterial hypertension to be the most important biological factor explaining educational differences in all-cause and CVD mortality outcomes. Different levels of cholesterol did not reveal any relationship with all-cause and CVD mortality. Diabetes demonstrated the highest relative risk of all-cause mortality, and stroke had the most important impact on mortality from CVD as compared to mortality risk from IHD, diabetes and stroke. This suggests that these health behaviours may be not only etiological risk factors, but also markers of generally risky lifestyles (23–25).

Limitations of the study

In this study, data were collected on a possible relation between education and mortality. Additionally, our study was restricted to the explanation of the economic activity as working, sick leave or disabled, or unemployed in the educational level groups. It is important to note that the material conditions, particularly for the lower secondary and primary school groups, are related with the risk of mortality. Only a limited number of biological risk factors were included in the study. Vegetable consumption would be an important health indicator in subjects of different educational level. Therefore, there is a recognized need to maximize the explanation of inequalities in health. Our findings suggest that the economic and psychosocial factors should be involved in the future research.

CONCLUSIONS

The MONICA study provided information on the behavioural and biological risk factors for all-cause and CVD mortality in relation to educational levels among middle-aged population. Results of our study formulated a number of policy recommendations. High priority is recommended to the reduction of the number of health-damaging habits among lower educational groups (such as smoking, a lack of physical activity, obesity, excessive alcohol consumption) and reduction of biological risk factors (hypertension and hypercholesterolemia).

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ELGSENOS IR BIOLOGINIŲ RIZIKOS VEIKSNIŲ SĄVEIKA SU IŠSILAVINIMU IR MIRTINGUMU TARP VIDUTINIO AMŽIAUS KAUNO GYVENTOJŲ 1983–2007 METAIS

Santrauka

Tyrimo tikslas – įvertinti išsilavinimo įtaką elgsenos ir biologiniams rizikos veiksniams ir nustatyti jų ryšį su mirtingumu nuo visų priežasčių, taip pat ir nuo širdies bei kraujagyslių ligų (ŠKL) tarp vidutinio amžiaus gyventojų.

Tyrimo metodai. 1983–1992 m. atlikti trys epidemiologiniai tyrimai atsitiktiniu principu atrinktiems 5403 35–64 m. Kauno gyventojams. Atsako dažnis – 65,1%. Gyventojų ištyrimui taikyti standartiniai epidemiologiniai tyrimo metodai. Elgsenos ir biologiniai rizikos veiksniai buvo nustatyti pagal PSO (Pasaulio sveikatos organizacijos) ir MONICA programos kriterijus. Per stebėjimo laikotarpį (1983–2007) mirė 1320 asmenų, iš kurių 654 asmenys nuo ŠKL. Mirties nuo visų priežasčių ir nuo ŠKL rizikai įvertinti pritaikyta Coxo regresinė analizė.

Rezultatai. Asmenims su pradiniu išsilavinimu ir nustatytais elgsenos veiksniais, palyginus su universitetinį išsilavinimą turinčiaisiais, rizika numirti RS = 1,36 (95 % PI 1,16–1,59), nuo ŠKL – RS = 1,25 (95 % PI 1,35–2,00). Tiriamiesiems su pradiniu išsilavinimu ir nustatytais biologiniais veiksniais, palyginus su universitetinį išsilavinimą turinčiaisiais, rizika numirti RS = 1,54 (95 % PI 1,30–1,83), nuo ŠKL – RS = 1,42 (95 % PI 1,12–1,81).

Išvados. Mirties rizika nuo visų priežasčių, taip pat ir nuo ŠKL asmenims su pradiniu išsilavinimu, palyginus su universitetinį išsilavinimą turinčiaisiais, yra didesnė, todėl jiems būtina taikyti profilaktines priemones, koreguojančias elgesio ir biologinius rizikos veiksnius.

Raktažodžiai: vidutinio amžiaus gyventojai, biologiniai veiksniai, elgsenos veiksniai