

# The role of socio-demographic status and risk factors in mortality from external causes

**Regina Rėklaitienė,  
Abdonas Tamošiūnas,  
Riėardas Radiėauskas,  
Kristina Jurėnienė**

*Institute of Cardiology, Kaunas  
University of Medicine,  
Kaunas, Lithuania*

*Correspondence to: Regina  
Rėklaitienė, Department of  
Population Studies, Institute of  
Cardiology, Kaunas University of  
Medicine, Sukilėliø 17, LT-50009  
Kaunas, Lithuania.*

E-mail: regina@kmu.lt

**The objective** of this study was to evaluate relations between behavioral, somatic and socio-demographic factors and the risk of death from external causes (injuries, accidents, suicides, etc.), to determine the time trends in the mortality from external causes, and to evaluate the significance of the effects of age, period and birth cohort on suicide mortality among middle-aged men during the period 1971–2000 in Lithuania.

**Materials and methods.** A random cohort of men aged 45–59 years from the Kaunas Rotterdam Intervention Study (conducted in 1972–74) and Study of Multifactorial Prevention of CHD (conducted in 1977–80) were examined (n = 6,480). The participants of the two surveys were observed until January 1, 2001. Over this time 2,841 men died, 230 from external causes among them. The Cox proportional hazards model was used to evaluate the risk of death from external causes. Trends in the mortality from external causes and the average annual changes were based on logarithmic regression analysis. For assessment of the effects of age, period and birth cohort the Poisson regression model was applied.

**Results.** The risk of mortality from external causes among men was positively related to smoking habits and arterial hypertension and negatively related to education level and total serum cholesterol concentration, but there was no association with alcohol consumption. The risk of suicide mortality was associated to family status and occupation only. Trends in the mortality from all external causes showed no significant changes during 1971–2000. After adjusting for age and cohort effects, the period effect was found to be statistically significant.

**Conclusion.** Prognosis of risk factors of the mortality from external causes and period effect on suicide mortality rates will form important parts of future research agendas.

**Key words:** socio-demographic factors, external causes, hazards ratio, trends, age-period-cohort effects

## INTRODUCTION

In Lithuania, like in the other European countries, external causes are ranked as the second leading causal group for mortality in male population, especially among men of younger age (1). In 1996 the risk of death from external causes in Lithuania and in the other Baltic States was five to six times higher than in the United Kingdom and the Netherlands (2). In all Baltic countries the main trends of mortality due to external causes of death are similar: a slight increase from 1970 to the end of stagnation period followed by a sharp decrease in mortality from 1984 to 1988 (3). Blood pressure, cholesterol concentration, smoking habits, and some socioeconomic characteristics were obviously expected to play a significant role in predicting cardiovascular disease.

The goals of the present study were to investigate the prognosis of socioeconomic status for the risk of death from external causes among men aged 45–59 years, to determine the time trends in the mortality from external causes and to reveal the importance of the effects of age, period and birth on the suicide mortality rate among men aged 25–64 years for the period from 1971 to 2000.

## MATERIALS AND METHODS

In the framework of the WHO Kaunas Rotterdam Intervention Study, an initial survey of the random sample of 2,447 men aged 45–59 years was carried out in 1972–74 (participation rate 69.2%). Five years later (1977–80), the Study of Multifactorial Prevention of CHD was carried out and the random sample

of 6,006 Kaunas men aged 40–59 years was examined (participation rate 69.8%). The data from both surveys of men aged 45–59 years ( $n = 6,480$ ) were analyzed in this study. Approval from the Ethics Committee was obtained and participants signed a written informed consent prior to the study.

Socioeconomic position, alcohol drinking and smoking habits were ascertained via questionnaires. The WHO criteria were used to determine all risk factors (4). The overweight was evaluated by body mass index (BMI 25.0–29.9 kg/m<sup>2</sup>) and obesity (BMI 30.0 kg/m<sup>2</sup> or more). Arterial hypertension was assessed as systolic blood pressure (SBP) 160 mm Hg or more and/or diastolic blood pressure (DBP) 95 mm Hg or more, or normal blood pressure if the person had taken antihypertensive drugs within the last two weeks. Serum total cholesterol concentration was measured by the method of Huang TC et al.

The estimates of hazards ratio (HR) and 95% confidence intervals (CI) were based on the multivariate Cox proportional hazards model (5). Prognosis of different risk factors was estimated using four end-points and a separate model for each end-point according to external causes. The difference between the parameters compared was considered to be greater than 1.95 ( $p < 0.05$ ). Data from the mortality register were used to analyze the mortality among the observed persons and among all Kaunas men aged 25–64 years. All death cases were registered from the beginning of every survey until January 1, 2001. Mortality trends were analyzed over the period from 1971 to 2000. Time trends of mortality rates were calculated from standardized annual ( $r_t$ ) mortality rates using the regression model:

$\log r_t = a + bt + e_t$  where  $\log$  denotes the natural logarithm and  $t$  the year, and  $e_t$  the error term. The parameter  $b$ , which is the rate of change of the mortality rate, will be called the trend of the mortality rate. The instantaneous change rate per year at time point  $t$  is a constant proportion,  $100b$  percent of the mortality rate at  $t$ . Four groups of death cases were analyzed in this study: the first group dealt with deaths from all external causes (E800-999 – codes of 9th revision of the International Classification of Diseases (ICD), and V01-Y98 – codes of 10th ICD); the second group comprised deaths from injuries and accidents (E800-949 – codes of 9th ICD and V01-X59 – codes of 10th ICD); the third group involved suicides (E950-959 – codes of 9th ICD and X60-X84 – codes of 10th ICD), and the fourth group consisted of deaths from

all diseases (001-799 – codes of 9th ICD and A00-R99 – codes of 10th ICD). Analysis of suicides was performed using the Poisson regression model with the parameters representing age, period and cohort effects. The goodness of fit of the models was assessed using likelihood ratio statistics. Estimates of the parameters and likelihood ratio statistics were revealed using the SAS program.

## RESULTS

During the follow-up period, among the 6,480 middle-aged men surveyed initially 2,841 deaths (43.8%) occurred, of them 230 were attributed to external causes (8.1%), 163 to injuries or accidents and 21 to suicides; 2,611 deaths were attributed to diseases.

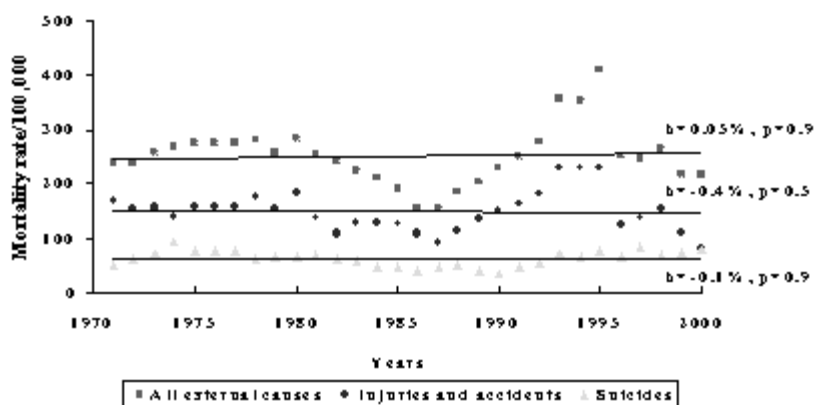


Fig. 1. Time trends in the mortality from all external causes, from injuries and accidents among Kaunas men aged 25–64 years from 1971 to 2000

At the time of initial survey, from all variables included into the model only family status and occupation were associated with the risk of suicide death (Table 1). The risk of death from suicide among divorced men was 9-fold as high as among married men. The risk of suicide death among workers was 3.6-fold higher than among employees. A negative association was detected between the education and the risk of death from injuries or accidents: the lower education level was associated with the higher risk of death. The risk of death from injuries and accidents in relation to smoking habits increased on an average by 29.8%. Among men with arterial hypertension, the risk of death from injuries and accidents was higher by 59.8% as compared to men with normal BP. At the same time the risk of death from injuries or accidents was 2.0-fold higher among men with the concentration of total cholesterol in the lowest quintile (1.37–5.02 mmol/l) as compared to men with the concentration of total cholesterol in the top quintile (6.87–13.5 mmol/l). The risk of death from external causes was higher by 63.4% among men with arterial hypertension as compared to men

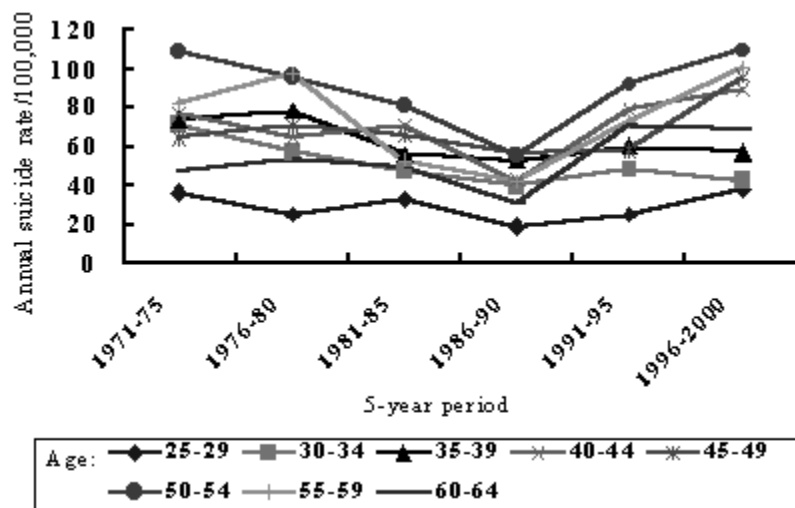


Fig. 2. The period effect: suicide rates of Kaunas men aged 25–64 years from 1971 to 2000

without this risk factor. The lower category of smoking habits as compared to the higher one was related with an increase of risk of death from external cause on average by 25.8%, whereas it was determined that consumption of alcohol was not related with the risk of death from any external cause. A negative association was detected between education and the risk of death from external causes. The risk of death was significantly higher among men with primary and not finished secondary education as compared to men with university education. The risk of death from external causes among the divorced men was 3-fold as high as in married men. The same difference in the risk level (HR = 2.87; 95% CI 1.173–7.008) was determined when widowers and married men were compared. The risk of death from diseases was associated with smoking habits, family status and education as shown by the initial survey. Conversely to the association between the risk of death from injuries or accidents, the risk of death from diseases showed a positive association with the concentration of total cholesterol. The increase in age by one year increased the risk of death from diseases by 5.4% (HR = 1.054; 95% CI 1.045–1.064).

The mortality from all external causes among Kaunas male population aged 25–64 years varied from 238.1 per 100,000 in 1971 to 215.7 per 100,000 in 2000 (Fig. 1). The mortality rate from injuries and accidents decreased from 168.5 per 100,000 in 1971 to 80.1 in 2000. The rate of suicide increased from 51.0 per 100,000 in 1971 to 77.9 in 2000, *i.e.* showed a 1.5-fold increase. In spite of a large variation of all external causes, injuries, accidents and suicide mortality rates, their average annual changes throughout the whole study period were not statistically significant.

The best model of mortality analysis was the age-period-cohort model (Table 2). From the age-cohort

and age-period models, the age-period model was assessed as more appropriate. After adjusting for age and cohort effects and age and period effects, the period effect was found to be statistically significant. The age-period-cohort analysis indicated that there were marked differences in rates of suicide in different periods. The rate of suicide decreased from 36.7 per 100,000 in 1973 to 19.1 per 100,000 in 1988 and then reached the previous level in 1998 (Fig. 2). The highest level of suicide mortality was demonstrated by males aged 50–54 years in 1973; it showed a 1.9-fold decrease in 1987 and returned to a rising rate of suicide mortality in 1998. The lowest rates of suicide mortality were detected in 1986–1990 in all age groups.

## DISCUSSION

For the four last decades epidemiological research has focused on the contribution of the main risk factors such as arterial hypertension, cigarette smoking, hypercholesterolemia, low socioeconomic status and other factors to the risk of cardiovascular death. A growing number of projects in this field have demonstrated that most of the risk factors also could be used in follow-up studies as predictors of external causes of mortality, including suicide, injury and accident mortality (6). Alcohol consumption, especially heavy alcohol consumption, is the most frequent risk factor for external causes of mortality (7). No relationship was found between alcohol consumption and the risk of death from external causes in the followed-up sample of Kaunas men aged 45–59 years. These results could be explained partly by the high correlation between alcohol use and smoking. Although the use of each substance carries its own risk when used one independently of the other, some joint effects are appreciable. The results of our study demonstrated a positive and strong relationship between smoking habits and the risk of death from injuries and accidents, and the risk of death from external causes. The same relationship was observed in the USA (8). A variety of reasons could explain the association between cigarette smoking and injuries. These include direct toxicity, distractibility, smoking-associated medical conditions, and confounding factors including personality or behavioral characteristics (9). Personality research may lead to a deeper understanding of cigarette smoking. Smokers were characterized by a high impulsiveness and excitement

Table 1. Prognostic value of different variables for the mortality from all external causes, mortality from injuries or accidents, suicides, and mortality from diseases in men aged 45–59 years (multivariate analysis)

Variables	Death from							
	External causes		Injuries or accidents		Suicides		Diseases	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
<i>Age, yrs</i>	0.975	0.942–1.010	0.989	0.951–1.028	0.970	0.868–1.084	1.054	1.045–1.064
<i>Education level:</i>								
Primary school	2.236	1.450–3.447	2.294	1.386–3.797			1.549	1.371–1.750
Not finished secondary school	1.768	1.138–2.747	1.655	0.981–2.792			1.397	1.234–1.580
Secondary school or college	1.338	0.843–2.124	1.398	0.818–2.390			1.382	1.221–1.564
University	1.0		1.0				1.0	
<i>Family status:</i>								
Married	1.0		1.0		1.0		1.0	
Divorced	3.055	1.701–5.485	2.884	1.465–5.679	9.106	2.681–30.934	1.414	1.123–1.780
Single	1.264	0.519–3.074	1.593	0.650–3.899	“–“	“–“	0.899	0.665–1.216
Widower	2.868	1.173–7.008	3.384	1.375–8.329	“–“	“–“	1.465	1.048–2.048
<i>Occupation:</i>								
Employee					1.0			
Worker					3.680	1.348–10.068		
Unemployed					“–“	“–“		
<i>Alcohol consumption</i>	1.139	0.999–1.298						
<i>Smoking habits:</i>	1.258	1.156–1.370	1.298	1.182–1.426			1.197	1.169–1.226
<i>Arterial hypertension</i>	1.634	1.235–2.163	1.598	1.145–2.230			1.591	1.469–1.724
<i>Quintiles of total cholesterol (mmol/l):</i>								
I (1.37–5.02)			2.021	1.170–3.492			0.851	0.755–0.959
II (5.03–5.61)			1.650	0.933–2.917			0.848	0.751–0.958
III (5.62–6.16)			1.506	0.850–2.669			0.814	0.721–0.919
IV (6.17–6.86)			1.215	0.665–2.219			0.855	0.758–0.964
V (6.87–13.5)			1.0				1.0	

**Continuous variables** and their measuring units in the model: age, 1 yr. **Categoric variables:** arterial hypertension – 1. Yes, 2. No; alcohol consumption – 1. Never-drinker, 2. Ex-drinker, 3. Several times a year, 4. Several times a month, 5. Once a week, 6. Several times a week, 7. Every day; smoking habits – 1. Never-smoker, 2. Ex-smoker, 3. Regular smoker 1–9 cigarettes a day, 4. Regular smoker 10–19 cigarettes a day, 5. Regular smoker 20 cigarettes or more a day. HR – hazard ratio; CI – confidence interval; “–“ – no death cases in this category.

Table 2. Suicide mortality among 25–64 aged men during the period 1971–2000: deviances and Chi-square tests of significance of period and cohort

Factors in the model	Deviance	Degrees of freedom	Chi-square test for effect (df)
Age + cohort	33.82	28	
Age + period	32.35	35	
Age + period + cohort	23.02	24	14.20 (5)* (period adjusted for age and cohort) 9.33 (11)# (cohort adjusted by age and period)

\*  $p = 0.014$ ; #  $p = 0.59$ .

seeking, low self-discipline and deliberation which pointed accident-prone persons (10). Controversial data are reported in follow-up studies and clinical trials on the association between total cholesterol concentration and the risk of death from accidents, and especially the risk of suicide. Follow-up studies found that persons with lower cholesterol levels have a tiny but significantly increased risk of committing suicide (11). The results of our study confirm the

negative association between total cholesterol concentration and the risk of death from accidents and injuries. Among several explanations as regards low cholesterol concentration, it could be linked to a high risk of violent death and suicide. The most frequently reported explanation is that low or declining serum cholesterol concentrations might alter the metabolism of serotonin, leading to depression and thus increasing the risk of suicide. A reduction in serum cholesterol may decrease brain-cell-membrane cholesterol, as well as lower the lipid microviscosity and decrease the exposure of protein serotonin receptors on the membrane surface, resulting in a poorer uptake of serotonin by brain cells. It

might trigger suicide or violence in susceptible individuals (12). Low mood appears to be associated with a low cholesterol concentration and is associated with an increased risk of suicide (13). Low serum cholesterol seems to be a peripheral marker among persons with personality disorder, violent and suicidal behavior.

It is well known that age, education, occupation and some other socioeconomic factors have a strong association with the risk of death from external causes. The cohort studies have shown that married persons exhibited a lower suicide rate than single, never married people, and that divorced, separated and widowed persons have the highest rates (6). Our study showed that the relative risk of death from external cause, from injuries and accidents, and the risk of suicide death was significantly higher among divorced and widowed middle-aged men as compared to married men.

A lot of large follow-up cohort studies have demonstrated a negative association between educational level and the risk of mortality from external causes, including mortality from accidents, injuries, and suicide (6, 12). Our findings confirmed the negative association between the education and the risk of death from external causes.

The results of this study revealed time-trends in mortality from external causes in 1971–2000 among Kaunas men aged 25–64 years. Data of mortality trends were analyzed using mortality statistics of ICD-9 and of ICD-10. It is known that it is difficult to assess the number of under-reported suicides, as it masked by other diagnoses such as accidents or undetermined causes of death. Most studies focused on causes of death requiring special attention for comparability (suicide, accidental deaths, unknown causes) so as to improve the homogeneity of certifiers training on the effect of the transition to ICD-10 (14). On the other hand, reliability analysis of the statistics of suicide in the republics of the former Soviet Union during the period 1970–1990 showed that suicide mortality statistics were reliable in the Baltic republics (15). From 1970 to 1985, mortality from all external causes decreased and a tendency to an increase was noted in 2000. Decreased suicide rates occurred in 1986–90 and then considerably increased in 1991–95, which can be interpreted as period effects. In 1986–90 were recorded the lowest suicide rates through the whole study period, especially among men aged 25–29 years. This period is called “perestroika” and was characterized by a restrictive policy with regard to alcohol consumption. Dramatic temporary improvements in mortality rates were also seen in Poland and in republics of the former Soviet Union (16). In Poland, mortality from all external causes among men dropped from 151.11 in 1991 to 131.53 in 1996, whereas mortality from suicide showed no trend. From 1991 to 2000, among Kaunas men mortality rates from suicides significantly increased, whereas mortality rates from injuries and accidents significantly

decreased. In Lithuania, the rising mortality from suicide could be attributed to the remarkable changes in the socioeconomic status, growing unemployment rate, changes in the health care system during the transition and post-transition periods.

## CONCLUSIONS

1. The risk of death from injuries or accidents and death from external causes among men aged 45–59 years showed a positive association between smoking habits and arterial hypertension.
2. Mortality from all external causes and mortality from injuries and accidents was negatively associated with the education level and the total serum cholesterol concentration.
3. During the period 1971 to 2000, among men aged 25–64 years there was no significant increase in mortality from external causes. The lowest mortality rates from suicide in 1986–1990 and a sharp increase in suicide rates in 1991–2000 could be attributed to period-related effects.

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**R. Rėklaitienė, A. Tamodėūnas, R. Radiėauskas,  
K. Jurėnienė**

#### **SOCIODEMOGRAFINIŲ IR KITŲ RIZIKOS VEIKSNIŲ REIKĖMĖ MIRTIMS NUO IĐORINIŲ PRIEĐASĖIŲ**

##### **Santrauka**

Đio darbo tikslas - ėvertinti sociodemografiniŲ, gyvenenos ir rizikos veiksniŲ prognozinė reikėmė nuo iĐoriniŲ prieĐasėiŲ (traumŲ, nelaimingŲ atsitikimŲ ir saviĐudybiŲ), taip pat mirtingumo nuo iĐoriniŲ prieĐasėiŲ

pokyėius 1971-2000 m. Lietuvoje tarp vidutinio amĐiaus vyrŲ priklausomai nuo amĐiaus, gimimo metŲ ir laikotarpio. Điam darbui panaudotos Kauno Roterdamo epidemiologinės studijos (1972-1974 m.) ir Iđeminės ėirdies ligos daugiafaktorinės profilaktikos programos (1977-1980 m.) 45-59 m. vyrŲ atsitiktinės atrankos tyrimo duomenys (n = 6480). Stebėjimo laikas - iki 2001 m. sausio 1d. Per ėį laikotarpį 2841 vyras mirė, iĐ jŲ 230 nuo iĐoriniŲ prieĐasėiŲ. Ąvertinant rizikos veiksniŲ prognozinė reikėmė nuo iĐoriniŲ prieĐasėiŲ buvo panaudotas Cox'o modelis. Mirtingumo rodikliŲ pokyėiŲ kryptys analizuotos logaritminės regresijos metodu. AmĐiaus, gimimo metŲ ir laikotarpio ėtaka buvo ėvertinta Poissono regresijos modeliu. Nustatytas tiesioginis ryĐys tarp mirtingumo nuo iĐoriniŲ prieĐasėiŲ, rŲkymo ėproėio bei arterinės hipertenzijos ir netiesioginis ryĐys tarp iĐsimokslinimo ir bendro cholesterolio koncentracijos. SaviĐudybiŲ rizika buvo tiesiogiai susijusi su ėeimos padėtimi ir veikla. 1971-2000 m. statistiėkai reikėmingŲ mirtingumo pokyėiŲ nuo iĐoriniŲ prieĐasėiŲ nebuvo nustatyta. Ąvertinus amĐiaus, gimimo metŲ ir laikotarpio ėtaką mirtigumui nuo iĐoriniŲ prieĐasėiŲ, patvirtinta statistiėkai reikėminga tik laikotarpio ėtaka.

**RaktaĐodėiai:** sociodemografiniai veiksniai, iĐorinės mirtingumo prieĐastys, pokyėiai, amĐiaus, gimimo metŲ ir laikotarpio ėtaka