Preventable Mortality Caused by the Use of Alcohol in Slovakia – a Regional and Socio-economic Perspective

GAVUROVÁ, B.[1,2], TÓTH, P.[1,2], BARTÁK, M.[3], PETRUŽELKA, B.[3]

1 | Faculty of Economics, Technical University of Košice, Slovak Republic
2 | Research and Innovation Centre Bioinformatics, UVP TECHNICOM, Košice, Slovakia
3 | Department of Addictology, First Faculty of Medicine, Charles University and General University Hospital in Prague, Czech Republic

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BACKGROUND: The purpose of the paper was to identify the impact of socio-economic conditions on the number of deaths caused by alcohol in Slovakia. **METHODS:** We used the dataset of all the deaths in the Slovak Republic from 2001 to 2015 and data about selected socio-economic indicators in Slovak regions. We calculated the potential gain in life expectancy and subsequently estimated a linear panel model. The analysis was performed in the R Software environment. **RESULTS:** The analysis showed that alcohol-related behavioural disorders affect men more than women. The rising trend for both sexes is significant. There are also marked regional differences among Slovak regions, to the detriment of structurally affected regions. On the basis of the estimated model, only the average nominal monthly wage has a statistically significant impact on the potential gain in life expectancy in cases of alcohol behavioural disorders. **CONCLUSIONS:** The results confirm the importance of the social and economic determinants of health and the importance of the study from the regional perspective.

Keywords | **Preventable mortality – Potential gain in life expectancy – Alcohol – Slovakia**

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Corresponding author | Beata Gavurová, Assoc. Prof., PhD., MBA, Faculty of Economics, Technical University of Košice, Němcovej 32, 040 01 Košice, Slovakia **beata.gavurova@tuke.sk**

1 INTRODUCTION

Preventable mortality related to alcohol use disorders is an important aspect of public health and health policy (see Room, Babor, & Rehm, 2005). Most deaths caused by addictive substances are generally related to smoking; however, the number of deaths caused directly by alcohol (in this article without external causes) is also relatively high. From the point of view of public health, these deaths are preventable and, in many cases, also premature (Detels et al., 2015).

Examining preventable mortality in individual diagnoses is a methodologically complex process, which is one of the reasons why these concepts do not appear in many analytical epidemiological studies. Substance dependence is an important risk factor for various diseases, which should be taken into account in addressing preventable mortality. Given the possibility of explicitly defining these diagnoses, we have decided to examine their impact on life expectancy through the potential gains in life expectancy concept (PGLE), which eliminates the causes of death for defined diagnoses. These facts formed a platform for defining the main goal of the paper, which is to examine the impact of selected socio-economic factors on the potential gain in life expectancy when the causes of death associated with the use of alcohol are excluded.

Knowledge of the extent of (preventable) mortality and its regional distribution (e.g. Piontek & Kraus, 2018) is a prerequisite for the development of effective public policies at the regional, national, and international levels. Likewise, this problem presents a challenge for addictological services, both residential and outpatient, for the health and social systems, and the management of the interface between these systems.

In the international context, there are a number of studies that deal with this issue. In summary, the topic is dealt with by Rehm et al. (2006), Martins et al. (2015), and, in a regional context, by Onyeka et al. (2015) and Rehm and Probst (2018), for example. Studies are usually conducted at the national level in relation to a particular addictive substance or in relation to a specific risk group. Alcohol use is one of the most common causes of death among adolescents (see e.g. Johnston et al., 2018; Leal & Jackson, 2018).

A recent article by Imtiaz, Probst, and Rehm (2018) shows that while mortality rates for the major causes in the US are declining, the rate of substance abuse-related deaths is rising. The use of alcohol, certain drugs, and illegal addictive substances plays a major role in the development of life expectancy. Authors who are concerned with this health crisis point out that this phenomenon is disproportionately present in people with a lower socio-economic status.

A study from Canada (Rehm et al., 2007) shows that 40,000 people died in Canada in 2002 as a result of substance abuse, with a considerable number of such deaths (4,258) being attributed to smoking and alcohol consumption. A smaller, but still significant, part of the total (1,695) was associated with the use of illicit drugs. It was also found that addiction can be attributed to the use of addictive substances for 3.8 million nursing days in hospitals, again in connection with the use of tobacco. Specifically for alcohol, see e.g. Rehm et al. (2009).

The situation in Australia is documented by Loxley et al. (2004). From a long-term perspective, the issue of preventable alcohol mortality in Italy was dealt with by Corrao et al. (2002). They found that about 68,000 and 42,000 deaths were attributed to alcohol consumption in 1983 and 1996 respectively, mostly from haemorrhagic stroke, liver cirrhosis, cancer, and injuries. The situation in the Scandinavian countries is described in papers by Westman et al. (2015) and/or Koch et al. (2015). Khaltourina and Korotayev (2008) dealt with the situation in the Russian Federation on the basis of the assumption that a reduction of alcohol-related problems in Russia may have strong effects on the decline in mortality. Ikeda et al. (2012) addressed preventable mortality in Japan and concluded that smoking and alcohol were responsible for a significant part of preventable mortality there.

2 DATA AND METHODOLOGY

Our database consists of three datasets. The mortality dataset in the Slovak Republic is provided by the National Health Information Centre (*Národné centrum zdravotníckych informácií*) of the Slovak Republic. In order to quantify preventable mortality caused by the use of alcohol and illegal drugs, we used a dataset of the population data from the Statistical Office of the Slovak Republic (*Štatistický úrad Slovenskej republiky*). The socio-economic factor dataset comes from Eurostat. We analysed the time period from 2001 to 2015.

The concept of avoidable mortality is an indicator of the health status of the population. It measures the quality and efficiency of the healthcare system and public health. Avoidable mortality provides a specific and comprehensive view of the quality of healthcare. Our research is based on avoidable mortality as defined by the European Commission. According to this study, avoidable mortality consists of two sub-groups: amenable mortality and preventable mortality.

Behavioural disorders resulting from drug use relate to preventable mortality. There are two groups of behavioural disorders (Office for National Statistics, 2012). The first comprises diseases associated with alcohol use, excluding external causes, and the second group consists of disorders associated with the use of illegal drugs. Alcohol use disorders consist of the following diagnoses: F10 – Mental and behavioural disorders due to use of alcohol, G31.2 – Degeneration of nervous system due to alcohol, G62.1 – Alcoholic polyneuropathy, I42.6 – Alcoholic cardiomyopathy, K29.2 – Alcoholic gastritis, K70 – Alcoholic liver disease, K73 – Chronic hepatitis, not elsewhere classified, K74.0 – Hepatic fibrosis, K74.1 – Hepatic sclerosis, K74.2 – Hepatic fibrosis with hepatic sclerosis, K74.6 – Other and unspecified cirrhosis of liver, and K86.0 – Alcohol-induced chronic pancreatitis. Our dataset of the deaths in the Slovak Republic consists only of the codes of three-character categories; we omitted four-character diagnoses. Therefore, in the case of alcohol use disorders, we analysed only the following three diagnoses: F10, K70, and K73. As for the behavioural disorders linked to illegal drug use, they are all three-character diagnoses, so we analysed all of them.

To fulfil the objective of the paper, we estimated a linear panel model with a dependent variable of the potential gain in life expectancy (PGLE) and socio-economic factors as explanatory variables. We analysed the impact of four socio-economic factors: Gross Domestic Product per capita (GDP), the average nominal monthly wage, the unemployment rate, and the level of education in the region, which is given as the percentage of employees with tertiary education.

The PGLE is calculated as the difference between life expectancy with cause i eliminated and life expectancy for all causes. It is given by equation (1), where $PGLE^{-i}$ means the potential gain in life expectancy with the cause of death i eliminated, e_x is the life expectancy for all causes of death, and e_x^{-i} denotes life expectancy with the cause of death i eliminated (Arias et al., 2013).

$$PGLE^{-i} = e_x^{-i} - e_x \quad (1)$$

Life expectancy e_x is derived from abridged life tables for all causes of death for five-year age groups x, x ϵ 0, 1, 5, 10, ..., 90, 95. The group probability of death ${}_nq_x$ for age group x with the length of the age group being n is computed by equation (2), where ${}_na_x$ represents the distribution of deaths, which is set at ${}_na_x$ = 2.5, on the basis of the assumption of random distribution of deaths in the age group (Jones et al., 2007). The variable ${}_nm_x$ is the observed death rate given as ${}_nm_x = {}_nD_x / {}_nK_x$, where ${}_nD_x$ is the number of deaths and ${}_nK_x$ is the mid-year population size.

$${}_nq_x = \frac{n.{}_nm_x}{1+{}_nm_x\left(n-{}_na_x\right)} \quad (2)$$

Using the group probability of death ${}_nq_x$ in equation (3), the number of survivors l_x is calculated. The number of survivors l_x expresses the number of persons who survive the beginning of the next age interval. The original population l0 is set as l0 = 100,000 (Greville, 1977). Then the proportion of deaths in the age group (${}_nd_x$) is computed with equation (4).

$$l_{x+n} = l_x.\left(1-{}_nq_x\right) \quad (3)$$

$${}_nd_x = l_x - l_{x+n} \quad (3)$$

In the next step, we calculate the total time in years lived between two indicated birthdays, called person-years lived ${}_nL_x$, explained by equation (4).

$${}_nL_x = \left(l_x + l_{x+n}\right)/2 \quad (4)$$

The sum of all the person-years lived ${}_nL_x$ represents the person-years of remaining life T_x, mathematically expressed by equation (5).

$$T_x = L_x + L_{x+1} + \ldots + L_{95} \quad (5)$$

Finally, on the basis of equation (6) the life expectancy e_x is calculated as the ratio of the person-years of remaining life T_x and the number of survivors l_x.

$$e_x = T_x / l_x \quad (6)$$

To calculate the life expectancy with the cause of death eliminated i, we need to build abridged life tables by eliminating the cause of death i. The process is similar to that in the case of the abridged life table for all causes of death, with several exceptions. The probability of death for the age group x with the length of the age group n with the cause of death eliminated i (${}_nq_x^{-i}$) is given by equation (7) (Tsai et al., 1978).

$${}_nq_x^{-i} = 1-{}_np_x^{\frac{{}_nD_x-{}_nD_x^i}{{}_nD_x}} \quad (7)$$

Other exceptions are presented in equations (8), (9), and (10).

$${}_nL_{95}^{-i} = l_{95}^{-i} + l_{95}^{-i}.q_{95}^{-i}/2 \quad (8)$$

$${}_nT_{95}^{-i} = \alpha.{}_nL_{95}^{-i} \quad (9)$$

$$\alpha = \frac{e_{95}.{}_nl_{95}}{{}_nL_{95}} \quad (10)$$

The effects of socio-economic factors on the potential gain in life expectancy by eliminating alcohol-related behavioural disorders are estimated using a linear panel model expressed by equation (11), where y_{it} is a dependent variable, α_{it} and β_{it} are regression coefficients, and u_{it} denotes a random disturbance term with a mean of 0. The index i = 1, ..., n marks an individual index, in our case regions in the Slovak Republic and t = 1, ..., T represents the time index (Croissant & Millo, 2008). We did not look into the impact of socio-economic factors on the potential gain in life expectancy through the elimination of disorders associated with the use of illegal drugs because of the lack of deaths caused by these disorders.

$$y_{it} = \alpha_i + \beta_i^T \mathbf{x}_i + u_i \qquad (11)$$

We estimated three linear panel models Model, a Fixed Effects Model, and a Random Effects Model. To decide which model is the most appropriate, we applied tests commonly used in the linear: a Pooling panel model estimation process. The analysis and all the outputs are produced in the R Software environment (R Core Team, 2017).

3 RESULTS AND DISCUSSION

The analysis consists of three parts. In the first part, we provide an overview of the diseases associated with alcohol use in Slovak districts. Second, we analyse the impact of these disorders on the expected life length in Slovak regions. The third part addresses the effects of socio-economic factors on the PGLE by complete elimination of the diseases associated with alcohol use.

3.1 Situation in Slovak districts

The development of deaths caused by diseases associated with alcohol use shows a growing trend for both sexes. In 2001, more than 20 men in 100,000 died of diseases connected with alcohol use. The number of men who died had increased to more than 28 in 2015. The numbers of women who died were significantly lower. In 2001, there were only about five women in 100,000 who died of diseases associated with alcohol use. This figure grew to almost eight in 2007. Then it dropped slightly, to less than six in 2013. In 2015 it rose again, to eight women in 100,000. The development of the number of deaths caused by the diseases associated with alcohol use is shown in *Figure 1.*

The regional distribution of deaths caused by the disorders associated with alcohol use among men in 2001 is depicted

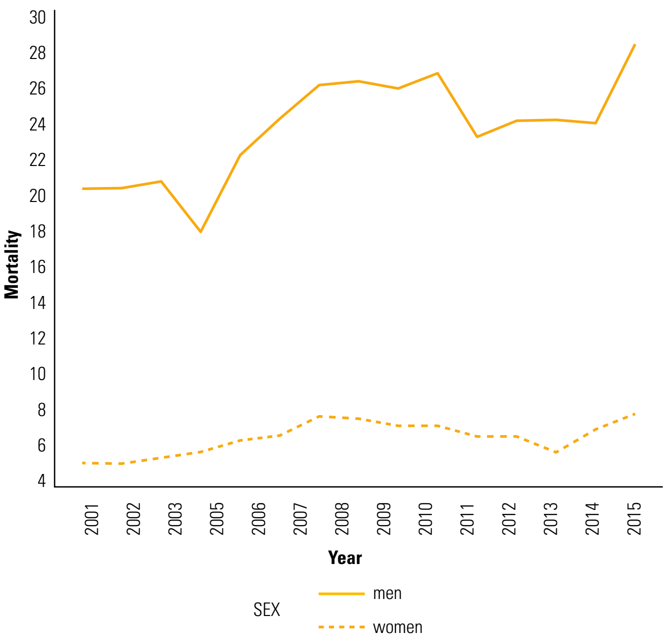

Figure 1 | The number of deaths caused by alcohol use disorders

in *Figure 2*. The area that was most affected was the southern part of the Slovak Republic. There are three regions with a standardised death rate of over 50. The lowest number of deaths caused by alcohol use disorders was in the central and southeastern parts of the Slovak Republic. In these regions, the standardised mortality rate was below ten in 2001.

In 2015, the standardised mortality rate increased in almost all districts. The highest figure was recorded in the Myjava district in the western part of the Slovak Republic, followed by other districts situated mainly in the southern part. The lowest standardised mortality rate was in districts in the north, in what is called the Orava region. The 2015 situation for men is presented in *Figure 3*.

The highest number of women who died of diseases caused by alcohol use disorders was reported in the Cadca district, in the northern part of the country, in 2001. It was almost 25 women in 100,000. The second highest mortality was in the Detva district in the central part, followed by the Stara Lubovna district in the northeastern part of the Slovak Republic. In nearly half of all the districts, the standardised mortality rate was close to zero. These regions are mainly situated in the eastern and northern parts of the country. This is shown in *Figure 4*.

The standardised mortality rate caused by diseases associated with alcohol use has grown for women, too. It is visible in *Figure* 5, where the number of districts with a standardised mortality rate close to zero decreased in 2015. In the same year, the highest mortality rate was in the Puchov district in the north. Three groups of districts with high levels of the standardised mortality rate caused by alcohol use disorders can be identified. The first group consists of districts in the northern part of the Slovak Republic, while the second comprises districts in the southwest. The last group involves districts in what is known as the Gemer region in the east of the central part of the country. A high mortality rate is also observed in the Trebisov district in the southeast.

3.2 Life expectancy

There are also major disparities among the regions in the Slovak Republic as regards life expectancy. Life expectancy with the complete elimination of alcohol use disorders in the more developed regions in the western part is higher than in the less developed regions in the east. This applies to all the years under study – see *Table 1*. A positive aspect of the analysis is that life expectancy with the complete elimination of alcohol use disorders increased during the study period.

The growth of life expectancy with the complete elimination of alcohol use disorders may result from two facts. The first fact is an increasing life expectancy for all causes of death which is the consequence of a healthier lifestyle, better healthcare, etc. The second effect may be an increasing number of deaths caused by the disorders associated with alcohol use, the elimination of which leads to an increase in

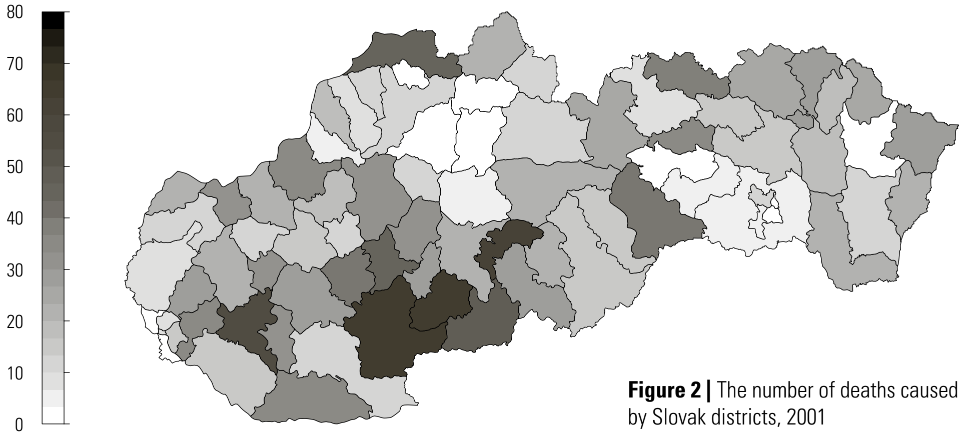

Figure 2 | The number of deaths caused by alcohol use disorders in men, by Slovak districts, 2001

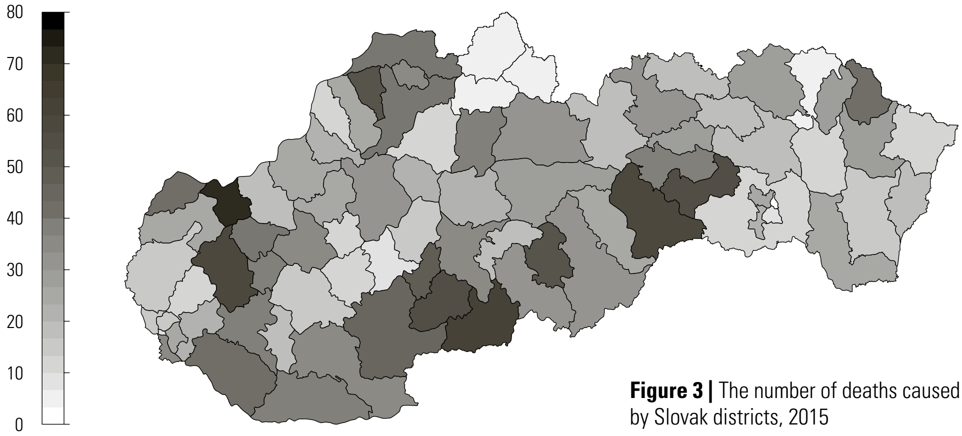

Figure 3 | The number of deaths caused by alcohol use disorders in men, by Slovak districts, 2015

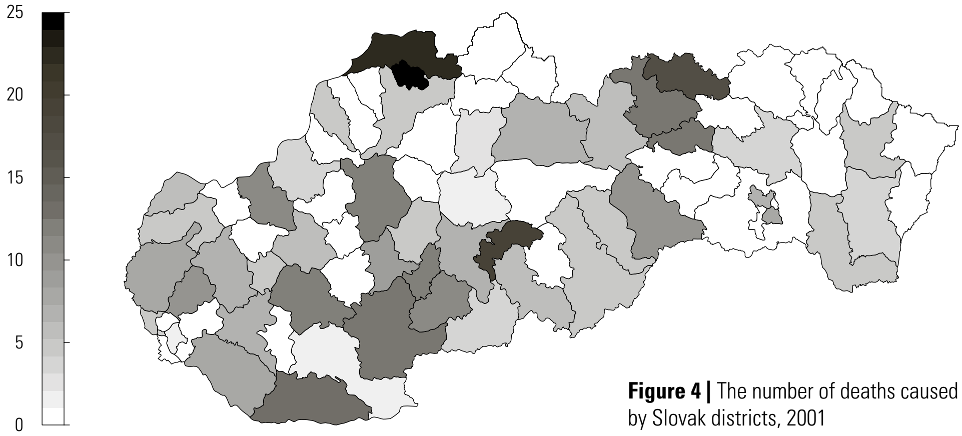

Figure 4 | The number of deaths caused by alcohol use disorders in women, by Slovak districts, 2001

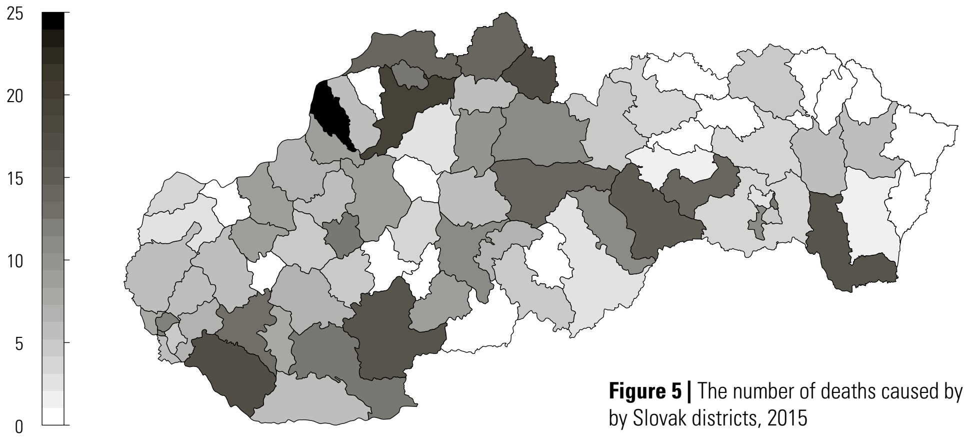

Figure 5 | The number of deaths caused by alcohol use disorders in women, by Slovak districts, 2015

Year	Regions							
	ba	tt	tn	nr	za	bb	po	ke
2001	75.193	73.811	75.043	73.442	73.804	72.825	73.968	72.977
2002	75.547	73.743	74.979	73.853	73.971	73.167	74.321	72.965
2003	75.633	74.099	74.711	73.758	74.215	73.260	74.267	72.885
2004	75.768	74.260	75.532	74.378	74.439	73.555	74.702	73.252
2005	75.764	74.779	75.089	74.140	74.256	73.545	74.557	73.579
2006	76.167	74.719	75.744	74.236	74.586	73.906	74.846	73.695
2007	76.824	74.898	75.477	74.435	74.568	73.956	74.795	73.857
2008	77.055	75.441	75.972	74.562	74.594	74.585	75.190	74.305
2009	77.227	75.728	76.068	75.061	75.119	74.777	75.776	74.483
2010	77.262	75.937	76.669	75.453	75.663	74.892	75.784	74.704
2011	77.866	76.245	77.192	75.638	76.160	75.701	76.457	75.191
2012	78.065	76.758	77.367	75.722	76.273	75.688	76.575	75.528
2013	78.178	76.747	77.869	76.428	76.514	76.241	76.759	75.777
2014	78.714	77.035	78.078	76.226	77.165	76.737	77.136	76.326
2015	78.573	77.027	78.202	76.316	76.835	76.225	76.507	76.319

Table 1 | Life expectancy (in years) at birth (age 0) with the complete elimination of alcohol use disorders, by Slovak regions
Note: ba – Bratislava region, tt – Trnava region, tn – Trenčín region, nr – Nitra region, bb – Banská Bystrica region, po – Prešov region, ke – Košice region

Year	Regions							
	ba	tt	tn	nr	za	bb	po	ke
2001	0.093	0.193	0.202	0.234	0.139	0.233	0.177	0.108
2002	0.087	0.175	0.193	0.312	0.124	0.177	0.157	0.123
2003	0.152	0.180	0.146	0.222	0.162	0.233	0.154	0.120
2004	0.176	0.159	0.133	0.217	0.145	0.178	0.124	0.147
2005	0.224	0.218	0.187	0.211	0.150	0.222	0.154	0.130
2006	0.247	0.272	0.198	0.260	0.149	0.190	0.160	0.191
2007	0.267	0.222	0.229	0.277	0.223	0.263	0.189	0.220
2008	0.254	0.262	0.212	0.262	0.273	0.272	0.179	0.233
2009	0.265	0.270	0.216	0.318	0.252	0.230	0.157	0.186
2010	0.294	0.263	0.188	0.236	0.264	0.241	0.187	0.239
2011	0.215	0.304	0.245	0.235	0.235	0.198	0.137	0.230
2012	0.276	0.272	0.197	0.238	0.229	0.260	0.194	0.185
2013	0.192	0.261	0.199	0.219	0.279	0.227	0.178	0.245
2014	0.180	0.259	0.202	0.219	0.343	0.273	0.218	0.244
2015	0.211	0.389	0.273	0.283	0.327	0.274	0.192	0.265

Table 2 | Potential gain in life expectancy (in years) at birth (age 0) with the complete elimination of alcohol use disorders, by Slovak regions
Note: ba – Bratislava region, tt – Trnava region, tn – Trenčín region, nr – Nitra region, bb – Banská Bystrica region, po – Prešov region, ke – Košice region

life expectancy with the complete elimination of alcohol use disorders. This can be measured by the PGLE as shown in *Table 2*. It is obvious that the PGLE with the complete elimination of alcohol use disorders grew in all the regions during the time period under consideration. It means that all the regions are burdened by alcohol use disorders to a greater degree than in the past. In 2015, the most affected regions were the Trnava region, the Zilina region, and the Nitra region. These regions belong among the more developed regions in the Slovak Republic. The lowest PGLE was in 2015 in the Presov region, which is one of the least developed regions. On the other hand, the second lowest PGLE was in the Bratislava region, which is the most developed one. It is necessary to add that there are several national health institutions in Bratislava, which implies better availability of specialised healthcare for people who live there.

	Fixed Effects Model (1)		Random Effects Model (2)		Pooling Model (3)	
	Estimate		Estimate		Estimate	
Intercept	-		-10.22742	***	-10.64882	***
Log(GDP)	0.07792		0.08248		0.13411	
Log(WAGE)	0.74102	*	1.01634	***	0.97894	***
Log(UNEM)	-0.10942		0.05288		0.08280	
Log(EDU)	-0.31559		-0.62436	***	-0.65754	***
R-Squared	0.43672		0.41011		0.39543	

Table 3 | Estimated coefficients of linear panel models for alcohol-related diseases
Note: ***, **, and * denote significance levels of 1, 5, and 10 per cent respectively. GDP denotes gross domestic product per capita, WAGE is the average wage, UNEM represents the unemployment rate, and EDU is the percentage of employees with tertiary education. The Poolability test for individual cross-sectional effects showed that all coefficients, excluding intercepts, are not equal for individual effects (F = 3.152***) or for time effects (F = 2.639***). On the basis of the F test, both individual effects (F = 6.998***) and time effects (F = 2.233**) are statistically significant. The Pesaran CD test confirmed that our model is not affected by the cross-sectional dependence (Z = 1.0116). Wooldridge's test for unobserved individual effects did not indicate any existence of serial correlation (Z = 1.581). In compliance with the Hausman test, the fixed effects model (1) should be preferred (Chi-squared = 5.175).

3.3 Impact of socio-economic conditions

We estimated a linear panel model to quantify the impact of socio-economic conditions on the PGLE with the complete elimination of alcohol use disorders. We analysed the effects of four socio-economic factors: GDP per capita, the average nominal monthly wage, the unemployment rate, and the level of education measured by the share of employees with tertiary education.

We built three models: (1) a Fixed Effects Model, (2) a Random Effects Model, and (3) a Pooling Model. The tests that were performed suggest that the Fixed Effects Model (1) is the most appropriate one. In that model, only the average nominal monthly wage is statistically significant. The estimated coefficient is positive, which means that an increase in the average nominal monthly wage in the region leads to an increase in the PGLE with the complete elimination of alcohol use disorders. The impact of other socio-economic factors is not statistically significant. (*Table 3.*)

4 CONCLUSION

As shown by both our study and several international studies, preventing alcohol-related mortality is an important public health issue. The main aim of this paper was to analyse the impact of socio-economic conditions on the potential gain in life expectancy in the event of the complete elimination of disorders associated with alcohol. We also conducted an analysis of regional disparities.

The analysis of regional differences provides us with much valuable information and unfortunately confirms the concentration of health problems in regions that can be described as structurally disadvantaged. The diagnosis examines their social gradient, whereby an increase in the average nominal wages in the region leads to an increase in the PGLE by eliminating alcohol use disorders, which in turn promotes health inequalities between population groups and regions. In 2001, the lowest PGLE was 0.093, in the Bratislava region. The highest PGLE was in the Nitra region. The situation changed in 2015, when the Prešov region was the region with the lowest PGLE. The highest PGLE was 0.389, in the Trnava region.

This confirms the importance of the study of the social and economic determinants of health and the importance of the study from the regional perspective. Therefore, solving these problems cannot be viewed only from a national perspective or from the view of international policy documents. Emphasis must be given to the regional as well as socio-economic conditions.

Authors' contribution: BG and PT designed the study. PT performed the statistical analysis and, together with BG, MB, and BP, participated in the interpretation of the data and the preparation of the manuscript. BG drew up the initial version of the manuscript. MB and BP conducted the literature review and summarised related work. BG also supervised the statistical analysis. All the authors contributed to the article and approved the final version of the manuscript.

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REFERENCES

Arias, E., Heron, M., & Tejada-Vera, B. (2013). United States life tables eliminating certain causes of death, 1999-2001. *National vital statistics reports: from the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System*, 61(9), 1-128.

Corrao, G., Rubbiati, L., Zambon, A., & Aricò, S. (2002). Alcohol attributable and alcohol preventable mortality in Italy: a balance in 1983 and 1996. *The European Journal of Public Health*, 12(3), 214-223.

Croissant, Y., & Millo G. (2008). Panel data econometrics in R: The plm package. *Journal of Statistical Software*, 27(2), 1-43.

Detels, R., Gulliford, M., Karim, Q. A., & Tan, C., C. (Eds.). (2015). *Oxford Textbook of Global Public Health, 6th edition.* Oxford: Oxford University Press.

Greville, T. N. E. (1977). *Short Methods of Constructing Abridged Life Tables. Mathematical Demography.* Berlin, Heidelberg: Springer, 53-60.

Ikeda, N., Inoue, M., Iso, H., Ikeda, S., Satoh, T., Noda, M., ... & Sobue, T. (2012). Adult mortality attributable to preventable risk factors for non-communicable diseases and injuries in Japan: a comparative risk assessment. *PLoS Medicine*, 9(1), e1001160.

Imtiaz, S., Probst, C., & Rehm, J. (2018). Substance use and population life expectancy in the USA: Interactions with health inequalities and implications for policy. *Drug and Alcohol Review*, 37, S263-S267.

Johnston, L. D., Miech, R. A., O'Malley, P. M., Bachman, J. G., Schulenberg, J. E., & Patrick, M. E. (2018). *Monitoring the Future national survey results on drug use, 1975-2017: Overview, key findings on adolescent drug use.* Available from: https://deepblue.lib.umich.edu/bitstream/handle/2027.42/142406/Overview%202017%20FINAL.pdf?sequence=1&isAllowed=y

Jones, J. H., et al. (2007). demogR: A Package for the Construction and Analysis of Age-structured Demographic Models in R. *Journal of Statistical Software*, 22(10), 1-28.

Khaltourina, D. A., & Korotayev, A. V. (2008). Potential for alcohol policy to decrease the mortality crisis in Russia. *Evaluation & the Health Professions*, 31(3), 272-281.

Koch, M. B., Diderichsen, F., Grønbæk, M., & Juel, K. (2015). What is the association of smoking and alcohol use with the increase in social inequality in mortality in Denmark? A nationwide register-based study. *BMJ open*, 5(5), e006588.

Leal, W. E., & Jackson, D. B. (2018). Energy drinks and escalation in drug use severity: An emergent hazard to adolescent health. *Preventive Medicine*, 111, 391-396.

Loxley, W., Toumbourou, J., Stockwell, T., Haines, B., Scott, K., Godfrey, C., ... & Marshall, J. (2004). *The prevention of substance use, risk and harm in Australia: a review of the evidence.* Commonwealth of Australia.

Martins, S. S., Sampson, L., Cerdá, M., & Galea, S. (2015). Worldwide prevalence and trends in unintentional drug overdose: a systematic review of the literature. *American Journal of Public Health,* 105(11), e29-e49.

Office for National Statistics (2012). Definition of avoidable mortality. Available from https://www.ons.gov.uk/ons/about-ons/consultations/closed-consultations/2011/definitions-of-avoidable-mortality/definition-of-avoidable-mortality.pdf. [cited 27. 4. 2018]

Onyeka, I. N., Beynon, C. M., Vohlonen, I., Tiihonen, J., Föhr, J., Ronkainen, K., & Kauhanen, J. (2015). Potential years of life lost due to premature mortality among treatment-seeking illicit drug users in Finland. *Journal of Community Health*, 40(6), 1099-1106.

Piontek, D., & Kraus, L. (2018). Trends in alcohol related mortality in East and West Germany, 1980-2014: age, period and cohort variations. *Addiction,* 113(5), 836-844.

Rehm, J., Taylor, B., & Room, R. (2006). Global burden of disease from alcohol, illicit drugs and tobacco, *Drug and Alcohol Review,* 25:6, 503-513.

Rehm, J., Gnam, W., Popova, S., Baliunas, D., Brochu, S., Fischer, B., ... & Taylor, B. (2007). The costs of alcohol, illegal drugs, and tobacco in Canada, 2002. *Journal of Studies on Alcohol and Drugs*, 68(6), 886-895.

Rehm, J., Mathers, C., Popova, S., Thavorncharoensap, M., Teerawattananon, Y., & Patra, J. (2009). Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *The Lancet*, 373(9682), 2223-2233.

Rehm, J., & Probst, C. (2018). What about drinking is associated with shorter life in poorer people? *PLoS Medicine*, 15(1), e1002477.

R Core Team. (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Room, R., Babor, T., & Rehm, J. (2005). Alcohol and public health. The Lancet, 365(9458), 519-530.

Tsai, S. P., Lee, E. S., & Hardy, R. J. (1978). The effect of a reduction in leading causes of death: potential gains in life expectancy. *American Journal of Public Health*, 68(10), 966-971.

Westman, J., Wahlbeck, K., Laursen, T. M., Gissler, M., Nordentoft, M., Hällgren, J., ... & Ösby, U. (2015). Mortality and life expectancy of people with alcohol use disorder in Denmark, Finland and Sweden. *Acta Psychiatrica Scandinavica*, 131(4), 297-306.