SIMILARITY OF SLOVAK REGIONS IN NEOPLASTIC MORTALITY IN THE CONTEXT OF RISK FACTORS AND ACCESS TO HEALTH CARE

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SUMMARY

Aim: Access to primary health care is highly connected to the prevention of cancer mortality, since the risk factors threatening health can be early identified. The aim of this paper is, firstly, to explore similarity within and between the regions of the Slovak Republic and cancer mortality patterns, and secondly, to reveal if similar regions are characterised by the similar access to health care or risk factors occurrence.

Methods: Data on deaths by sex, type of cancer death and region from 1996 to 2014 is provided by the National Health Information Centre of Slovakia. The relationships between 8 regions and 16 cancer types are described by correspondence analysis for both sexes.

Results: The most similar cancer mortality patterns among Slovak regions are between the Nitra and Trnava regions for both sexes, and the Košice region for males. The Prešov region is showed as an outlier from other regions for females, likely due to the highest concentration of Roma marginalised communities. As for access to health care, the Trnava region as well as Nitra region report the lowest densities of physicians, 2.4 and 2.6 per 1,000 inhabitants, respectively. The most serious cancer types mortality is attributed to the digestive organs (C15-C26) in each Slovak region for both sexes with the average proportion of 35.56%. Observed high association between the Nitra region and respiratory cancer (C30-C39) in males may be confirmed by the increased incidence of radon in this region. Similarly, a tight relationship between the Bratislava region and cancer of male genital organs (C60-C63) can relate to the highest proportion of drug users in the Bratislava region.

Conclusions: Based on the findings of similar regions in cancer mortality patterns, we recommend to set the same prevention programs in the Trnava and Nitra regions, on the other hand, different preventive interventions should be introduced in the Prešov region.

Key words: cancer types mortality, correspondence analysis, Slovak regions

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INTRODUCTION

Due to different types of geographic locations in the Slovak Republic or unequal medical decisions based on socio-economic characteristics of patients, it may grow disparities in the delivery of health care services. Subsequently, these are reflected in the diverse morbidity and mortality patterns from various diseases across countries or even within small-areas. The aim of any health policy should be to increase access to health care in terms of geographic distribution of health care services focusing on primary prevention of chronic diseases, such as cancer that causes the second largest amounts of deaths worldwide and also in the Slovak Republic (1–4).

Geographic Distribution of Primary Health Care

Geographic distribution of primary health care reflects the number of physicians per 1,000 inhabitants according to the classification of territorial units NUTS II or NUTS III and the density of physicians in urban or rural areas. Based on NUTS III classification, Slovakia is divided into the 8 regions with the number of inhabitants considering status in middle period 2004 from time interval 1996 to 2014: Bratislava region (600,277), Trnava region (552,624), Trenčín region (601,722), Banská Bystrica region (658,753), Košice region (770,112), Nitra region (709,414), Prešov region (795,848), Žilina region (693,824). The density of physicians is conveniently greater in urban regions (6.7 per 1,000 inhabitants) compared to rural regions (2.6 per 1,000 inhabitants) in the Slovak Republic. Differences in the number of general practitioners according to NUTS II are as follows: Bratislava region (6.6 per 1,000 inhabitants), Western Slovakia (2.5), Central Slovakia (2.9) and Eastern Slovakia (3.3) (5). Under the Slovak Government Regulation No.640/2008 Coll., the minimum network of healthcare providers in each individual medical field was defined in order to meet the demand for health care services (6).

WHO survey (7) notes, there were not reported significant regional differences in the provision of primary health care by

general practitioners in Slovakia, however, recognises significant differences between the various districts of the region. For example, analysis of the situation in Banská Bystrica region revealed large differences in the number of patients pertaining to one practitioner, what may indicate a relative lack of practitioners in some areas. The density of doctors per 1,000 inhabitants in individual regions of Slovakia (NUTS III) is as follows: Bratislava (6.6), Trnava (2.4), Trenčín (2.5), Nitra (2.6), Žilina (3.2), Banská Bystrica (2.6), Prešov (2.7), Košice (3.9) (8). Consequently, Bratislava region has an average of 1.7 to 2.8 times larger number of doctors than other regions of Slovakia. However, only well educated and motivated physicians caution their patients to be careful about risk factors that significantly affect cancer mortality.

Cancer Mortality and Risk Factors

Although significant advances have been made in the fight against cancer, it remains a key public health item after cardiovascular diseases and a considerable burden on societies across the European countries (9). In 2012, more than one and a quarter million residents of the EU-28 died from cancer, just 26% of all deaths. In Slovakia, the share of deaths from cancer in the total number of deaths reached 24.6%: among men this share was around 27.3%, while among women it was 21.9%. In Slovakia, the average standardised mortality of cancer rates for men (472 per 100,000 European standard population) is around twice higher than for women (229 per 100,000 European standard population) during the past two decades (10).

Many factors determine cancer mortality patterns, mostly - uncontrollable ones, such as genetics, age and sex, as well as controllable ones, such as social, economic, environmental factors, lifestyle, smoking, obesity, alcohol consumption may also play an important role (11).

Unfortunately, data on the majority of cancer risk factors is not available at the regional level in Slovakia, such as alcohol consumption, smoking, fruit and vegetable consumption. However, there are some determinants that can be specified for the Slovak regions.

The evidence shows that drugs, such as methamphetamine, heroin, cannabis, contain hundreds of harmful chemicals that cause many types of cancer, mostly of the lungs, head, neck, and respiratory tract (12–14). Cannabis use increases the risk of testicular cancer, especially in younger people (15). In 2014, the highest proportion of patients undergoing treatment of drug abuse by permanent address was in Bratislava (115.3 per 100,000 inhabitants) and Trnava (69.3) regions and the lowest in Prešov region (10.9). Trenčín, Nitra and Žilina regions reported an average of 42.2 abused people per 100,000 inhabitants, Košice and Banská Bystrica showed 31 on average (16). It is seemed that rate of drug users has been increasing from Eastern Slovakia to Western Slovakia.

Similarly, the increased risk of death from cancer is raising from environmental factors. One of the main risk factors relating to the environment is radon, as a natural radioactive gas, which gets into the respiratory system by breathing and causes tissue damage, with consequent formation of lung cancer (17–20). The rate of radon risk in individual regions of Slovakia is determined by their geological structures, as well as the presence of uranium deposit in their territory. Slovak territories with low and high radon risk were specified in the Ministry of Health Decree no. 406/1992 Coll. on requirements for limiting exposure to radon and other natural radionuclides (21). Areas with medium or high risk of radon levels include the following districts and their corresponding regions: Šaľa district, Topolčany, Zlaté Moravce (Nitra region); Bánovce nad Bebravou district and Púchov (Trenčín region); Bytča district (Žilina region), Pezinok district (Bratislava region). Košice region and Prešov region are assigned among the areas with a higher occurrence of uranium.

Age is one of the out of controlled variables influencing mortality. Since 1996, a sharp increase in an average percentage share of cancer deaths has been observed in people aged from 30 to 74 in each Slovak region. After age 75, shares continually have fallen (16). There are not significant age differences in cancer mortality across regions. On the other hand, the ageing index, expressed as the ratio of post-productive population (65+ age group) and pre-productive age population (0–14 age group) multiplied by 100, supposes a higher mortality at older ages in these three regions: Trenčín region (115.3), Nitra region (113.94), Trnava (103.18) (16). It should be keep in mind, that ageing index consider all cause mortality, not only cancer mortality.

The aim of this study is to reveal similarity between regions of the Slovak Republic and mortality from the specific cancer types, and subsequently to determine similar characteristics pertaining to these regions. It may serve as a base for setting prevention programs aimed at the most common groups of cancer and endangered region.

MATERIALS AND METHODS

Source of data on deaths by sex, type of cancer death and region from 1996 to 2014 is provided by National Health Information Centre in Slovakia. Main analytical method in our paper is correspondence analysis. Its goal is to describe the relationships between two categorical variables in a cross table in a low-dimensional space. For each variable, the distances between category points in a plot reflect the relationships between the categories with similar categories plotted close to each other. Projecting points for one variable on the vector from the origin to a category point for the other variable describe the relationship between the variables. Factor analysis or principal components are standard techniques for describing relationships between variables in a low-dimensional space. However, they require interval data, and the number of observations should be at least five times the number of variables. Correspondence analysis, on the other hand, assumes nominal variables and can describe the relationships between categories of each variable, as well as the relationship between the variables.

Graphical result of correspondence analysis is so called correspondence map that depicts relative positions of rows and columns of cross table. Table rows (in our case – groups of cancer types) which are close together in correspondence map are similar from viewpoint of their proportions in table columns (in our case – Slovak regions). In our case we have got cross-table with 16 rows and 8 columns. The objective of correspondence analysis is to project both rows and columns of cross table to two dimensional plane and preserve as much information as possible about positions of groups of cancer types in original 16 dimensional space of rows

and about positions of Slovak regions in original 8 dimensional space of columns. Quality of correspondence analysis is measured by relative amount of so called "inertia" (similar to explained variance in regression). Statistical software IBM SPSS version 19 was used for the analysis. Our assumption is that age structure was similar in all Slovak regions so it was not necessary to standardize counts. From official population data of Statistical Office of the Slovak Rerpublic it is clear that proportions in corresponding age intervals differ by only one or two percent among regions. It means relative differences among regions are negligible.

RESULTS

The results section is divided according to sex as a one of the basic biosocial characteristics of deceased. If we look at the Table 1 of original counts for females, then it is difficult to make any conclusions about similarity of cancer types according to their counts in Slovak regions. And vice versa, what can be said about similarity of Slovak regions from the viewpoint of cancer types? That is the reason, why correspondence analysis is applied.

Groups of cancer types together with corresponding Slovak regions are depicted in Figure 1 of correspondence map.

First axis explains 37.95% of the inertia of the true proportions, the second one 22.81% (total 60.76%). So we can make some (at least qualitative) statements about original positions of both diagnoses and regions. We can see that diagnosis C97 (Malignant neoplasms with multiple primary outbreaks in various locations) as initial death cause is adjacent. Similarly, other groups of diagnoses are different: C30-C39 (Malignant neoplasms of respiratory and intrathoracic organs), D37-D48 (Neoplasms of uncertain or unknown behaviour), D10-D36 (Benign neoplasms), C40-C41 (Malignant neoplasms of bone and articular cartilage) and C45-C49 (Malignant neoplasms of mesothelial and soft tissue). Their position is far away from the rest of cancer initial causes of death. If we look at the Table 2 of diagnoses row proportions in Slovak regions, we can see why above mentioned diagnoses groups are different.

In last row of Table 2 we can see average row proportions in separate regions. They are the proportions in regions in all cancer types. Extreme values (minimums and maximums) are marked as bold. Overall, the smallest proportion of cancer types is in Trenčín region (10.84%). The largest one is in Nitra region (15.64%).

Let us start with C97 (Malignant neoplasms with multiple primary outbreaks in various locations). It is the only one diagnosis with the largest proportion in Trenčín region (19.31%) and the smallest proportion in Prešov region (6.07%). Group C30-C39 (Malignant neoplasms of respiratory and intrathoracic organs) has got the largest proportion in Košice region (16.47%) and the smallest one in Prešov region (9.28%). Neoplasms of uncertain or unknown behaviour (D37-D48) have got the largest proportion in Žilina region (17.10%) and the smallest one in Banská Bystrica region (7.76%). Last adjacent group is C40-C41 (Malignant neoplasms of bone and articular cartilage). It has got the largest proportion in Prešov region (16.71%). The smallest one is in Trenčín region (8.23%). Last outstanding diagnoses are C45-C49 (Malignant neoplasms of mesothelial and soft tissue). They have got the largest proportion in Košice region (15.14%) while the smallest proportion is in Trnava region (9.19%).

The other diagnoses groups have got extreme proportions in several and the same regions. In Trenčín region with the smallest proportions and Nitra region with the largest proportions there are following diagnoses: C00-C14 (Malignant neoplasms of lip, oral cavity and pharynx), C15-C26 (Malignant neoplasms of digestive organs), C69-C72 (Malignant neoplasms of eye, brain and other parts of central nervous system), C76-C80 (Malignant

Table 1. *Cross table of absolute death counts caused by neoplastic diseases types in Slovak regions, women*

CD	Region								
	Bratislava	Trnava	**Trenčín**	Nitra	**Žilina**	B. Bystrica	Prešov	Košice	Total
C00-C14	147	141	137	239	145	182	143	167	1,301
C15-C26	4,382	3,759	3,668	5,479	3,946	4,054	3,945	4,563	33,796
C30-C39	1,273	871	841	1,250	850	1,185	784	1,391	8,445
C40-C41	42	42	34	59	54	59	69	54	413
C43-C44	246	184	186	285	232	295	219	239	1,886
C45-C49	129	85	107	113	103	114	134	140	925
C50	2,224	1,725	1,640	2,357	1,675	1,842	1,482	1, 885	14,830
C51-C58	1,942	1,626	1,631	2,329	1,702	1,879	1,683	1,989	14,781
C64-C68	584	490	456	529	483	508	491	501	4,042
C69-C72	391	345	342	479	395	391	397	425	3,165
C73-C75	78	59	67	90	86	84	79	74	617
C76-C80	368	268	236	470	329	256	271	247	2,445
C81-C96	894	726	718	949	862	860	856	864	6,729
C97	67	85	140	107	127	62	44	93	725
D10-D36	36	32	22	35	28	23	46	28	250
D37-D48	110	65	77	93	119	54	98	80	696
Total	12,913	10,503	10,302	14,863	11,136	11,848	10,741	12,740	95,046

Table 2. *Row proportions (in %) of death counts caused by neoplastic diseases types in Slovak regions, women*

ICD	Region							
	Bratislava	Trnava	**Trenčín**	Nitra	**Žilina**	B. Bystrica	Prešov	Košice
C00-C14	11.30	10.84	10.53	18.37	11.15	13.99	10.99	12.84
C15-C26	12.97	11.12	10.85	16.21	11.68	12.00	11.67	13.50
C30-C39	15.07	10.31	9.96	14.80	10.07	14.03	9.28	16.47
C40-C41	10.17	10.17	8.23	14.29	13.08	14.29	16.71	13.08
C43-C44	13.04	9.76	9.86	15.11	12.30	15.64	11.61	12.67
C45-C49	13.95	9.19	11.57	12.22	11.14	12.32	14.49	15.14
C50	15.00	11.63	11.06	15.89	11.29	12.42	9.99	12.71
C51-C58	13.14	11.00	11.03	15.76	11.51	12.71	11.39	13.46
C64-C68	14.45	12.12	11.28	13.09	11.95	12.57	12.15	12.39
C69-C72	12.35	10.90	10.81	15.13	12.48	12.35	12.54	13.43
C73-C75	12.64	9.56	10.86	14.59	13.94	13.61	12.80	11.99
C76-C80	15.05	10.96	9.65	19.22	13.46	10.47	11.08	10.10
C81-C96	13.29	10.79	10.67	14.10	12.81	12.78	12.72	12.84
C97	9.24	11.72	19.31	14.76	17.52	8.55	6.07	12.83
D10-D36	14.40	12.80	8.80	14.00	11.20	9.20	18.40	11.20
D37-D48	15.80	9.34	11.06	13.36	17.10	7.76	14.08	11.49
Total	13.59	11.05	10.84	15.64	11.72	12.47	11.30	13.40

neoplasms of ill-defined, secondary and unspecified sites) and C81-C96 (Malignant neoplasms, stated or presumed to be primary, of lymphoid, haematopoietic and related tissue). So they are similar from this viewpoint and that is why they are near together in correspondence map.

If we look for Slovak regions at correspondence map (Fig. 1) we see that Prešov region is far away from other regions. At the Table 3 of column proportions we see that all regions have got the largest proportions in group C15-C26 (Malignant neoplasms of digestive organs). Average total proportion is 35.56%. All other regions have got the smallest proportion in group D10-D36 (Benign neoplasms) with average total proportion equal to 0.26%, except Prešov region. Prešov region is the only one with the smallest proportion in group C97 (Malignant neoplasms of independent (primary) multiple sites). Two most similar regions are Trnava and Nitra and they are closely associated with the cancer mortality from C00-C14 (Malignant neoplasms of lip, oral cavity and pharynx), C15-C26 (Malignant neoplasms of digestive organs), C51-C58 (Malignant neoplasms of female genital organs). Another couple of similar regions is Banská Bystrica and Košice that are a little bit associated with C30-C39 (Malignant neoplasms of respiratory and intrathoracic organs) and C43-C44 (Melanoma and other malignant neoplasms of skin).

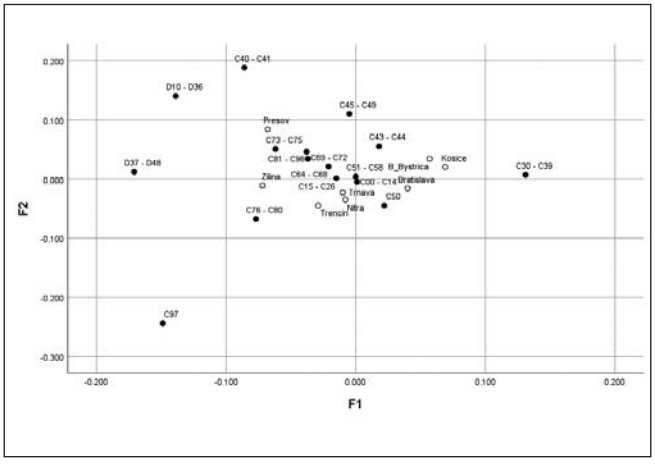

Fig.1. *Correspondence map of female cancer mortality in groups of cancer types in Slovak regions.*

Counts of male death from the individual cancer types are depicts in Table 4. Again, this cross table of counts is not sufficient for analysing similarity of Slovak regions.

Male cancer types together with corresponding Slovak regions are depicted in Figure 2 of correspondence map. First axis explains 41.03% of the inertia of the true proportions, the second one 21.95% (total 62.98%). Again, we can see that cancer types C97 (Malignant neoplasms with multiple primary outbreaks in various locations), C40-C41 (Malignant neoplasms of bone and articular cartilage) and D10-D36 (Benign neoplasms) are adjacent. Contrary to women, C00-C14 (Malignant neoplasms of lip, oral cavity and pharynx) are also outlying.

Let us look at Table 5 of cancer types of death (row) proportions in Slovak regions to see why above mentioned diagnoses groups are different. The largest total proportion is again in Nitra region (15.30%). The smallest proportion is in Bratislava region (11.00%).

As it is in case of women diagnosis C97 (Malignant neoplasms with multiple primary outbreaks in various locations) is the only

Table 3. *Column proportions (in %) of death counts caused by neoplastic diseases types in Slovak regions, women*

ICD	Region								
	Bratislava	Trnava	**Trenčín**	Nitra	**Žilina**	B. Bystrica	Prešov	Košice	Total
C00-C14	1.14	1.34	1.33	1.61	1.30	1.54	1.33	1.31	1.37
C15-C26	33.93	35.79	35.60	36.86	35.43	34.22	36.73	35.82	35.56
C30-C39	9.86	8.29	8.16	8.41	7.63	10.00	7.30	10.92	8.89
C40-C41	0.33	0.40	0.33	0.40	0.48	0.50	0.64	0.42	0.43
C43-C44	1.91	1.75	1.81	1.92	2.08	2.49	2.04	1.88	1.98
C45-C49	1.00	0.81	1.04	0.76	0.92	0.96	1.25	1.10	0.97
C50	17.22	16.42	15.92	15.86	15.04	15.55	13.80	14.80	15.60
C51-C58	15.04	15.48	15.83	15.67	15.28	15.86	15.67	15.61	15.55
C64-C68	4.52	4.67	4.43	3.56	4.34	4.29	4.57	3.93	4.25
C69-C72	3.03	3.28	3.32	3.22	3.55	3.30	3.70	3.34	3.33
C73-C75	0.60	0.56	0.65	0.61	0.77	0.71	0.74	0.58	0.65
C76-C80	2.85	2.55	2.29	3.16	2.95	2.16	2.52	1.94	2.57
C81-C96	6.92	6.91	6.97	6.38	7.74	7.26	7.97	6.78	7.08
C97	0.52	0.81	1.36	0.72	1.14	0.52	0.41	0.73	0.76
D10-D36	0.28	0.30	0.21	0.24	0.25	0.19	0.43	0.22	0.26
D37-D48	0.85	0.62	0.75	0.63	1.07	0.46	0.91	0.63	0.73

Table 4. *Cross table of absolute death counts caused by neoplastic diseases types in Slovak regions, men*

ICD	Region								
	Bratislava	Trnava	**Trenčín**	Nitra	**Žilina**	B. Bystrica	Prešov	Košice	Total
C00-C14	866	1,147	970	1,782	1,310	1,390	1,395	1,474	10,334
C15-C26	5,298	5,286	5,385	7,271	5,549	5,892	5,917	6,185	46,783
C30-C39	3,683	4,336	3,908	5,616	4,575	4,925	4,549	5,097	36,689
C40-C41	36	57	66	89	81	85	75	68	557
C43-C44	287	223	260	294	248	271	244	249	2,076
C45-C49	147	103	122	129	100	103	135	137	976
C50	36	24	19	30	26	27	15	20	197
C60-C63	1,374	1,146	1,219	1,454	1,302	1,390	1,385	1,408	10,678
C64-C68	997	905	953	1,197	1,023	1,157	1,044	1,038	8,314
C69-C72	392	391	384	522	420	383	496	554	3,542
C73-C75	56	48	47	60	57	52	52	52	424
C76-C80	367	319	312	591	374	346	380	307	2,996
C81-C96	872	754	818	1,039	1,050	960	989	1,023	7,505
C97	89	115	193	139	151	63	50	147	947
D10-D36	20	18	17	26	22	23	43	19	188
D37-D48	104	76	87	107	156	58	96	73	757
Total	14,624	14,948	14,760	20,346	16,444	17,125	16,865	17,851	132,963

one with the largest proportion in Trenčín region (20.38%) and the smallest proportion in Prešov region (5.28%). Both diagnoses C00-C14 (Malignant neoplasms of lip, oral cavity and pharynx) and C40-C41 (Malignant neoplasms of bone and articular cartilage) have got the largest proportions in Nitra region (17.24%, resp. 15.98%). The smallest ones are in Bratislava region (8.38%, resp. 6.46%). Last adjacent diagnoses group D10-D36 (Benign neoplasms) has got the largest proportion in Prešov region (22.87%) and the smallest one in Trenčín region (9.04%). C50 (Malignant neoplasm of breast) reports the largest proportion in Bratislava region (18.27%) and the smallest one in Prešov region (7.61%).

Let us look for Slovak regions at Table 6 of column proportions. We see that all regions have got the largest proportions in group C15-C26 (Malignant neoplasms of digestive organs) and the

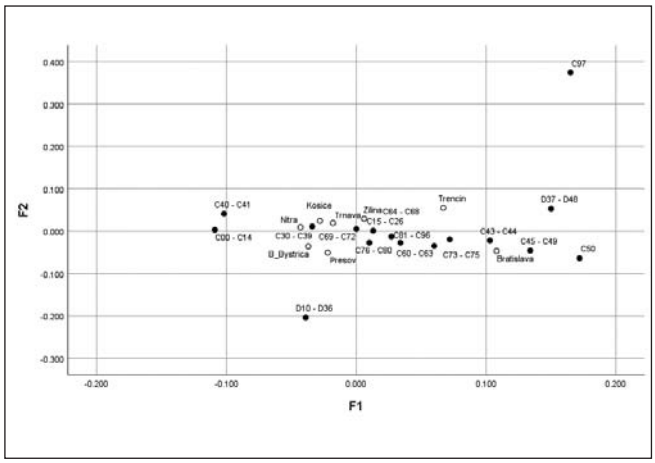

Fig. 2. *Correspondence map of male cancer mortality in groups of cancer types in Slovak regions.*

smallest ones are in case of group D10-D36 (Benign neoplasms) with the exception of Prešov region with the smallest proportion in group C50 (Malignant neoplasm of breast).

The most similar regions are Košice, Nitra and Trnava. These regions are tight associated with C30-C39 (Malignant neoplasms of respiratory and intrathoracic organs). Deaths from C43-C44 (Melanoma and other malignant neoplasms of skin) and C45-C49 (Malignant neoplasms of mesothelial and soft tissue) are situated closest to Bratislava region what indicate higher occurence of these causes of cancer deaths in Bratislava region than in other regions.

DISCUSSION

For both sexes, C97 (Malignant neoplasms of independent primary multiple sites), C40-C41 (Malignant neoplasms of bone and articular cartilage) and D10-D36 (Benign neoplasms) have the most unequal distributions across regions. They represent some extremes whose determinants should be explored in the future, with the aim to reveal reasons why they are outliers. In females, we found that Trenčín region captures the most counts of the smallest proportions of cancer types compared to other regions. Surprisingly, cancer type C97 (Malignant neoplasms of independent primary multiple sites) which is outlier from other types takes the highest proportion (19.31%) just in Trenčín region. For comparison, the lowest proportion of C97 is only 6.07%, namely in Prešov region. Health policy interventions should be focused on this divergence. Principally, why have deaths from C97 the highest proportion in Trenčín region? Moreover, C97 holds the highest proportion in Trenčín region also in males.

Prešov region seems to be outlier compared to other regions for females. It may be caused by high concentration of Roma marginalised communities whose health behaviours differ from the rest population in Slovakia, what ultimately leads to the different mortality patterns (22–25). On the other hand, Bratislava region is an outlier for male cancer deaths.

The most serious cancer types mortality is attributed to the digestive organs in each Slovak region for both sexes. Necessarily, neoplasms of digestive organs have to become a priority in introducing prevention programs in Slovakia.

Table 5. *Row proportions (in %) of death counts caused by neoplastic diseases types in Slovak regions, men*

ICD	Region							
	Bratislava	Trnava	**Trenčín**	Nitra	**Žilina**	B. Bystrica	Prešov	Košice
C00-C14	8.38	11.10	9.39	17.24	12.68	13.45	13.50	14.26
C15-C26	11.32	11.30	11.51	15.54	11.86	12.59	12.65	13.22
C30-C39	10.04	11.82	10.65	15.31	12.47	13.42	12.40	13.89
C40-C41	6.46	10.23	11.85	15.98	14.54	15.26	13.46	12.21
C43-C44	13.82	10.74	12.52	14.16	11.95	13.05	11.75	11.99
C45-C49	15.06	10.55	12.50	13.22	10.25	10.55	13.83	14.04
C50	18.27	12.18	9.64	15.23	13.20	13.71	7.61	10.15
C60-C63	12.87	10.73	11.42	13.62	12.19	13.02	12.97	13.19
C64-C68	11.99	10.89	11.46	14.40	12.30	13.92	12.56	12.48
C69-C72	11.07	11.04	10.84	14.74	11.86	10.81	14.00	15.64
C73-C75	13.21	11.32	11.08	14.15	13.44	12.26	12.26	12.26
C76-C80	12.25	10.65	10.41	19.73	12.48	11.55	12.68	10.25
C81-C96	11.62	10.05	10.90	13.84	13.99	12.79	13.18	13.63
C97	9.40	12.14	20.38	14.68	15.95	6.65	5.28	15.52
D10-D36	10.64	9.57	9.04	13.83	11.70	12.23	22.87	10.11
D37-D48	13.74	10.04	11.49	14.13	20.61	7.66	12.68	9.64
Total	11.00	11.24	11.10	15.30	12.37	12.88	12.68	13.43

Table 6. *Column proportions (in %) of death counts caused by neoplastic diseases types in Slovak regions, men*

CD	Region								
	Bratislava	Trnava	**Trenčín**	Nitra	**Žilina**	B. Bystrica	Prešov	Košice	Total
C00-C14	5.92	7.67	6.57	8.76	7.97	8.12	8.27	8.26	7.77
C15-C26	36.23	35.36	36.48	35.74	33.74	34.41	35.08	34.65	35.18
C30-C39	25.18	29.01	26.48	27.60	27.82	28.76	26.97	28.55	27.59
C40-C41	0.25	0.38	0.45	0.44	0.49	0.50	0.44	0.38	0.42
C43-C44	1.96	1.49	1.76	1.45	1.51	1.58	1.45	1.39	1.56
C45-C49	1.01	0.69	0.83	0.63	0.61	0.60	0.80	0.77	0.73
C50	0.25	0.16	0.13	0.15	0.16	0.16	0.09	0.11	0.15
C60-C63	9.40	7.67	8.26	7.15	7.92	8.12	8.21	7.89	8.03
C64-C68	6.82	6.05	6.46	5.88	6.22	6.76	6.19	5.81	6.25
C69-C72	2.68	2.62	2.60	2.57	2.55	2.24	2.94	3.10	2.66
C73-C75	0.38	0.32	0.32	0.29	0.35	0.30	0.31	0.29	0.32
C76-C80	2.51	2.13	2.11	2.90	2.27	2.02	2.25	1.72	2.25
C81-C96	5.96	5.04	5.54	5.11	6.39	5.61	5.86	5.73	5.64
C97	0.61	0.77	1.31	0.68	0.92	0.37	0.30	0.82	0.71
D10-D36	0.14	0.12	0.12	0.13	0.13	0.13	0.25	0.11	0.14
D37-D48	0.71	0.51	0.59	0.53	0.95	0.34	0.57	0.41	0.57

Based on the correspondence map, we state that the most similar regions are Trnava and Nitra regions in female cancer mortality. Primarily, they are associated with the mortality from C00-C14 (Malignant neoplasms of lip, oral cavity and pharynx). Banská Bystrica and Košice regions are also very close each other together with the mortality from C43-C44 (Melanoma and other malignant neoplasms of skin). It is appreciated that there are higher concentration of ultraviolet radiation or solar exposure which influence melanoma skin cancer (26–28). For complex explanation of these causalities, medical analyses would have to be conducted in Slovak regions. As for men, the highest proportion of skin neoplasms is for once concentrated in Bratislava region. The most similar are Košice region, Nitra and Trnava and the most common cancer type is C30-C39 (Malignant neoplasms of respiratory and intrathoracic organs). Especially, a high association between Nitra region and respiratory cancer is confirmed by the increased incidence of radon mentioned in Introduction section. Similarly, we assume that the highest proportion of drug users in Bratislava region may partially explains tight relationship between mortality from C60-C63 (Malignant neoplasms of male genital organs) and Bratislava region (see Fig. 1).

To conclude, we observed that the most similar Slovak regions are Nitra and Trnava for both sexes, additionally Košice region for males. When considering access to health care measured by the density of physicians per 1,000 inhabitants in these regions, we can see that just Nitra region and Trnava region report one of the lowest densities. This can lead to underestimating of primary health care from the patients' perspective.

Our analysis can serve as a basis for creating cancer preventive interventions in each Slovak region separately. Obviously, many educational activities devoting to the prevention programs for cancer risk factors are priorities of health policy in the Slovak Republic, namely Project MONIKA (29), Project CINDI (30), The National Action Plan for the prevention of obesity for the years 2015–2025 (31). Their aim is to ensure effective long-term education of the population on all social levels of society.

Our research was limited mainly in data unavailability. Consideration of higher number of lifestyle factors in each Slovak region, such as alcohol consumption, smoking, diet could provide more detailed and relevant insight on regional cancer mortality issue. As for methods, in our case, two dimensions explain 62% of inertia. It is questionable, if adding other dimensions would change the strength of associations between regions and cancer types. In spite of mentioned limitations, our paper brings beneficial results in the field of public health.

CONCLUSIONS

This paper focused on the finding the most similar Slovak regions concerning mortality from cancer types and determining possible risk factors. Our analysis showed that the main interest should be devoted to Nitra region because there is the highest proportion of cancer mortality compared to all cancer deaths in Slovakia for both sexes. Similarly, our main warning about the most serious cancer type relates to the malignant neoplasms of digestive organs.

Due to the potential possibilities of influencing the health status of population in Slovakia, it is necessary to conduct analyses of the factors affecting the deterioration of population's health continuously and to draw conclusions and take action.

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Conflict of Interests

None declared

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