Article

A long-term trend of cancer-induced deaths in European countries

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Abstract

In present study, data of standardised death rates of malignant neoplasms per 100000 inhabitants in 31 European countries during 1994~2013 were used to analyze the profile and trend of cancer-induced deaths. The results showed that malignant neoplasm of trachea, bronchus and lung (~25%) is the No. 1 cancer in 31 European countries, second by malignant neoplasm of prostate (men) (22%), third by malignant neoplasms of breast (women) (16%) and colon, rectosigmoid junction, rectum, anus and anal canal (16%). Finland, Bulgaria, Switherland, and Portugal, etc., are the countries with the least death rate of total cancers. Hungary has the highest death rate of total cancers in 31 European countries, followed by Croatia, etc. Portugal, Sweden and Finland, etc., have the least death rate, and Hungary, Denmark, Netherlands, and Poland have the highest in the death rate of malignant neoplasm of prostate (men). Romania, Malta, and Italy, etc., have the lowest rate, and Norway has one of the highest death rate in malignant neoplasm of prostate (men). Spain shows the lowest death rate, and Denmark and Malta have the highest death rate in malignant neoplasm of breast (women). Greece, Finland and Switzerland are the three countries with the least death rate and Hungary has the highest in death rate in malignant neoplasm of colon, rectosigmoid junction, rectum, anus and anal canal.

In average, the standardized death rates of all types of cancers in recorded European countries declined significantly during the recorded period 1994~2013. Death rate of all childhood cancers in Bulgaria and Estonia declines mostly in 31 countries, followed by Romania and Czech. Czech, Poland, and Netherlands decline mostly in death rate of malignant neoplasm of trachea, bronchus and lung. Conversely, the death rate of Macedonia and Romania increases most significantly; Germany and Sweden increase in death rate also. Belgium declines mostly in death rate of malignant neoplasm of prostate (men), followed by France, Austria, etc. And Latvia and Estonia increase most quickly. Malta has the greatest decline in death rate of malignant neoplasm of breast (women), followed by Netherlands, Denmark, etc. The death rate in Croatia increases significantly.

According to these statistics and knowledge, the major external factors, smoking / drinking, environmental pollution, late marriage / late childbearing, unhealthy sexual behavior, unhealthy dietary behavior, less physical excise, and workplace stress, etc., may have contributed to most cancer-induced deaths in Europe.

Keywords malignant neoplasms; death rates; linear regression; trend; Europe.

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1 Introduction

Cancer is the leading cause of death worldwide. According to WHO (2014), cancer-induced deaths in 2012 reached 8.2 millions in the world. Averagely 8.8 millions of cancer deaths worldwide are recorded every year, accounting for 1/6 of deaths of all deseases. Half of the new cases of cancers in 2012 were found in Asia and in particular China. In China, 3.07 millions of new cancer cases and 2.2 millions of cancer-induced deaths were recorded, accounted for 21.9% and 26.8% of the world respectively. In 2012, Denmark, France, Australia, Belgium and Norway were top countries in the list of cancer cases. Mongolia, Hungary, Armenia, Serbia and Uruguay were the top countries in cancer-induced deaths. Lung cancer was reported as the top cancer with the highest prevalence and death rate. There were 1.88 millions of lung cancer cases and 1.59 millions died in 2012. It was estimated that the cancer cases increased from 14 millions in 2012 to 19 millions in 2025 and 24 millions in 2035.

Cancer is a phrase used to identify immense number of similar diseases resulting from the interplay of gene(s) and environmental factors (Reya et al., 2001; Goldthwaite, 2006; Emilsson et al., 2008; Iqbal et al., 2014; Zhang, 2017b). One of its features is the rapid proliferation of abnormal cells that grow beyond their usual boundaries, invade adjoining parts of the body, and subsequently spread through blood and lymphatic vessels to form metastases in other organs which can lead to secondary tumors (Ibrahim et al., 2011). Malignant neoplasms arise from one single cell in a multistage process, typically involving progression from a pre-cancerous lesion to a malignant tumor. The changes leading to cancer are the result of the interaction between a person's genetic predisposition and external factors such as chemicals (Ibrahim et al., 2011; Zhang et al., 2011; Su and Zhang, 2014). In order to provide some valuable information for cancer research and management, in present study I used the data of standardised death rates of malignant neoplasms per 100000 inhabitants in 31 European countries during 1994~2013 to analyze profile and trend of cancer-induced deaths in Europe.

2 Materials and Methods

Data of standardised death rates of malignant neoplasms per 100000 inhabitants in 31 European countries were collected from EUROSTAT (European Commission, 2017; http://ec.europa.eu/health/home_en). Data range was generally from 1994 to 2013 (in total of 20 years), but data for some countries and years were absent. Ten types of cancers include malignant neoplasms of (I) all childhood cancers (total population), (II) skin (i.e., malignant melanoma; total population), (III) breast (women), (IV) cervix uteri (women), (V) colon, rectosigmoid junction, rectum, anus and anal canal (total population), (VI) lymphatic/haematopoietic tissue (total population), (VII) prostate (men), (VIII) stomach (total population), (IX) trachea, bronchus and lung (total population), and (X) malignant neoplasms (total population).

Time series of above malignant neoplasms were assumed to be a linear function of year. We used linear regression (Zhang, 2017a) to fit the trends for each of the countries and cancers: $x = a + b\,t$, where t is year, x is standardised death rate at t, and b is the annual growth rate of standardised death rate. Linear regressions were statistically tested with F-statistic, based on r^2 for the regression.

Simple statistics, e.g., average, percentage, etc., were also used to analyze the data.

The averages of countries in the last rows Average of Table 2a and b are for all recorded European countries, i.e., both 31 countries and a little more countries with much less data, e.g., Turkey, and data contribution of the later countries are almost ignorable.

3 Results and Analysis

3.1 Death levels of malignant neoplasms

3.1.1 Relative importance of nine malignant neoplasms

According to Fig. 1, for both the full period (1994~2013) and the latest period (2009~2013), standardised death rate of malignant neoplasm of trachea, bronchus and lung (total population) (24~25%) is the No. 1 cancer in 31 European countries, second by malignant neoplasm of prostate (men) (22%), third by malignant neoplasms of breast (women) (16%) and colon, rectosigmoid junction, rectum, anus and anal canal (total population) (16%) (see Table 1a-b for the last row Average also).

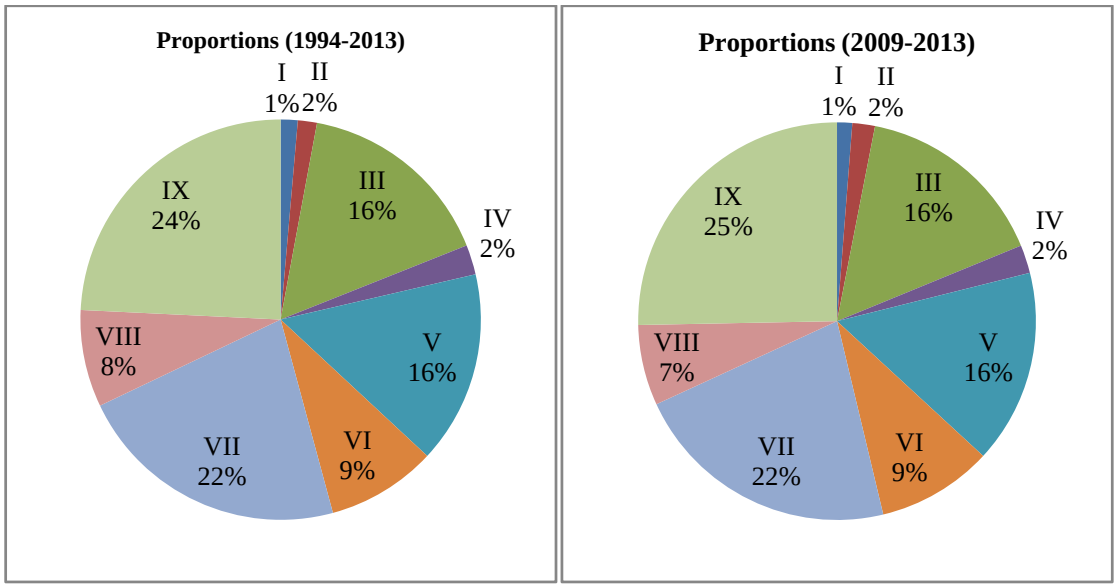

Fig. 1 Proportions of averages of 31 European countries for 9 types of cancers during the full period (1994~2013) and the latest period (2009~2013). I-IX represent malignant neoplasms of (I) all childhood cancers (total population), (II) skin (i.e., malignant melanoma; total population), (III) breast (women), (IV) cervix uteri (women), (V) colon, rectosigmoid junction, rectum, anus and anal canal (total population), (VI) lymphatic/haematopoietic tissue (total population), (VII) prostate (men), (VIII) stomach (total population), and (IX) trachea, bronchus and lung (total population).

3.1.2 Between-country comparison of death rate of total malignant neoplasms

As indicated in Fig. 2 and Table 1 (column X), for both the full period (1994~2013) and the latest period (2009~2013), Finland (233.1 and 236.8 for the full period and latest period respectively), Bulgaria (242.1 and 225.2), Switherland (249.3 and 227.8), and Portugal (250.6 and 245.2), etc., are the countries with the least death rate of total cancers. Hungary (386.8 and 358.2) has the highest death rate of total cancers in 31 European countries, followed by Croatia (334.9 and 337.8), etc.

3.1.3 Between-country comparison of death rates of all malignant neoplasms

(1) Malignant neoplasm of trachea, bronchus and lung (total population). For both the full period (1994~2013) and the latest period (2009~2013), Portugal (33.7 and 35.6), Sweden (38.9 and 39.6), and Finland (43.3 and 41.3), etc., have the least death rate of malignant neoplasm of trachea, bronchus and lung (total population). Hungary (90.5 and 91.2), Denmark (78.3 and 74), Netherlands (71.3 and 70.6), and Poland (72.2 and 70.4) are the highest in the death rate.

(2) Malignant neoplasm of prostate (men). Romania (29, 30.9), Malta (37.6 and 28.7), and Italy (35.8 and 30.1), etc., have the lowest death rate. And Norway (75.8 and 66.2) is one of the countries with the highest death rate.

(3) Malignant neoplasm of breast (women). Spain (38.4 and 25.6) has the lowest death rate. Denmark (43.4 and 42.2) and Malta (37.9 and 41.7) are two countries with the highest death rate.

(4) Malignant neoplasm of colon, rectosigmoid junction, rectum, anus and anal canal (total population). Greece

(21.8 and 22), Finland (24.3 and 22.8) and Switzerland (26.9 and 24) are the three countries with the least death rate. Hungary (59.8 and 56.7) is the highest in death rate.

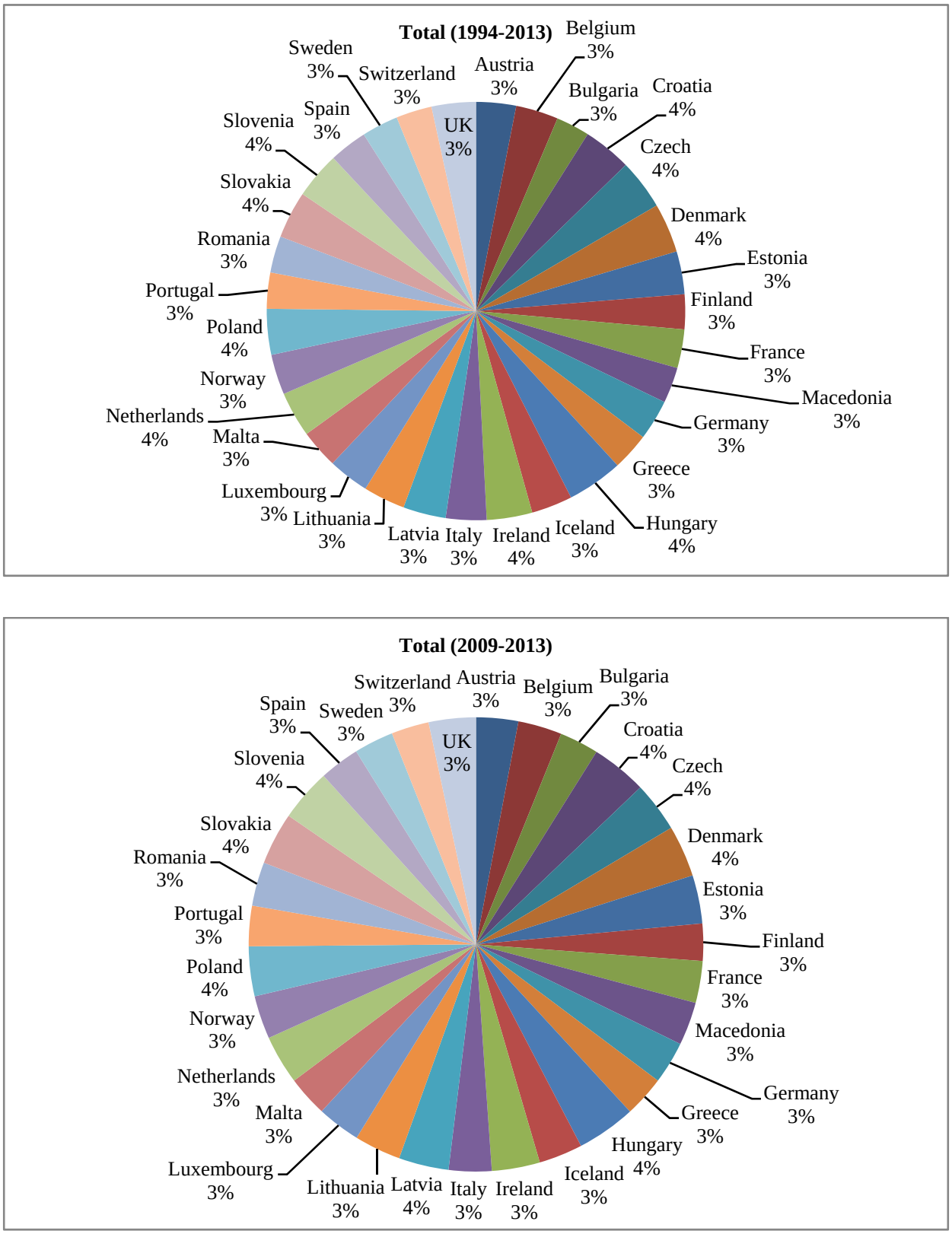

Fig. 2 Proportions of malignant neoplasms (total population; X) for 31 European countries for during the full period (1994~2013) and the latest period (2009~2013). Details can be found in Table 1a-b column X.

Table 1a Averaged standardised death rates of malignant neoplasms per 100000 inhabitants for the full period 1994~2013.

Average (1994-2013)																				
I		II		III		IV		V		VI		VII		VIII		IX		X		
Luxembourg	1.6	Greece	1.5	Spain	38.4	Italy	1.3	Greece	21.8	Bulgaria	10.5	Macedonia	28.5	France	8.8	Portugal	33.7	Bulgaria	233.1
France	2.2	Malta	2	Poland	45.1	Greece	2	Finland	24.3	Macedonia	10.7	Romania	29	Denmark	9.1	Sweden	38.9	Finland	242.1
Austria	2.3	Portugal	2	Bulgaria	30.2	Finland	2.2	Switzerland	26.9	Romania	12.5	Bulgaria	30.1	Switzerland	9.4	Bulgaria	43.2	Macedonia	249
Belgium	2.4	Romania	2	Portugal	39.7	France	2.4	Macedonia	27	Latvia	18	Italy	35.8	Sweden	9.7	Finland	43.3	Switzerland	249.3
Germany	2.5	Spain	2.1	Finland	39.3	Switzerland	2.5	Romania	28.5	Lithuania	18.6	Greece	37.1	Belgium	10.4	Switzerland	44.9	Portugal	250.6
Ireland	2.5	Bulgaria	2.2	Romania	50.4	Luxembourg	2.7	France	29.8	Poland	19	Malta	37.6	Norway	12	Malta	45.8	Sweden	253.9
Norway	2.6	Italy	2.7	Sweden	33.2	Spain	2.8	Iceland	30.2	Portugal	19	Poland	41.5	Luxembourg	12.1	Austria	48.3	Romania	255.3
Sweden	2.6	France	2.8	Greece	31.3	Malta	2.9	Sweden	30.3	Greece	19.4	Spain	42.8	UK	12.3	Macedonia	48.7	Greece	261.1
Switzerland	2.6	Belgium	2.9	Lithuania	35.5	Netherlands	3	Italy	31.2	Spain	19.4	France	45.7	Finland	13	Romania	49.6	Spain	262.6
UK	2.7	Germany	3	Norway	33.8	Sweden	3.3	UK	32.8	Estonia	20.4	Luxembourg	46.2	Netherlands	13.2	France	50.4	Malta	268
Slovenia	2.8	Lithuania	3.1	Estonia	39.8	Iceland	3.4	Austria	33.5	Croatia	20.6	Germany	48	Greece	13.9	Germany	50.8	France	268.6
Denmark	2.9	Luxembourg	3.4	Latvia	33	Belgium	3.5	Malta	33.6	Slovakia	20.7	Slovakia	48.1	Ireland	14.4	Spain	50.8	Austria	277.8
Finland	2.9	UK	3.5	Macedonia	43.8	UK	3.9	Belgium	33.7	Germany	20.8	Hungary	49.9	Iceland	15.3	Lithuania	50.9	Norway	279.9
Netherlands	2.9	Poland	3.5	France	38.6	Austria	4	Bulgaria	33.7	Malta	21.2	Belgium	51.2	Malta	15.8	Norway	51.4	Germany	281.4
Iceland	3.1	Ireland	3.6	Slovakia	45.9	Germany	4.1	Lithuania	33.9	Switzerland	21.8	Austria	53.1	Germany	16.4	Latvia	52.1	Italy	282.1
Spain	3.2	Finland	3.6	Italy	36.2	Portugal	4.2	Spain	34.7	Belgium	22	UK	53.4	Spain	16.6	Italy	54.5	Luxembourg	284.6
Italy	3.3	Latvia	3.6	Switzerland	33.7	Norway	4.5	Estonia	35.3	Hungary	22.1	Portugal	53.6	Austria	17.3	Slovakia	56.3	Iceland	284.8
Croatia	3.4	Iceland	3.7	Austria	33	Croatia	4.8	Poland	35.5	Austria	22.2	Czech	53.6	Czech	19	Estonia	56.5	Lithuania	290.5
Czech	3.4	Hungary	3.8	Luxembourg	38.5	Ireland	5	Latvia	35.9	Netherlands	22.3	Croatia	56.2	Italy	20	Luxembourg	57.2	Belgium	294.7
Malta	3.4	Estonia	3.9	Iceland	49.1	Slovenia	5.2	Portugal	36.1	Iceland	22.4	Finland	56.2	Poland	21.5	Greece	59.4	Latvia	297.1
Poland	3.4	Switzerland	4.1	Czech	46.6	Macedonia	5.4	Luxembourg	36.4	Slovenia	22.5	Lithuania	58.8	Romania	21.8	Slovenia	60.2	Estonia	297.5
Greece	3.5	Czech	4.1	Croatia	33	Denmark	5.5	Netherlands	37.9	Czech	22.7	Netherlands	58.9	Slovakia	21.9	Iceland	62.9	UK	306.7
Portugal	3.6	Austria	4.2	Germany	30.1	Czech	7.6	Germany	37.9	France	22.9	Switzerland	59	Bulgaria	22.4	Ireland	63.1	Netherlands	315.8
Slovakia	3.6	Netherlands	4.3	Slovenia	30.3	Slovakia	8.7	Ireland	39.1	Italy	22.9	Latvia	59.1	Croatia	23.5	Czech	65.7	Ireland	316.6
Macedonia	3.7	Slovakia	4.4	UK	31.4	Bulgaria	8.8	Norway	41.7	UK	22.9	Ireland	60.9	Hungary	25.3	Croatia	66.4	Poland	317.8
Hungary	4	Croatia	4.7	Hungary	35.9	Latvia	9.1	Slovenia	44.6	Sweden	23.1	Estonia	61	Slovenia	25.3	Belgium	66.6	Slovenia	325.3
Latvia	4.2	Sweden	4.9	Belgium	41.1	Hungary	9.1	Denmark	45.8	Norway	23.5	Slovenia	63.7	Portugal	28.3	UK	68.5	Slovakia	328.2
Estonia	4.3	Denmark	4.9	Ireland	28.8	Estonia	9.4	Croatia	48	Finland	23.6	Iceland	65.2	Macedonia	28.4	Netherlands	71.3	Croatia	334.9
Lithuania	4.3	Slovenia	5.5	Netherlands	31.8	Poland	10.5	Slovakia	51.9	Luxembourg	24	Denmark	66.2	Latvia	29.3	Poland	72.2	Denmark	342.6
Bulgaria	5.2	Macedonia	5.6	Malta	37.9	Lithuania	13.2	Czech	54.4	Denmark	24.2	Sweden	72	Lithuania	29.7	Denmark	78.3	Czech	350.5
Romania	5.3	Norway	6.5	Denmark	43.4	Romania	17.4	Hungary	59.8	Ireland	26.3	Norway	75.8	Estonia	30.3	Hungary	90.5	Hungary	386.8
Average	3.2	Average	3.6	Average	37.4	Average	5.6	Average	36.3	Average	20.7	Average	51.6	Average	18.3	Average	56.5	Average	289.9

Note: I-X represent malignant neoplasms of (I) all childhood cancers (total population), (II) skin (i.e., malignant melanoma; total population), (III) breast (women), (IV) cervix uteri (women), (V) colon, rectosigmoid junction, rectum, anus and anal canal (total population), (VI) lymphatic/haematopoietic tissue (total population), (VII) prostate (men), (VIII) stomach (total population), (IX) trachea, bronchus and lung (total population), and (X) malignant neoplasms (total population).

3.2 Trend of standardised death rates of malignant neoplasms

In average, the standardized death rates of all types of malignant neoplasms in recorded European countries declined significantly ($b<0$ and $p<0.05$) during the recorded period 1994~2013 (Table 2a and b).

(1) All childhood cancers (total population). Death rate of Bulgaria (-0.258) and Estonia (-0.21) declines most quickly in 31 countries, followed by Romania (-0.189) and Czech (-0.181). Germany (-0.035) and Finland (-0.036) decline slightly. Belgium and Ireland, etc., have not clear trend in changes of death rate.

(2) Malignant neoplasm of trachea, bronchus and lung (total population). Czech (-0.907), Poland (-0.852), and Netherlands (-0.836) decline most quickly in death rate, and Spain (-0.107) declines slightly. Conversely, death rate of Macedonia (0.895) and Romania (0.546) increases most significantly; Germany (0.2) and Sweden (0.208) increase in death rate also. France and Crotia, etc., have not distinctive trend.

(3) Malignant neoplasm of prostate (men). Belgium (-2.057) declines most quickly in death rate, followed by France (-1.553), Austria (-1.419), etc. United Kindom (-0.608) declines slightly. Latvia (1.934) and Estonia (1.566) increase most quickly.

(4) Malignant neoplasm of breast (women). Malta (-1.843) is the country with the greatest decline in death rate, followed by Netherlands (-1.009), Denmark (-0.977), etc. The death rate in Croatia (0.308) increases significantly.

(5) Malignant neoplasm of colon, rectosigmoid junction, rectum, anus and anal canal, total population. Czech (-1.302) yields the greatest decline in death rate, followed by Germany (-0.999), Denmark (-0.71), etc. However, the death rate in Romania (0.631) and Croatia (0.602), etc., grows during the period.

Table 1b Averaged standardised death rates of malignant neoplasms per 100000 inhabitants for the latest period 2009~2013.

Average (2009-2013)																				
I		II		III		IV		V		VI		VII		VIII		IX		X		
Luxembourg	1.3	Greece	4.4	Spain	25.6	Italy	1.2	Greece	22.0	Macedonia	10.9	Malta	28.7	Sweden	7.1	Portugal	35.6	Finland	225.2
France	2.0	Romania	3.2	Norway	27.6	Iceland	1.7	Finland	22.8	Bulgaria	11.8	Italy	30.1	Switzerland	7.1	Sweden	39.6	Switzerland	227.8
Denmark	2.1	Spain	2.5	Portugal	28.1	Finland	1.8	Switzerland	24.0	Romania	13.1	Romania	30.9	Belgium	7.5	Finland	41.3	Bulgaria	236.8
Austria	2.1	Portugal	4.8	Sweden	28.4	Switzerland	1.9	Austria	27.8	Spain	18.3	Bulgaria	33.1	Iceland	7.5	Switzerland	43.4	Sweden	239.7
UK	2.2	Bulgaria	4.1	Finland	29.1	Malta	2.1	France	28.0	Greece	18.4	Greece	33.7	Denmark	7.8	Malta	44.5	Spain	243.2
Norway	2.2	Malta	5.6	Poland	29.4	Luxembourg	2.4	UK	29.0	Poland	18.6	Macedonia	34.3	France	7.8	Bulgaria	45.1	Portugal	245.2
Switzerland	2.2	France	4.7	Bulgaria	30.6	France	2.4	Macedonia	29.0	Lithuania	18.6	Spain	35.4	Norway	8.2	Austria	46.3	Malta	245.6
Germany	2.2	Italy	4.0	Estonia	31.0	Netherlands	2.5	Italy	29.0	Latvia	19.2	Luxembourg	36.1	UK	8.8	Lithuania	47.0	Greece	248.9
Czech	2.2	Luxembourg	2.9	Romania	31.1	Greece	2.6	Belgium	29.1	Malta	19.9	Belgium	38.8	Finland	9.3	Spain	49.8	France	253.7
Finland	2.4	Iceland	4.9	Iceland	31.8	Spain	2.7	Sweden	29.4	Portugal	19.9	France	39.7	Luxembourg	9.6	Latvia	49.8	Austria	255.2
Sweden	2.4	Belgium	3.3	Lithuania	32.0	Sweden	3.0	Iceland	30.4	Hungary	20.0	Germany	40.3	Netherlands	10.0	France	50.2	Germany	256.9
Ireland	2.4	Germany	1.8	Czech	32.0	UK	3.0	Germany	30.5	Switzerland	20.2	Hungary	41.4	Ireland	11.4	Germany	50.8	Italy	259.1
Belgium	2.5	Lithuania	3.8	Greece	32.2	Norway	3.1	Romania	31.7	Czech	20.5	Poland	41.9	Austria	11.5	Estonia	51.8	Macedonia	261.7
Slovenia	2.5	Hungary	3.1	Italy	33.0	Belgium	3.2	Malta	31.9	Germany	20.8	Austria	42.2	Greece	11.6	Italy	52.3	Norway	262.0
Netherlands	2.5	UK	4.9	Austria	33.4	Austria	3.3	Luxembourg	32.2	Sweden	21.1	Czech	45.3	Germany	11.7	Slovakia	52.4	Luxembourg	262.9
Spain	2.6	Finland	2.9	France	33.7	Germany	3.4	Lithuania	33.8	Croatia	21.1	Portugal	46.6	Malta	12.5	Romania	52.6	Iceland	265.0
Poland	2.7	Poland	4.1	Switzerland	33.8	Denmark	3.4	Bulgaria	34.5	Slovakia	21.3	Finland	46.9	Czech	13.0	Macedonia	52.8	Romania	265.4
Italy	2.7	Latvia	3.7	Latvia	34.6	Macedonia	4.0	Ireland	34.6	Belgium	21.4	UK	48.8	Spain	13.1	Norway	53.3	Belgium	265.8
Portugal	2.9	Czech	3.1	Slovakia	36.1	Portugal	4.0	Spain	35.0	Finland	21.4	Slovakia	49.7	Italy	15.3	Luxembourg	53.4	Lithuania	282.1
Malta	2.9	Switzerland	2.5	Macedonia	36.3	Slovenia	4.0	Estonia	35.1	Norway	21.5	Netherlands	49.7	Poland	17.3	Slovenia	57.2	UK	285.9
Iceland	3.0	Austria	5.3	Germany	36.3	Ireland	4.9	Netherlands	36.2	Denmark	21.8	Switzerland	50.2	Bulgaria	17.8	Czech	58.6	Ireland	291.7
Lithuania	3.1	Estonia	7.6	UK	36.9	Croatia	5.0	Latvia	36.5	France	21.8	Ireland	51.9	Slovakia	17.8	Greece	59.4	Estonia	292.6
Slovakia	3.1	Croatia	4.0	Luxembourg	37.7	Czech	6.4	Poland	36.5	Austria	22.1	Croatia	56.5	Hungary	19.1	Ireland	61.1	Netherlands	297.2
Croatia	3.2	Slovakia	2.3	Slovenia	37.7	Hungary	7.5	Portugal	36.8	UK	22.1	Lithuania	62.4	Romania	19.5	Iceland	63.0	Poland	301.3
Estonia	3.3	Ireland	2.1	Hungary	38.8	Slovakia	8.7	Norway	38.4	Italy	22.1	Denmark	64.4	Slovenia	19.8	UK	63.6	Latvia	303.0
Hungary	3.3	Macedonia	4.8	Netherlands	39.2	Poland	8.9	Denmark	39.6	Netherlands	22.4	Sweden	64.9	Croatia	21.1	Belgium	64.1	Czech	304.2
Bulgaria	3.5	Netherlands	6.5	Belgium	40.3	Bulgaria	8.9	Czech	42.7	Estonia	22.5	Iceland	65.3	Portugal	22.8	Croatia	66.4	Denmark	312.2
Latvia	3.6	Sweden	2.2	Ireland	40.6	Estonia	9.1	Slovenia	43.1	Ireland	24.2	Slovenia	65.8	Estonia	23.5	Poland	70.4	Slovakia	317.1
Greece	3.8	Denmark	5.5	Croatia	40.9	Latvia	10.5	Croatia	50.1	Luxembourg	25.0	Norway	66.2	Lithuania	23.6	Netherlands	70.6	Slovenia	317.5
Macedonia	3.9	Slovenia	4.3	Malta	41.7	Lithuania	11.9	Slovakia	50.5	Slovenia	25.3	Latvia	68.2	Latvia	24.9	Denmark	74.0	Croatia	337.8
Romania	4.3	Norway	3.9	Denmark	42.2	Romania	16.3	Hungary	56.7	Iceland	26.7	Estonia	70.9	Macedonia	26.3	Hungary	91.2	Hungary	358.2
Average	2.7	Average	4.0	Average	34.3	Average	5.0	Average	34.4	Average	20.5	Average	47.7	Average	14.3	Average	55.2	Average	274.9

Note: I-X represent malignant neoplasms of (I) all childhood cancers (total population), (II) skin (i.e., malignant melanoma; total population), (III) breast (women), (IV) cervix uteri (women), (V) colon, rectosigmoid junction, rectum, anus and anal canal (total population), (VI) lymphatic/haematopoietic tissue (total population), (VII) prostate (men), (VIII) stomach (total population), (IX) trachea, bronchus and lung (total population), and (X) malignant neoplasms (total population).

Table 2a Regression parameters for standardised death rates of malignant neoplasms per 100000 inhabitants in 31 European countries for the period 1994~2013.

All childhood cancers, total population					Skin, total population					Breast, women					Cervix uteri, women					Colon, rectosigmoid junction, rectum, anus and anal canal, total population				
Country	*a*	*b*	r^2	*p*	Country	*a*	*b*	r^2	*p*	Country	*a*	*b*	r^2	*p*	Country	*a*	*b*	r^2	*p*	Country	*a*	*b*	r^2	*p*
Bulgaria	522.0	-0.258	0.63	0.000	Spain	-22.2	0.012	0.41	0.002	Malta	3740.8	-1.843	0.60	0.000	Iceland	572.1	-0.284	0.69	0.000	Czech	2663.1	-1.302	0.87	0.000
Estonia	425.8	-0.210	0.39	0.003	France	-34.7	0.019	0.43	0.015	Netherlands	2068.3	-1.009	0.98	0.000	Denmark	512.0	-0.253	0.84	0.000	Germany	2038.9	-0.999	0.99	0.000
Romania	385.0	-0.189	0.82	0.000	Italy	-36.0	0.019	0.56	0.000	Denmark	2008.1	-0.977	0.89	0.000	Poland	486.2	-0.237	0.96	0.000	Denmark	1467.6	-0.710	0.90	0.000
Czech	366.9	-0.181	0.89	0.000	Germany	-47.3	0.025	0.53	0.000	UK	1794.3	-0.874	0.98	0.000	Macedonia	474.3	-0.234	0.70	0.001	Belgium	1453.2	-0.708	0.97	0.000
Lithuania	357.9	-0.177	0.54	0.000	Bulgaria	-69.2	0.036	0.41	0.003	Czech	1726.2	-0.842	0.86	0.000	Hungary	446.7	-0.218	0.87	0.000	Luxembourg	1394.1	-0.678	0.64	0.000
Denmark	267.6	-0.132	0.60	0.000	Belgium	-87.8	0.045	0.58	0.000	Norway	1619.4	-0.792	0.95	0.000	Norway	409.4	-0.202	0.89	0.000	Ireland	1214.3	-0.587	0.84	0.000
Hungary	263.7	-0.130	0.67	0.000	Finland	-90.1	0.047	0.45	0.001	Belgium	1583.4	-0.768	0.94	0.000	Czech	382.9	-0.187	0.82	0.000	UK	1136.7	-0.551	0.96	0.000
Poland	232.8	-0.115	0.81	0.000	Greece	-93.7	0.048	0.76	0.000	Hungary	1506.9	-0.730	0.88	0.000	Slovenia	377.2	-0.186	0.69	0.000	Hungary	1057.2	-0.498	0.69	0.000
Portugal	217.8	-0.107	0.65	0.000	UK	-97.1	0.050	0.92	0.000	Austria	1493.7	-0.726	0.95	0.000	Romania	381.4	-0.181	0.75	0.000	Switzerland	971.7	-0.472	0.87	0.000
Malta	209.8	-0.103	0.07	0.253	Portugal	-100.2	0.051	0.83	0.000	Switzerland	1458.7	-0.709	0.79	0.000	UK	310.5	-0.153	0.94	0.000	France	968.2	-0.468	0.97	0.000
Italy	207.1	-0.102	0.81	0.000	Slovakia	-101.7	0.053	0.22	0.049	Ireland	1365.3	-0.659	0.81	0.000	Germany	256.6	-0.126	0.89	0.000	Norway	893.3	-0.425	0.78	0.000
Slovakia	198.5	-0.097	0.44	0.003	Denmark	-116.6	0.061	0.58	0.000	Germany	1113.5	-0.536	0.92	0.000	Estonia	242.4	-0.116	0.20	0.046	Italy	585.5	-0.277	0.96	0.000
Latvia	198.1	-0.097	0.23	0.042	Malta	-144.4	0.073	0.23	0.033	Spain	990.9	-0.480	0.95	0.000	Lithuania	235.2	-0.111	0.21	0.045	Finland	498.8	-0.237	0.84	0.000
Slovenia	181.7	-0.089	0.28	0.021	Poland	-148.4	0.076	0.87	0.000	Luxembourg	941.8	-0.451	0.23	0.032	Switzerland	195.6	-0.096	0.70	0.000	Netherlands	506.6	-0.234	0.74	0.000
Spain	175.7	-0.086	0.80	0.000	Lithuania	-155.3	0.079	0.65	0.000	France	929.8	-0.446	0.97	0.000	Austria	174.6	-0.085	0.60	0.000	Sweden	219.5	-0.094	0.48	0.001
France	134.6	-0.066	0.83	0.000	Sweden	-180.1	0.092	0.85	0.000	Italy	915.8	-0.439	0.95	0.000	Netherlands	136.2	-0.067	0.66	0.000	Spain	-66.1	0.050	0.21	0.040
UK	119.4	-0.058	0.82	0.000	Slovenia	-193.2	0.099	0.40	0.003	Slovenia	849.7	-0.404	0.63	0.000	Finland	124.1	-0.061	0.63	0.000	Greece	-219.2	0.120	0.21	0.041
Norway	107.6	-0.052	0.26	0.022	Netherlands	-224.5	0.114	0.93	0.000	Portugal	789.5	-0.379	0.78	0.000	Belgium	121.0	-0.059	0.55	0.001	Portugal	-257.5	0.147	0.51	0.000
Netherlands	106.0	-0.051	0.45	0.001	Estonia	-242.9	0.123	0.65	0.000	Sweden	762.1	-0.365	0.83	0.000	Sweden	104.5	-0.051	0.54	0.000	Bulgaria	-355.5	0.194	0.32	0.011
Switzerland	90.1	-0.044	0.20	0.050	Norway	-258.6	0.132	0.76	0.000	Estonia	628.7	-0.297	0.39	0.003	Italy	46.1	-0.022	0.64	0.000	Poland	-423.3	0.229	0.66	0.000
Austria	83.6	-0.041	0.41	0.002	Ireland	-311.1	0.157	0.83	0.000	Finland	599.5	-0.284	0.75	0.000	Spain	42.4	-0.020	0.38	0.004	Macedonia	-1000.5	0.513	0.55	0.006
Sweden	74.8	-0.036	0.21	0.041	Switzerland	-42.4	0.023	0.16	0.080	Poland	187.6	-0.079	0.34	0.012	Latvia	-325.8	0.167	0.51	0.001	Croatia	-1161.4	0.602	0.77	0.000
Finland	74.7	-0.036	0.16	0.086	Iceland	-264.7	0.134	0.22	0.066	Croatia	-579.4	0.308	0.36	0.040	Greece	-82.5	0.042	0.31	0.010	Romania	-1238.1	0.631	0.97	0.000
Germany	72.2	-0.035	0.55	0.000	Latvia	-97.1	0.050	0.12	0.157	Iceland	2157.2	-1.059	0.22	0.068	France	37.7	-0.018	0.28	0.065	Malta	599.9	-0.283	0.19	0.056
Macedonia	404.6	-0.200	0.23	0.112	Croatia	-90.8	0.048	0.12	0.260	Latvia	-225.5	0.129	0.17	0.090	Malta	191.8	-0.094	0.15	0.096	Iceland	805.8	-0.388	0.19	0.092
Luxembourg	81.3	-0.040	0.06	0.308	Macedonia	221.5	-0.108	0.11	0.303	Lithuania	242.6	-0.105	0.11	0.157	Ireland	78.4	-0.037	0.14	0.103	Slovenia	356.5	-0.156	0.13	0.113
Croatia	109.3	-0.053	0.06	0.425	Czech	18.4	-0.007	0.04	0.391	Romania	142.4	-0.055	0.14	0.168	Croatia	-120.1	0.062	0.23	0.112	Slovakia	380.4	-0.164	0.11	0.184
Iceland	11.3	-0.004	0.00	0.970	Luxembourg	13.5	-0.005	0.00	0.907	Bulgaria	-149.1	0.090	0.08	0.249	Portugal	58.3	-0.027	0.12	0.135	Austria	832.8	-0.399	0.06	0.295
Greece	4.5	-0.001	0.00	0.984	Romania	-13.0	0.008	0.05	0.436	Macedonia	-518.5	0.276	0.11	0.290	Bulgaria	-58.7	0.034	0.10	0.197	Latvia	-71.8	0.054	0.02	0.536
Ireland	-0.2	0.001	0.00	0.943	Hungary	-12.3	0.008	0.06	0.308	Slovakia	277.9	-0.121	0.05	0.358	Luxembourg	-74.4	0.039	0.02	0.555	Lithuania	6.5	0.014	0.01	0.749
Belgium	-1.7	0.002	0.00	0.949	Austria	-15.0	0.010	0.04	0.408	Greece	-54.7	0.044	0.02	0.515	Slovakia	40.3	-0.016	0.01	0.673	Estonia	14.6	0.010	0.00	0.868
Average	165.6	-0.081	0.86	0.000	Average	-98.4	0.051	0.82	0.000	Average	1176.1	-0.568	0.90	0.000	Average	116.5	-0.055	0.64	0.000	Average	783.0	-0.373	0.93	0.000

Note: Note: I-X represent malignant neoplasms of (I) all childhood cancers (total population), (II) skin (i.e., malignant melanoma; total population), (III) breast (women), (IV) cervix uteri (women), (V) colon, rectosigmoid junction, rectum, anus and anal canal (total population), (VI) lymphatic/haematopoietic tissue (total population), (VII) prostate (men), (VIII) stomach (total population), (IX) trachea, bronchus and lung (total population), and (X) malignant neoplasms (total population). Green: countries with significantly declined standardized death rate; Red: countries with significantly increased standardized death rate; Black: countries without significantly both declined and increased standardized death rate.

Table 2b Regression parameters for standardised death rates of malignant neoplasms per 100000 inhabitants in 31 European countries for the period 1994~2013.

Lymphatic/haematopoietic tissue, total population					Prostate, men					Stomach, total population					Trachea, bronchus and lung, total population					Malignant neoplasms, Total population				
Country	*a*	*b*	r^2	*p*	Country	*a*	*b*	r^2	*p*	Country	*a*	*b*	r^2	*p*	Country	*a*	*b*	r^2	*p*	Country	*a*	*b*	r^2	*p*
Finland	703.9	-0.339	0.82	0.000	Belgium	4173.0	-2.057	0.94	0.000	Hungary	1959.3	-0.965	0.95	0.000	Czech	1883.2	-0.907	0.94	0.000	Czech	11152.1	-5.391	0.91	0.000
Malta	632.3	-0.305	0.42	0.002	France	3163.2	-1.553	0.97	0.000	Estonia	1894.5	-0.931	0.91	0.000	Poland	1783.2	-0.852	0.91	0.000	Belgium	9731.6	-4.709	0.96	0.000
France	635.0	-0.305	0.91	0.000	Austria	2896.7	-1.419	0.91	0.000	Czech	1799.4	-0.889	0.97	0.000	Netherlands	1751.1	-0.836	0.76	0.011	Hungary	9362.1	-4.480	0.86	0.000
Ireland	634.7	-0.303	0.55	0.001	Switzerland	2830.8	-1.384	0.85	0.000	Austria	1784.0	-0.882	0.95	0.000	Luxembourg	1610.3	-0.775	0.43	0.002	Malta	8509.0	-4.113	0.76	0.000
Hungary	605.4	-0.291	0.68	0.000	Netherlands	2766.6	-1.352	0.97	0.000	Iceland	1753.3	-0.868	0.63	0.000	UK	1578.8	-0.754	0.89	0.000	Luxembourg	8437.7	-4.069	0.79	0.000
Denmark	601.7	-0.288	0.77	0.000	Malta	2617.8	-1.288	0.63	0.000	Slovenia	1726.7	-0.849	0.90	0.000	Slovakia	1545.9	-0.743	0.79	0.000	France	7891.9	-3.798	0.99	0.000
Sweden	532.8	-0.254	0.81	0.000	Hungary	2587.3	-1.267	0.84	0.000	Portugal	1618.7	-0.794	0.96	0.000	Italy	1343.0	-0.642	0.98	0.000	Germany	7656.1	-3.681	0.97	0.000
Czech	513.5	-0.245	0.60	0.000	Germany	2522.9	-1.235	0.93	0.000	Lithuania	1590.9	-0.779	0.96	0.000	Belgium	1252.0	-0.591	0.74	0.000	Denmark	7356.2	-3.501	0.94	0.000
Switzerland	499.3	-0.238	0.89	0.000	Luxembourg	2499.8	-1.225	0.57	0.000	Germany	1449.3	-0.715	0.97	0.000	Lithuania	1031.9	-0.490	0.84	0.000	Ireland	6900.3	-3.286	0.96	0.000
Norway	480.6	-0.228	0.69	0.000	Norway	2518.0	-1.219	0.92	0.000	Croatia	1421.7	-0.697	0.92	0.000	Malta	992.6	-0.473	0.29	0.014	Iceland	6807.6	-3.259	0.46	0.004
Italy	472.6	-0.224	0.89	0.000	Finland	2365.5	-1.153	0.83	0.000	Slovakia	1376.6	-0.676	0.93	0.000	Estonia	882.2	-0.412	0.54	0.000	Austria	6705.0	-3.208	0.97	0.000
Poland	464.4	-0.222	0.75	0.003	Ireland	2154.5	-1.045	0.78	0.000	Italy	1369.1	-0.673	0.97	0.000	Denmark	897.3	-0.409	0.51	0.001	Switzerland	6635.4	-3.187	0.94	0.000
Belgium	317.2	-0.147	0.54	0.004	Spain	2079.9	-1.017	0.94	0.000	Poland	1315.7	-0.646	0.99	0.000	Finland	826.1	-0.391	0.77	0.000	Italy	6438.6	-3.073	0.98	0.000
Spain	253.9	-0.117	0.54	0.000	Portugal	2076.2	-1.009	0.87	0.000	Latvia	1311.0	-0.639	0.92	0.000	Ireland	660.1	-0.298	0.43	0.004	UK	5971.1	-2.827	0.98	0.000
UK	148.5	-0.063	0.35	0.006	Czech	1423.5	-0.684	0.39	0.003	Bulgaria	1262.1	-0.619	0.95	0.000	Austria	629.9	-0.290	0.83	0.000	Netherlands	5748.9	-2.712	0.96	0.000
Portugal	-195.9	0.107	0.46	0.001	Italy	1400.7	-0.681	0.94	0.000	Norway	1135.6	-0.561	0.94	0.000	Slovenia	586.8	-0.263	0.38	0.004	Finland	5307.7	-2.528	0.96	0.000
Romania	-257.6	0.135	0.74	0.000	Sweden	1398.5	-0.662	0.57	0.000	Malta	1108.5	-0.545	0.60	0.000	Latvia	529.4	-0.238	0.29	0.020	Spain	5186.0	-2.457	0.97	0.000
Bulgaria	-289.0	0.150	0.44	0.002	UK	1272.2	-0.608	0.92	0.000	Finland	1080.8	-0.533	0.95	0.000	Switzerland	384.9	-0.170	0.52	0.001	Norway	4825.2	-2.269	0.94	0.000
Latvia	-314.6	0.166	0.39	0.006	Romania	-478.3	0.253	0.32	0.029	Spain	1068.1	-0.525	0.97	0.000	Spain	264.9	-0.107	0.58	0.000	Slovakia	4598.0	-2.130	0.52	0.001
Slovenia	-579.2	0.300	0.50	0.001	Poland	-729.0	0.384	0.37	0.008	UK	1059.9	-0.523	0.98	0.000	Germany	-351.4	0.200	0.85	0.027	Sweden	3136.1	-1.439	0.81	0.000
Estonia	-635.9	0.328	0.64	0.000	Bulgaria	-819.3	0.424	0.67	0.000	Netherlands	993.9	-0.490	0.96	0.000	Sweden	-377.6	0.208	0.54	0.000	Poland	2749.7	-1.213	0.34	0.012
Germany	-421.6	0.220	0.68	0.086	Lithuania	-1893.6	0.974	0.60	0.000	Luxembourg	975.2	-0.481	0.75	0.000	Portugal	-429.6	0.231	0.76	0.000	Slovenia	2457.9	-1.064	0.52	0.000
Iceland	835.0	-0.406	0.12	0.183	Estonia	-3077.0	1.566	0.66	0.000	Belgium	957.8	-0.473	0.95	0.000	Bulgaria	-563.6	0.303	0.40	0.004	Portugal	2096.9	-0.922	0.70	0.000
Lithuania	-103.7	0.061	0.09	0.201	Latvia	-3818.3	1.934	0.80	0.000	Ireland	951.0	-0.468	0.91	0.000	Norway	-808.1	0.429	0.74	0.000	Greece	2020.8	-0.878	0.39	0.003
Croatia	-190.0	0.105	0.15	0.216	Macedonia	-1019.5	0.523	0.26	0.094	Macedonia	948.6	-0.459	0.50	0.010	Romania	-1046.5	0.546	0.91	0.000	Lithuania	1411.5	-0.560	0.25	0.024
Netherlands	-49.5	0.036	0.07	0.562	Slovenia	-1239.2	0.650	0.28	0.016	Romania	906.6	-0.441	0.91	0.000	Macedonia	-1744.8	0.895	0.88	0.000	Bulgaria	-1831.4	1.030	0.29	0.019
Slovakia	-87.3	0.054	0.03	0.490	Denmark	368.1	-0.151	0.09	0.214	Sweden	732.2	-0.361	0.97	0.000	Hungary	264.8	-0.087	0.04	0.399	Latvia	-1867.9	1.080	0.63	0.000
Austria	-5.3	0.014	0.01	0.613	Greece	286.9	-0.125	0.07	0.271	Switzerland	718.3	-0.354	0.89	0.000	Greece	109.0	-0.025	0.03	0.456	Romania	-3642.7	1.943	0.88	0.000
Luxembourg	-55.2	0.040	0.01	0.739	Slovakia	-133.5	0.091	0.01	0.629	Greece	549.7	-0.267	0.88	0.000	Iceland	-308.9	0.186	0.03	0.516	Macedonia	-4256.2	2.248	0.73	0.000
Macedonia	78.0	-0.034	0.01	0.744	Croatia	-101.8	0.079	0.01	0.784	France	524.9	-0.257	0.96	0.000	Croatia	30.6	0.018	0.01	0.792	Croatia	-670.3	0.501	0.23	0.112
Greece	2.0	0.009	0.00	0.878	Iceland	8.4	0.028	0.00	0.970	Denmark	409.2	-0.200	0.70	0.000	France	73.6	-0.012	0.00	0.833	Estonia	759.1	-0.230	0.06	0.300
Average	198.5	-0.089	0.59	0.000	Average	1365.3	-0.656	0.94	0.000	Average	1173.4	-0.577	0.99	0.000	Average	526.6	-0.235	0.69	0.000	Average	5454.2	-2.578	0.98	0.000

Note: I-X represent malignant neoplasms of (I) all childhood cancers (total population), (II) skin (i.e., malignant melanoma; total population), (III) breast (women), (IV) cervix uteri (women), (V) colon, rectosigmoid junction, rectum, anus and anal canal (total population), (VI) lymphatic/haematopoietic tissue (total population), (VII) prostate (men), (VIII) stomach (total population), (IX) trachea, bronchus and lung (total population), , and (X) malignant neoplasms (total population). Green: countries with significantly declined standardized death rate; Red: countries with significantly increased standardized death rate; Black: countries without significantly both declined and increased standardized death rate.

4 Discussion

According to above statistics and common knowledge, the major external factors, smoking / drinking, environmental pollution, late marriage / late childbearing, unhealthy sexual behavior, unhealthy dietary behavior (dietary of high fat / high protein / high sugar, and overeating), less physical excise, and workplace stress, etc., may have contributed to most cancer-induced deaths in Europe. For example, cigarettes contain 69 substances that may induce cancers. About 20% of cancer-induced deaths and 70% of lung cancer-induced deaths were caused by smoking in 2012. Further measures should be used to reduce cancer-induced deaths.

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