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Paper

LIFE EXPECTANCY IN CROATIA IN TERMS OF ELIMINATING CERTAIN CAUSES OF DEATH

Ivan Čipin[*], Šime Smolić[**], Petra Međimurec[***]

Abstract

Recent decades in Croatia are marked by a gradual decline in mortality and a constantly progressing life expectancy. Eurostat data show men have gained 3,3 and women have gained 2,6 years of life expectancy at birth from 2000 until 2013. However, with present decreasing levels of mortality in Croatia, life tables dealing only with all-cause mortality have lost their usefulness as an indicator of population health.

In this paper we present an overview of the trends and patterns in causes of death and explore the effect the eradication of certain diseases would have had on age-specific probabilities of dying. In addition, we investigate which age groups contributed the most to the life extension in Croatia, separately for men and women. The effect of eliminating a certain group of diseases as the cause of death is estimated using a multiple-decrement approach. When exploring the effect on life expectancy which stems from the elimination of one or more causes of death, construction of multiple-decrement life tables is a standard and suitable approach. Simply put, a multiple-decrement life table considers deaths by cause. As a first step, we develop a regular life table in which all deaths combined are taken into account, in the form of an abridged life table for the population of Croatia in 2011. In what follows, we use the cause-specific deaths to calculate life table components assuming that a particular cause of death is eliminated. The number of deaths for each of these multiple-decrement tables is calculated by excluding deaths due to certain specified causes.

In this paper we investigate main causes of death, beginning with diseases of circulatory system and malignant neoplasms. These two account for approximately three quarters of all causes of death according to official data published by the Croatian Bureau of Statistics. Life table calculations are based on the 2011 estimated mid-year population and death recorded during the period 2010-2012.

Results indicate the impact of the elimination of major diseases on overall life expectancy in Croatia. The gain in life expectancy is shown to be the highest when diseases of circulatory system as the cause of death are eliminated. If diseases of circulatory system as the cause of death are eliminated, the number of additional years at birth that an inhabitant of Croatia would expect to live on average surpasses 14. The second highest influence is that of the elimination of malignant neoplasms as the cause of death. Eradication of other causes of death is shown to have a much smaller impact on life expectancy. As the aforementioned results are suggesting, from birth, an individual in Croatia has a significantly greater chance of dying from diseases of the circulatory system compared to the chance of dying from malignant neoplasms.

The extension of life expectancy at birth can be accomplished by lowering mortality throughout the life cycle. It is of interest to show in which age groups mortality decreased the most, i.e. where the gains in life expectancy are the highest. Analysis of changes in life expectancy, conducted by the application of decomposition techniques, revealed that male life expectancy at birth increased during the last two decades mostly due to the reduction of mortality in the age group 60-69, while the highest contribution to the reduced female mortality is found in the age group 70-79 (followed by the age group 60-69). To draw a comparison, in western European countries the biggest gains in life expectancy at birth for men are realized by reducing mortality in the age group 70-79, and for women in the age group 80+. Such a development can probably be expected in Croatia as well.

As for policy implications, we may argue that the initial results of our analysis seem to indicate the importance of health promotion and interventions regarding the reduction of the prevalence of cardiovascular diseases, which could lead to a morbidity compression, especially in advanced, older ages.

Keywords: life expectancy, causes of death, Croatia

INTRODUCTION

The period after World War II in Croatia is marked by a gradual decline in mortality and constant gains in life expectancy (CBS, 2014). From 2000 until 2013, according to Eurostat (2015), men have gained 3,3 and women have gained 2,6

[*] University of Zagreb, Faculty of Economics and Business, (icipin@efzg.hr)
[**] University of Zagreb, Faculty of Economics and Business, (ssmolic@efzg.hr)
[***] University of Zagreb, Faculty of Economics and Business, (pmedimurec@efzg.hr)

years of life expectancy at birth. However, with decreasing levels of mortality present in Croatia, life tables dealing only with all-cause mortality have lost their usefulness as an indicator of population health.

In this paper we give a brief overview of recent trends and patterns in causes of death in Croatia. Furthermore, we explore the effect of eliminating certain diseases as causes of death on age-specific probabilities of dying. For that purpose, we employ a multiple-decrement approach.

When exploring the effect on life expectancy which stems from the elimination of one or more causes of death, construction of multiple-decrement life tables is a standard and suitable approach. Simply put, multiple-decrement life tables consider deaths by cause. As a first step, we develop a regular life table in which all deaths combined are taken into account, i.e. we construct an abridged life table for the population of Croatia in 2011. In what follows, we use cause-specific deaths to calculate multiple-decrement life table components which assume that a particular cause of death is eliminated.

According to official data published by the Croatian Bureau of Statistics (CBS, 2014), diseases of circulatory system and malignant neoplasms account for approximately three quarters of all deaths in Croatia. Life table calculations presented in this paper are based on the 2011 midyear population estimates (considered to be very accurate as the population census in Croatia took place in 2011) and deaths recorded during the period 2010-2012.

Moreover, we investigate which age groups contributed the most to the life extension in Croatia, separately for men and women. Finally, we conclude by discussing policy measures and implications related to our research findings.

TRENDS AND PATTERNS IN CAUSES OF DEATH IN CROATIA

Mortality decline in Croatia is well documented and vital statistics data are available since the 1950s. This section gives an overview of recent trends and pattern in causes of death in Croatia: we restrain our analysis to the period 2000-2012 and give special attention to five leading causes of death (see table 1): 1) diseases of the circulatory system, 2) malignant neoplasms, 3) injury, poisoning and certain other consequences of external causes, 4) diseases of digestive system and 5) diseases of respiratory system.

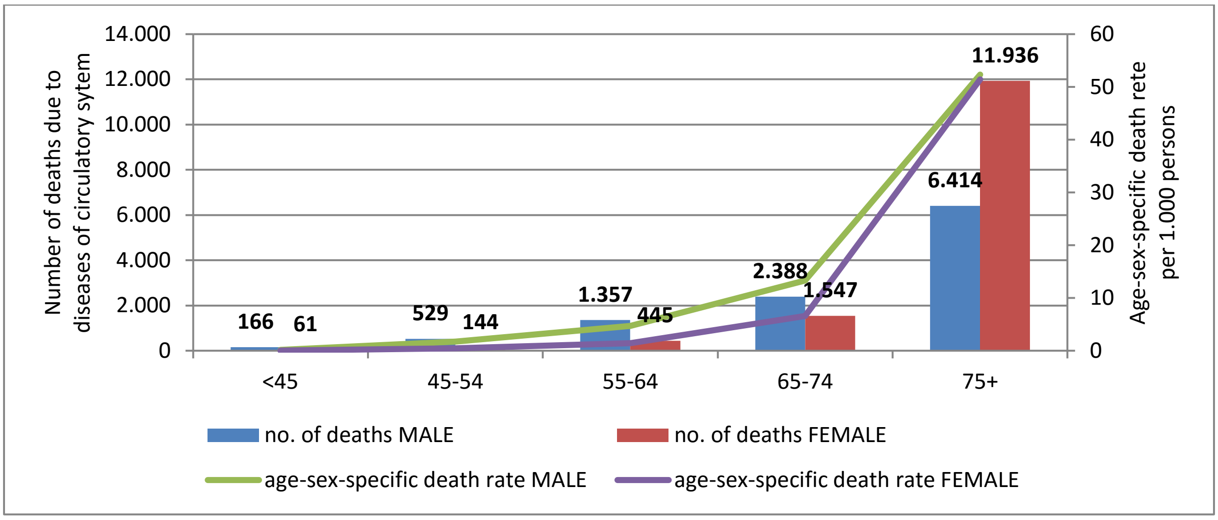
Table 1: *Deaths due to five leading causes as percentage of total deaths*

Year	Share in total deaths attributable to deaths due to					Sum
	Diseases of circulatory system	Malignant neoplasms	External causes	Diseases of digestive system	Diseases of respiratory system	
2000	53,18%	23,26%	5,77%	4,99%	3,80%	91,00%
2001	53,57%	23,66%	5,53%	4,79%	3,62%	91,17%
2002	52,80%	23,88%	5,35%	4,73%	3,71%	90,47%
2003	53,02%	23,54%	5,43%	4,51%	4,63%	91,13%
2004	50,17%	24,70%	5,76%	4,76%	5,48%	90,88%
2005	50,27%	24,41%	5,55%	4,56%	5,81%	90,60%
2006	50,85%	24,92%	5,45%	4,61%	4,65%	90,47%
2007	50,62%	24,22%	5,63%	4,50%	4,69%	89,66%
2008	50,32%	25,09%	5,80%	4,67%	4,09%	89,98%
2009	49,56%	25,41%	5,70%	4,64%	4,08%	89,38%
2010	49,20%	25,88%	5,70%	4,72%	3,60%	89,10%
2011	48,69%	26,75%	5,42%	4,54%	3,77%	89,17%
2012	48,33%	26,50%	5,71%	4,38%	3,85%	88,77%

Source: own calculations based on data provided by WHO (2015).

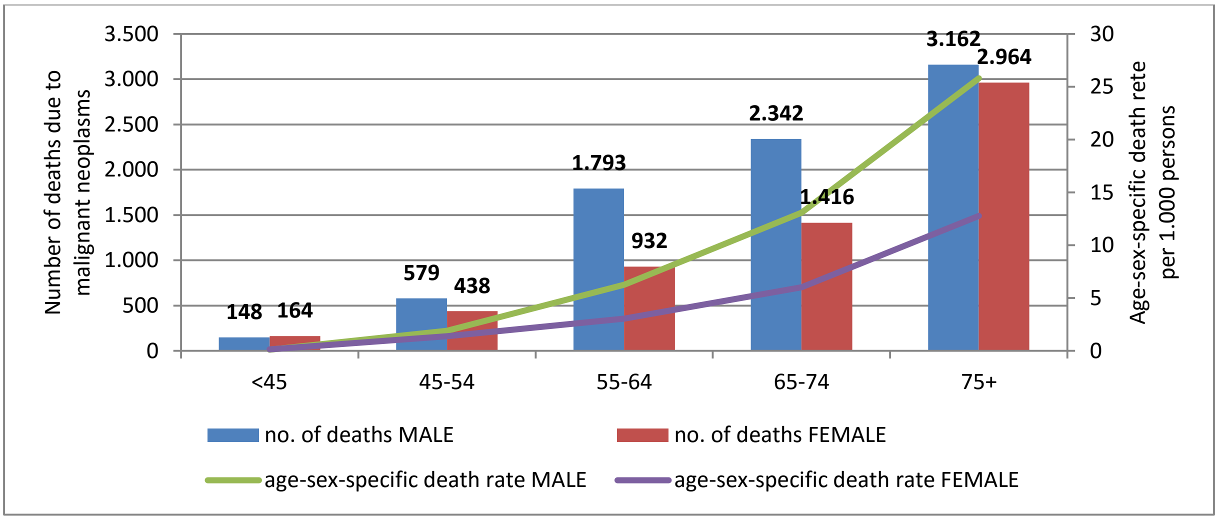
Circulatory diseases were the most common cause of death in Croatia yet since 1990's. According to the latest available data (CNIPH, 2015: 9), in 2013 24,232 deaths (569.4/100,000) were attributed to this group as compared to 26,710 deaths in 2000 (a decrease of 10 percent). Malignant neoplasms are the second most common cause of death in Croatia. Every fourth resident died from this cause in 2013. i.e. 14,012 people (329.6/100,000). This is an increase of 20 percent since 2000. Approximately three quarters of all deaths in Croatia is due to these two groups of diseases. Graphs 1 and 2 depict the distribution of deaths due to diseases of circulatory system and malignant neoplasms by age and sex in 2012.

Graph 1: *Deaths due to diseases of circulatory system by age and sex in 2012*



Source: own calculations based on data provided by CBS (2014).
Note: Cases with unknown age (although very rare) are distributed arithmetically among all other age groups. To accomplish the arithmetic distribution of the unknowns we employ a well-known prorating procedure (see e.g. Hobbs, 2014, pp. 154-155).

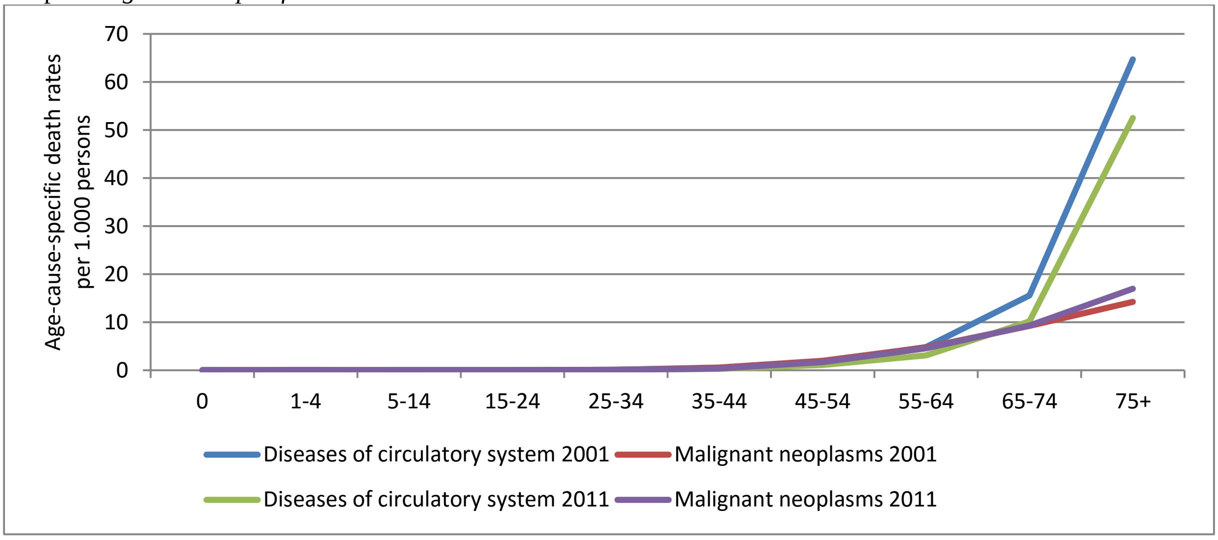
Graph 2: *Deaths due to malignant neoplasms by age and sex in 2012*



Source: own calculations based on data provided by CBS (2014).
Note: Cases with unknown age (although very rare) are distributed arithmetically among all other age groups.

Age-cause-specific death rates referring to two most common causes of death in Croatia (diseases of circulatory system and malignant neoplasms) do seem to be dropping in the reference period, albeit very slow (see graph 3).

Graph 3*: Age-cause-specific death rates in 2001 and 2011*

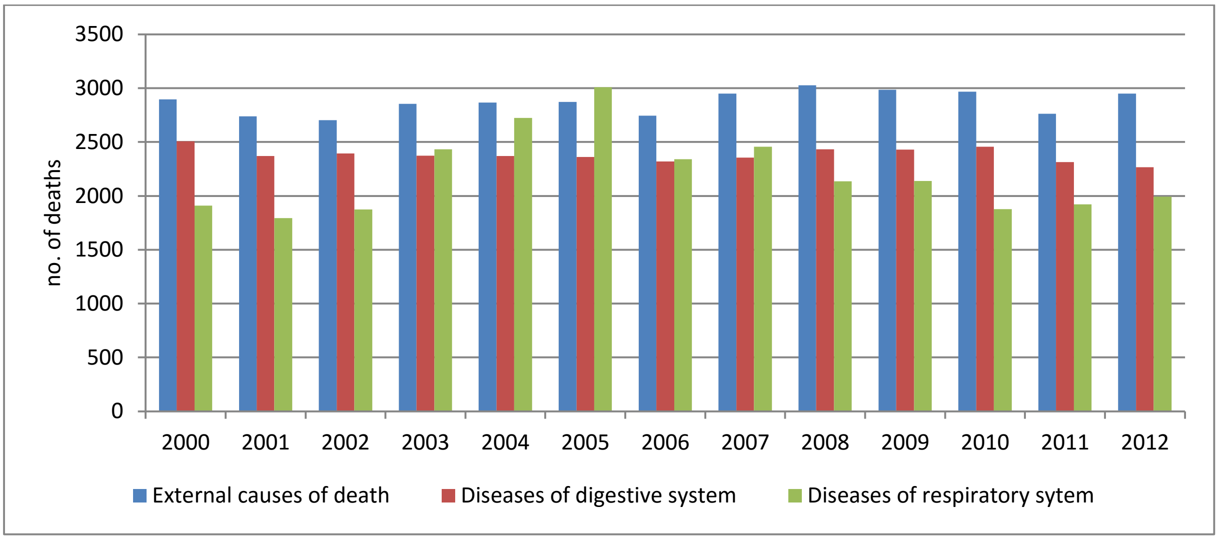


Source*: own calculations based on data provided by CBS (2003, 2013).*

Note: Cases with unknown age (although very rare) are distributed arithmetically among all other age groups.

The remaining deaths are related to injuries and poisoning, diseases of digestive system, respiratory system diseases and other less common causes. Their number remained relatively stable throughout the observed period (see graph 4).

Graph 4: *Deaths due to injuries, poisoning and certain other consequences of external causes, diseases of digestive system and respiratory system diseases in selected years*



Source: *WHO (2015).*

1. CAUSE-SPECIFIC MORTALITY FROM A MULTIPLE-DECREMENT PERSPECTIVE

This section introduces abridged cause-elimination life tables and multiple-decrement life table functions for five leading causes of death in Croatia (for both sexes combined).

We start by developing an abridged single-decrement life table where a cohort of persons is diminished as a result of deaths from all causes combined. The concepts and formulae used in the computation of an abridged single-decrement life table are listed in table 2.

Table 2: *Components of an abridged life table*

Abridged life table function	Formula
${}_nm_x$: death rate btween age x and $x + n$	${}_nm_x={}_nd_x/{}_nP_x$ (${}_nP_x$ stands for midyear population)
${}_nq_x$: probability of dying between age x and $x + n$	${}_nq_x=2\times n\times{}_nm_x/(2+n\times{}_nm_x)$
p_x: probability of survival to exact age $x + n$	${}_np_x=1-{}_nq_x$
l_x: survivors at age x	$l_{x+n}=l_x-{}_nd_x$
${}_nd_x$: deaths between age x and $x + n$	${}_nd_x={}_nq_x \times l_x$
${}_nL_x$: person-years lived between age x and $x + n$	${}_nL_x=n/2\times(l_x+l_{x+n})$
T_x: person-years lived beyond age x	$L_x=\sum L_{x+t}$ (t=0, 1, 2, …)
e_x: life expectancy beyond age x	$e_x= T_x/L_x$

Source: Yusuf et al. (2014).

The input data include registered deaths in Croatia by age for the period 2010-2012 (CBS 2012, 2013, 2014) and midyear population estimates (obtained from CBS by direct correspondence). The average annual death rates are calculated by dividing the annual average of 2010-2012 deaths by the 2011 midyear population.

The results obtained are exhibited in table 3 and serve as a benchmark of overall mortality when all causes of death are taken into account.

Table 3: An abridged life table for Croatia in 2011

Age	${}_nm_x$	${}_nq_x$	${}_np_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x
0	0,00426	0,00426	0,99574	100.000	426,2	99.701,7	7.756.997,4	77,57
1-4	0,00018	0,00074	0,99926	99.574	73,2	398.148,9	7.657.295,8	76,90
5-14	0,00012	0,00116	0,99884	99.501	115,2	994.430,2	7.259.146,9	72,96
15-24	0,00044	0,00435	0,99565	99.385	432,7	991.690,5	6.264.716,7	63,03
25-34	0,00063	0,00630	0,99370	98.953	623,3	986.410,1	5.273.026,2	53,29
35-44	0,00137	0,01364	0,98636	98.329	1.341,0	976.588,2	4.286.616,1	43,59
45-54	0,00423	0,04141	0,95859	96.988	4.016,0	949.802,9	3.310.027,8	34,13
55-64	0,01026	0,09755	0,90245	92.972	9.069,5	884.375,3	2.360.224,9	25,39
65-74	0,02506	0,22270	0,77730	83.903	18.685,3	745.601,6	1.475.849,7	17,59
75+	0,08931	1,00000	0,00000	65.218	65.217,5	730.248,1	730.248,1	11,20

Source: *own calculations based on data provided by the CBS (2012, 2013, 2014, direct correspondence).*

Note: *Cases with unknown age (although very rare) are distributed arithmetically among all other age groups. For age 0, m0 is taken as an approximation of q0. To estimate L75+ the formula l75+/ m75+ was employed.*

We next proceed to develop abridged cause-elimination life tables. Single-decrement life tables (such as the one exhibited in table 3) assume that the number of persons in the life table cohort can be decreased by attrition from only one cause of decrement: all causes of death combined. A multiple-decrement approach allows for an extension of this concept.

Simply put, multiple-decrement life tables simultaneously deal with several causes of death. To be more precise, life tables produced by a multiple decrement perspective show the mortality experience of a hypothetical cohort assuming that a particular cause of death is eliminated. We consider the leading causes of death for the population of Croatia (see previous section of this paper). Table 4 provides cause-specific deaths for the period 2010-2012 (averages) that are used to construct cause-elimination life tables.

Table 4: *Estimated population in 2011 and deaths by cause of death and age (for both sexes combined) in 2010-2012*

Age	Estimated population	Deaths from all causes	Deaths from					
			Diseases of circulatory system	Malignant neoplasms	External causes	Diseases of digestive system	Diseases of respiratory system	All other causes
0	41.773	178	1	0	4	0	3	170
1-4	170.400	31	1	8	5	0	0	17
5-14	437.470	51	3	11	21	0	0	16
15-24	504.221	220	9	27	152	2	2	28
25-34	582.424	368	42	63	203	11	5	44
35-44	570.281	783	162	223	226	61	9	102
45-54	626.576	2.649	693	1.084	344	244	55	229
55-64	587.840	6.028	1.837	2.694	366	484	164	485
65-74	413.131	10.353	4.212	3.835	396	566	409	935
75+	346.506	30.946	18.194	5.887	1.178	979	1.406	3.302

Source: *CBS (2012, 2013, 2014, direct correspondence), own calculations.*
Note: *Cases with unknown age (although very rare) are distributed arithmetically among all other age groups. Deaths from all other causes (the last column in the table) are calculated by subtracting the sum of deaths due to five leading causes from the total number of deaths.*

The cause-specific deaths listed in table 4 are used to construct multiple-decrement life tables which assume the elimination of a particular cause of death. We follow the procedure described in Yusuf et al. (2014, pp. 217-221) and present such a life table below (see table 5): it assumes the elimination of diseases of the circulatory system as the cause of death. The number of deaths in table 5 is calculated by ignoring the deaths caused by diseases of the circulatory system. The estimated total population by age in 2011 is used to calculate the ${}_nm_x$ values. All other columns in table 5 are calculated using the formulae given in table 2, i.e. each of the regular (abridged) life table functions is re-estimated under the assumption that no one dies from the selected cause of death.

Table 5: *Abridged life table for deaths due to causes other than diseases of circulatory system (for both sexes combined)*

Age	Deaths	${}_nm_x$	${}_nq_x$	${}_np_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x[1]
0	177	0,00424	0,00424	0,99576	100.000	423,8	99.703,4	9.195.327,9	91,95
1-4	30	0,00018	0,00071	0,99929	99.576	70,9	398.163,1	9.095.624,5	91,34
5-14	48	0,00011	0,00110	0,99890	99.505	109,1	994.507,7	8.697.461,4	87,41
15-24	211	0,00042	0,00418	0,99582	99.396	415,8	991.883,2	7.702.953,6	77,50
25-34	326	0,00056	0,00559	0,99441	98.980	553,1	987.038,7	6.711.070,5	67,80
35-44	621	0,00109	0,01083	0,98917	98.427	1.066,2	978.942,4	5.724.031,8	58,15
45-54	1.956	0,00312	0,03074	0,96926	97.361	2.992,6	958.648,8	4.745.089,4	48,74
55-64	4.192	0,00713	0,06886	0,93114	94.369	6.497,8	911.196,9	3.786.440,6	40,12
65-74	6.141	0,01486	0,13836	0,86164	87.871	12.157,9	817.918,4	2.875.243,7	32,72
75+	12.752	0,03680	1,00000	0,00000	75.713	75.712,9	2.057.325,3	2.057.325,3	27,17

Source: *own calculations based on data provided by the CBS (2012, 2013, 2014, direct correspondence).*
Note: *Deaths shown in the second column of this table are calculated by subtracting deaths due to diseases of circulatory system from the total number of deaths (see table 4). For age 0, m_0 is taken as an approximation of q_0. To estimate L_{75+} the formula l_{75+}/m_{75+} was employed.*

Multiple-decrement life tables assuming the elimination of malignant neoplasms, injuries, poisoning and other external causes, diseases of digestive system and diseases of respiratory system as the cause of death are constructed in the same manner. The results obtained are available from the authors upon request.

Table 6 presents the impact of eliminating selected causes of death on overall life expectancy. Columns in table 6 may be interpreted as follows.

$e_x^1 – e_x$: increase in life expectancy due to elimination of diseases of circulatory system as the cause of death
$e_x^2 – e_x$: increase in life expectancy due to elimination of diseases of malignant neoplasms as the cause of death
$e_x^3 – e_x$: increase in life expectancy due to elimination of external causes as the cause of death
$e_x^4 – e_x$: increase in life expectancy due to elimination of diseases of digestive system as the cause of death
$e_x^5 – e_x$: increase in life expectancy due to elimination of diseases of respiratory system as the cause of death
$e_x^6 – e_x$: increase in life expectancy due to elimination of all other causes but previous as the cause of death

Table 6: *Influence of eliminating selected causes of death*

Age	$e_x^1–e_x$	$e_x^2–e_x$	$e_x^3–e_x$	$e_x^4–e_x$	$e_x^5–e_x$	$e_x^6–e_x$
0	14,38	4,80	1,23	0,72	0,56	1,93
1-4	14,44	4,82	1,22	0,72	0,55	1,62
5-14	14,45	4,81	1,21	0,72	0,55	1,59
15-24	14,46	4,80	1,18	0,72	0,55	1,56
25-34	14,51	4,79	1,01	0,72	0,55	1,54
35-44	14,56	4,76	0,84	0,72	0,55	1,51
45-54	14,61	4,65	0,70	0,68	0,55	1,46
55-64	14,74	4,25	0,56	0,59	0,55	1,40
65-74	15,13	3,48	0,47	0,46	0,55	1,36
75+	15,98	2,63	0,44	0,37	0,53	1,34

Source: *own calculations based on data provided by the CBS (2012, 2013, 2014, direct correspondence).*

As can be seen from table 6, the effect is largest when it comes to eliminating diseases of the circulatory system as the cause of death ($e_x^1–e_x$ column). The gain in life expectancy at birth surpasses 14 years when this group of diseases is assumed to be eradicated as the cause of death. Such a development is not surprising when taking into account the share of deaths attributable to diseases of the circulatory in the total number of deaths (all causes combined). Second largest impact is that of the elimination of malignant neoplasms as the cause of death ($e_x^2–e_x$ column). Other leading causes of death have a much smaller impact.

Several points regarding multiple-decrement life tables presented in this section should be emphasized. Firstly, these tables do not provide a detailed insight into mortality patterns among persons suffering from a certain disease. To gain such an insight, special studies which would produce appropriate information need to be undertaken. Secondly, these tables assume only the eradication of a certain *cause of death*, not the elimination of an entire group of diseases (or any disease for that matter) as a *health condition*. This means that we assume that all of the selected diseases (or injuries) continue at the level prevailing in the period 2010-2012. Each person that would have died from those diseases is (for the purposes of our study) assumed to return to a normal state of health precisely at the moment when she otherwise would have died.

2. GAINS IN LIFE EXPECTANCY BY AGE: A DECOMPOSITION ANALYSIS

Life expectancy over the last few decades

Prolongation of life expectancy at birth in Croatia and other developed countries by more than 30 years presents one of the greatest economic, health and social achievements of the last century. The main reason for this great accomplishment is primarily seen in the reduction of mortality in younger age groups, especially in infancy and childhood. Over the last 50 years (during the period 1950-2010) life expectancy at birth in Croatia increased by about 9,2 years for men, or 1,8 years per decade. During the same period life expectancy for women increased by about 10,9 years, or 2,2 years by decade (CBS, 2014; Eurostat, 2015).

It is obvious that life expectancy at birth in Croatia and the EU is growing. Over the last decade (during the period 2000-2010) life expectancy at birth for women has increased by 1,8 years, i.e. increased by a little more than two months per year. At the same time, life expectancy at birth for men has increased by about 2,6 years, i.e. increased by a little more than three months each year (Eurostat, 2015). Thus, life expectancy at birth for men in Croatia grew faster during the last decade than over half a century's average. Also, differences in life expectancy between men and women gradually decreased. According to Eurostat (2015), life expectancy at birth for men in Croatia in 2013 amounted to 73,8 years, which is lower than in countries with the highest life expectancy in the EU for about 6 years. According to these figures, from a static perspective (assuming continuation of current annual/ten-year growth) Croatia lags behind other European countries for more than two decades. Although men in Croatia (other than those in Slovenia and the Czech Republic) can expect longer life expectancy than men from other former socialist countries, lagging behind western European countries is quite visible, and room for improvement and more rapid progress in reducing mortality and increasing life expectancy clearly exists. At the same time, life expectancy at birth for women in Croatia in 2013 amounts to 80,3 years, which is for about 4,6 years less than in France, the country with the highest life expectancy in the EU. If previous annual/ten-year growth continues, the expectation of life for women in Croatia will become significantly lower than the expectation of life for women in France (the difference being approximately 25 years in favor of France).

Gains in life expectancy 1993-2013

It is clear that life expectancy at birth in Croatia increased over the last two decades. During the period 1993-2013, life expectancy at birth for men extended by 3,5 years. The analogous extension for women is somewhat lower and amounts to 2,9 years.

Prolongation of life expectancy at birth can be achieved by lowering mortality throughout the entire life cycle. It is interesting to explore in which age group mortality decreased the most, i.e. where the gains in life expectancy were the highest. Analysis of changes in life expectancy, conducted by means of demographic decomposition techniques[1], shows that for men life expectancy at birth increased the most due to the reduction of mortality in the age group 60-69. For women, the highest contribution to the reduced mortality comes from the age group 70-79 (see tables 7 and 8).

[1] Gains in life expectancy are presented as a percentage breakdown of changes in life expectancy by age groups, for men and women separately in the period 1991-2013, and for each of the 28 EU member states, as well as for the EU28 as a whole. Among different composition methods, the so-called Arriaga's decomposition was used in this calculation. Arriaga's (1984) decomposition method is based on the concept of "temporary life expectancies". Arriaga (1984: 87) points out that "the effect that a change in mortality of a specific age group has on the life expectancy at birth or any other age may be the result of 'direct' and 'indirect' effects generated because mortality has changed only within the age group specified, and also due to 'interactions' as a consequence of changing mortality at older ages on the number of survivors". Arriaga (1984: 87) defined the direct effect as the effect on life expectancy "due to the change in life years within a particular age group as a consequence of the mortality change in that age group" and the indirect effect as "the number of life years added to a given life expectancy because the mortality change within (and only within) a specific age group will produce a change in the number of survivors at the end of the age interval".

Table 7: *Distribution of gains in life expectancy for men by age group, 1993-2013*

Member state	Changes in life expectancy at birth (years)	Distribution of changes by age group (%)										
		0	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
EU28	3,3	4,5	1,7	3,1	5,4	5,4	12,2	11,3	15,8	24,8	15,8	100
BE	5,1	8,3	1,5	3,7	6,0	5,3	8,3	8,7	18,4	26,6	13,3	100
BG	3,8	17,2	5,6	4,3	6,1	11,7	16,0	12,5	7,2	12,4	7,1	100
CZ	5,9	8,7	2,3	2,4	3,6	5,7	11,5	19,5	20,6	19,1	6,7	100
DK	5,8	3,8	1,2	2,6	4,7	8,1	8,9	11,5	24,3	25,9	9,2	100
DE	5,8	3,8	1,6	2,9	5,2	6,6	9,6	12,1	21,1	23,9	13,2	100
EE	10,5	10,1	2,5	4,6	10,9	11,1	17,5	19,3	13,4	7,1	3,5	100
IE	6,5	3,3	1,6	2,9	3,0	1,8	3,8	13,6	28,8	30,2	11,0	100
EL	3,7	10,1	1,8	3,4	7,3	4,2	5,0	1,9	18,2	25,0	23,1	100
ES	6,1	5,9	2,1	3,4	9,9	11,7	8,9	9,3	16,1	20,0	12,8	100
FR	5,6	4,8	1,7	3,1	7,8	9,4	10,2	10,3	17,7	20,6	14,4	100
HR	3,5	7,3	2,0	3,2	6,7	6,2	15,1	17,2	18,6	17,7	5,9	100
IT	5,7	5,8	1,8	3,3	5,8	6,8	6,2	12,3	23,3	23,4	11,2	100
CY	5,4	9,6	4,4	4,7	4,6	2,0	6,3	13,9	21,4	26,3	6,7	100
LV	4,9	8,5	4,6	2,9	14,6	11,8	15,7	16,9	12,8	7,7	4,4	100
LT	5,4	15,7	5,3	4,8	9,0	11,6	19,0	15,5	8,2	8,2	2,8	100
LU	7,6	2,9	3,0	4,1	8,4	8,3	8,0	8,7	19,8	25,3	11,6	100
HU	7,5	7,5	2,0	1,7	5,7	15,7	22,8	17,9	14,4	9,1	3,2	100
MT	4,8	12,6	3,4	5,4	4,1	3,4	3,3	11,0	19,6	23,9	13,3	100
NL	5,6	4,6	1,8	2,5	2,7	4,0	6,4	11,4	25,1	29,1	12,6	100
AT	5,8	5,1	1,4	4,4	6,7	5,7	9,4	12,7	20,0	22,8	11,9	100
PL	5,8	16,0	2,4	1,9	3,7	7,4	12,5	15,6	17,7	15,6	7,3	100
PT	6,6	7,7	4,3	5,8	10,7	9,3	5,7	8,5	17,8	19,6	10,6	100
RO	5,7	19,4	8,3	3,0	4,7	11,1	15,5	12,4	10,1	9,9	5,6	100
SI	7,8	5,1	1,0	2,7	6,9	8,2	12,6	17,6	21,3	17,0	7,7	100
SK	5,2	9,6	1,6	1,8	4,1	7,2	17,4	20,3	19,9	13,3	4,8	100
FI	5,9	3,9	1,7	2,4	3,3	5,1	10,3	13,3	21,0	26,6	12,4	100
SE	4,6	4,3	2,0	1,6	0,8	4,1	8,0	13,5	22,2	28,7	14,9	100
UK	5,7	3,9	1,6	2,2	3,4	1,6	2,9	12,5	28,2	30,4	13,2	100

Source: *European Commission (2015).*

Table 8: *Distribution of gains in life expectancy for women by age group, 1993-2013*

Member state	Changes in life expectancy at birth (years)	Distribution of changes by age group (%)										
		0	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+	Total
EU-28	2,5	5,3	1,8	1,8	2,0	2,9	7,2	6,9	10,8	28,0	33,3	100
BE	3,3	8,5	1,4	2,5	3,2	2,9	6,8	4,0	10,4	29,5	30,7	100
BG	3,5	14,3	5,8	2,6	3,6	3,4	1,4	4,4	19,8	28,5	16,2	100
CZ	4,8	8,7	2,0	1,7	1,9	3,6	6,5	9,5	18,7	30,3	17,1	100
DK	4,6	2,2	2,2	1,8	1,8	4,4	9,5	14,4	24,9	23,4	15,4	100
DE	3,8	4,5	2,0	2,0	2,4	4,3	7,8	7,2	15,4	31,8	22,6	100
EE	7,7	11,1	3,1	1,7	2,8	3,7	10,1	11,1	18,5	21,4	16,3	100
IE	5,0	4,1	1,0	1,0	0,7	2,2	5,1	9,4	21,2	32,4	22,9	100
EL	4,2	8,8	1,4	1,8	1,9	1,5	2,6	2,3	15,9	30,7	33,2	100
ES	4,7	6,2	2,4	1,7	4,0	4,2	3,6	4,0	12,4	26,6	34,8	100
FR	3,9	4,3	1,8	2,4	4,2	5,0	5,2	4,6	11,0	23,3	38,2	100
HR	2,9	10,8	1,3	2,0	0,8	1,9	4,6	8,4	19,2	33,0	18,1	100
IT	4,3	7,4	3,0	1,7	2,6	3,7	4,0	6,8	13,9	27,0	30,0	100
CY	5,2	11,4	1,7	0,7	4,0	2,2	3,9	6,5	13,7	35,5	20,2	100
LV	3,1	12,0	7,5	4,3	0,2	4,1	3,6	14,4	13,1	19,9	20,9	100
LT	3,6	17,1	3,7	1,9	2,4	3,7	8,1	11,6	13,4	23,3	14,9	100
LU	4,3	2,7	2,4	2,7	2,7	2,7	4,3	11,9	12,7	29,1	29,1	100
HU	5,1	10,3	2,4	1,6	2,6	10,3	13,4	10,5	16,1	20,0	12,6	100
MT	4,5	0,1	0,6	1,4	0,5	0,9	3,0	8,9	20,0	36,9	27,9	100
NL	3,1	4,9	3,1	1,4	2,6	4,7	6,5	7,4	13,3	27,7	28,3	100
AT	4,4	5,7	2,0	2,3	2,6	3,5	7,7	9,0	12,6	28,4	26,2	100
PL	5,3	15,1	2,2	0,9	1,4	3,6	7,1	6,8	14,1	27,4	21,4	100
PT	5,9	7,2	3,5	2,3	3,3	3,9	5,1	8,5	14,3	26,4	25,4	100
RO	5,4	17,3	7,4	1,4	2,2	5,6	7,5	8,6	14,7	21,4	13,8	100
SI	6,0	3,6	2,1	1,1	2,7	3,7	7,0	10,2	18,2	28,1	23,4	100
SK	3,8	7,3	2,5	1,3	1,9	3,3	5,7	12,8	21,5	31,3	12,5	100
FI	4,6	4,2	0,9	0,4	1,4	3,1	4,5	6,3	13,8	32,4	32,9	100
SE	2,9	4,6	2,0	2,3	1,1	4,2	7,0	9,4	16,2	26,4	26,6	100
UK	4,1	4,6	1,6	1,7	1,5	1,3	4,1	10,0	24,4	30,9	20,0	100

Source: European Commision (2015).

In tables 7 and 8 the first column represents the absolute difference between life expectancy at birth in 2013 and life expectancy at birth in 1993. The columns to its right show the relative (percent) distribution from a mortality reduction in the corresponding age group to the total increase in life expectancy: positive numbers indicate a decline in mortality for the specified age group, which in turn contributes to a longer life expectancy (European Commission, 2015).

In Belgium, Greece, Spain, France, Italy, Luxembourg, Malta, the Netherlands, Austria, Portugal, Finland and Sweden the decline in mortality at ages 80+ contributed the most to the increase in life expectancy at birth for women. For men, the highest contribution in terms of mortality can be observed in the 70-79 age groups.

In sum, changes in life expectancy at birth over time decomposed into contributions of specific age groups show that gains in life expectancy in western European countries are found in older age groups than in the majority of former socialist countries, including Croatia. We expect (with reference to past trends) a further extension of life expectancy at birth in Croatia that will be achieved through a decrease in mortality among the oldest old subgroup of the population.

POLICY IMPLICYTIONS

Disease prevention, especially primary prevention is always of special importance. Infectious and non-infectious diseases i.e. major public health problems including cardiovascular diseases, malignant diseases, mental disorders, respiratory disease, diabetes, injuries, diseases of the digestive system and oral health are subject of preventive programmes. Three levels of prevention should be emphasized: (1) the primary level with purpose to increase the vaccination coverage, health promotion, information and education of the population; (2) at the secondary level it is necessary to strengthen the capacity of primary health care for early detection and intervention, improve the management, coordination and promotion of national programmes and (3) tertiary level aims to implement measures to preserve and improve the health of the ill, elderly and disabled in order to maintain their functional ability in everyday life.

Tradition of public health actions in Croatia has been quite long and strong but yet much inefficiency still persists. Prevention activities in Croatia are funded through the Central budget, and have been notably influenced by the excessive deficit procedure. Many prevention programmes and activities that overlap are combined with low level of coordination at regional and national level among key institutions Croatian National Institute of Public Health and county public health institutes. This situation resulted in unsatisfactory coverage of certain subpopulations, the absence of individual programmes evaluation and, consequently, poor access to effective and efficient interventions. To conclude, the use of existing resources in prevention programmes in general has been inefficient and suboptimal. However, certain issues can be resolved by implementing a systematic approach allowing us identification of successful prevention projects or the adoption of algorithms for implementing the program recommended by health professionals.

Key public health programmes in Croatia are summarized in table 9. They are all national programmes and are developed and approved by the Ministry of Health.

Table 9: *Public health programmes in Croatia*

Programme	Duration
Mandatory Vaccination Programme	1948 (ongoing)
Breastfeeding Promotion Programme	1992 (ongoing)
National Programme for Roma	2003 (ongoing)
National Plan of Preparedness for Flu Pandemic	2005 (ongoing)
National Programme of Prevention and Early Detection of Breast Cancer	2006 (ongoing)
National Programme of Prevention and Early Detection of Colorectal Cancer	2007 (ongoing)
Programme of Psycho-social Aid at Children's Oncology Wards	2007 (ongoing)
National Programme of Health Care of Persons with Diabetes	2007 (ongoing)
Programme of Protection Against Domestic Violence	2009 (ongoing)
National Programme for Control of Antibiotic Resistance of Bacteria	2009–2014
System of Prevention and Treating Addictions and Mental Health in County Institutes of Public Health	2009 (ongoing)
Prevention of Injuries in Children	2010 (ongoing)
Prevention of Obesity (Action Plan)	2010–2012
National Programme for Prevention of HIV/AIDS	2011–2015
Prevention of Suicide in Children and Youth	2011–2013
National Programme of Prevention and Early Detection of Cervical Cancer 2012	(ongoing)

Source: Džakula et al. (2014: 101).

One of the leading public health problems in Croatia are malignant neoplasms. This cause of death holds a second place on mortality scale with a share of 27% in 2013, and the same pattern is observed in the number of hospitalizations with a share of 14.1% (CNIPH, 2015). Recognizing the size of this problem in Croatia, three programmes for early detection of cancer (breast, colon and cervix) have been implemented.

The National Programme for the Early Detection of Breast Cancer, established in 2006, was the first national programme for the early detection of malignant diseases in Croatia. The goal of mammography screening is to reduce mortality from breast cancer by 25 percent five years after this programme implementation. First cycle call ended in 2009 when 720,982 women were invited at mammogram, and 46 percent of them actually completed a mammography scan. In 1593 cases a breast cancer was confirmed (Parun Šupe, 2011). In the second cycle in late 2011 610,279 women of target age group were invited. The average turnout was around 60 percent. Another 262,910 mammography screenings have been carried out in 2014 and 798 cancer cases were discovered (about 380,000 women invited during

2014 within third cycle). Last cycle call started in May 2014 when 190,265 women were invited and is still in progress. In 64,660 mammography screenings 28 cancer cases have been discovered (Antoljak et al., 2015).

The National Programme for the Early Detection of Colorectal Cancer was started in 2007 and includes an occult blood test for all persons over the age of 50 (Džakula et al., 2015: 101). In the first cycle 808,913 tests have been sent and only 19.9 percent were returned back. In this round 7.7 percent of tests were positive, and 388 cancers were confirmed (Strand & Šogorić, 2010: 461). The second cycle on early detection of colorectal cancer began in 2013. By the end of 2014 the overall average turnout was 21 percent in the invitation letter ranging from 15 to 37 percent. Around 249 thousand tests for 83,067 people were processed resulting in 3,104 positive results or 3.7 percent (Antoljak et al., 2015).

The Early Cervical Cancer Detection Programme was launched at the end of 2012 and will include a Pap smear every three years for women aged 25–64 (Džakula et al., 2015: 101). Approximately 685,891 women in several rounds were invited so far. The response rate at the national level is 11%. In the first four invitation rounds in 2014 of 271,873 invited women 33,597 responded and 31,922 made Pap smear, of which 2,540 showed abnormal findings (6.7%) (Antoljak et al., 2015).

National health care programme for diabetes was launched in Croatia in 2007, and is primarily focused on prevention, on early diagnosis, the early recognition and treatment of diabetes in pregnancy and reduce the number of complications in this disease.

National programme of mass vaccination is one of the most successful and most comprehensive preventive health actions in the country.

The results presented in this paper indicate the importance of health promotion and interventions regarding the reduction of the prevalence of circulatory system diseases, which could lead to a morbidity compression, especially in advanced, older ages. Obviously, some measures are already being implemented. Most of them are aimed at raising the awareness about malignant neoplasms. However, in line with our research findings, there is still room for further increases in life expectancy, which calls for refinements in current health policy.

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