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AGE- AND CAUSE-SPECIFIC COMPONENTS OF RECENT LIFE EXPECTANCY IMPROVEMENTS IN CROATIA, SERBIA AND SLOVENIA

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All ex-Yugoslav countries experienced improvements in life expectancy during the last few decades. This study describes and compares recent life expectancy trends in Croatia, Serbia and Slovenia. What age groups and what causes of death account for the largest mortality declines? Have the three countries joined the cardiovascular revolution? Do patterns differ between countries? And, is there room for further improvements? We use life tables and decomposition methods to address these questions. Our key findings are: 1) lower mortality from circulatory diseases at older ages contributed most to life expectancy growth 2001–2017 for both sexes in all three countries; 2) despite this common pattern, life expectancy in Slovenia grew fastest and the gap between countries increased; 3) under the Slovenian age-specific cardiovascular mortality schedule, Croatia added 1.79 years to both female and male life expectancies, while Serbia added 3.97 and 3.26 to female and male life expectancies.

Keywords: life expectancy, age- and cause-specific mortality, past and potential gains in life expectancy, decomposition analysis, ex-Yugoslav countries

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INTRODUCTION

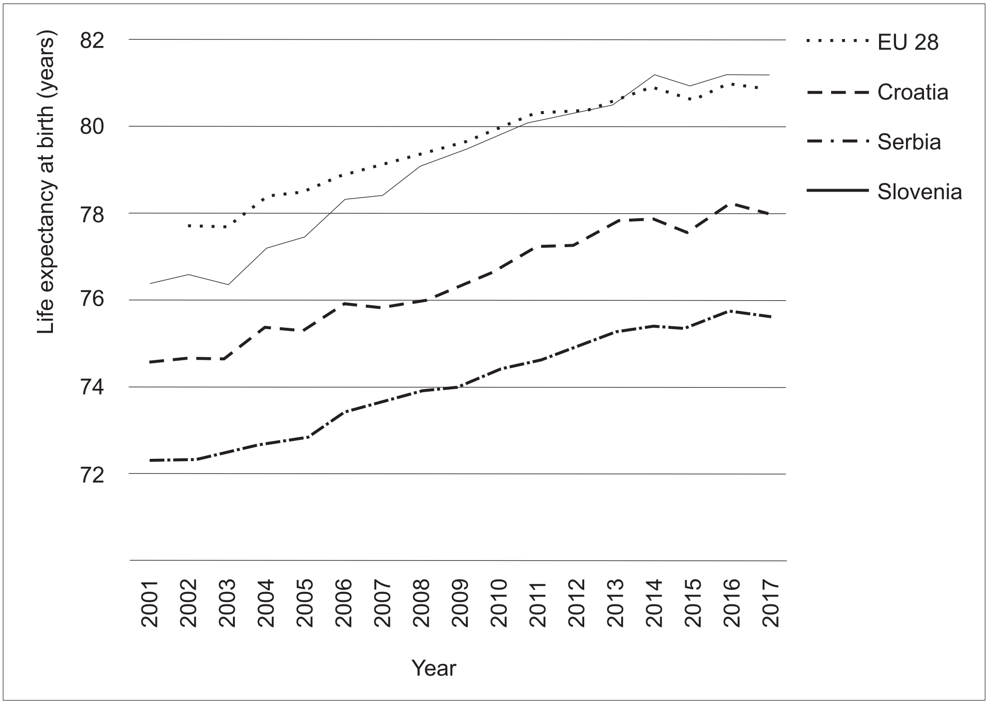
Demographic transition – i.e., a long-term shift from high to low death and birth rates (e.g., Kirk, 1996) – inevitably leads to population ageing: fewer births increase the share of older people and longer lives augment their numbers. A nickname for this widespread phenomenon has already been coined, 'the silver tsunami' (e.g., Bartels & Naslund, 2013).

Life expectancy has been increasing worldwide over the last two centuries (Oeppen & Vaupel, 2002). While at the beginning of the demographic transition, most of the gains in life expectancy came as a result of declining infant and child mortality, developed countries are nowadays at the forefront of the 'longevity transition' (Eggleston & Fuchs, 2012), wherein most of the gains in life expectancy are realised later in life. Thus, the economic and social burden of raising children that is typical of the onset of the demographic transition has nowadays shifted towards securing support for the elderly. Even the most developed countries are struggling to find resources for the retirement income, health care costs and long-term care for the bulging elderly population (Ogura & Jakovljevic, 2014). The growing burden of the ageing population necessitates a policy response, but insufficient fiscal capacities often limit the scope of policy interventions.

The theory of epidemiologic transition (Omran, 1971) provides a framework for a more detailed explanation of mortality decline over the course of the demographic transition. The theory posits that initial gains in life expectancy are driven by declining mortality from communicable diseases that mainly affect the young. During the final transition stage, mortality from communicable diseases drops to very low levels, with degenerative diseases or 'lifestyle illnesses' (e.g., diseases of the circulatory system or neoplasms) emerging as the leading cause of death (Eggleston & Fuchs, 2012; Canudas-Romo & Schoen, 2005; Klenk, Keil, Jaensch, Christiansen, & Nagel, 2016). The end result of the epidemiologic transition is a slow-down in life expectancy growth. This, however, has not proven to be the experience of developed countries, where life expectancy continued to rise rather quickly throughout the latter half of the twentieth century (Timonin et al., 2016), with most of the improvements arising from declining cardiovascular mortality (Grigoriev et al., 2014). The health transition theory (Frenk, Bobadilla, Stern, Frejka, & Lozano, 1991) has established a broader framework to explain these developments, and subsequent extensions of the model (Vallin & Meslé, 2004) introduce the concept of the 'cardiovascular revolution' (steady reductions in cardiovascular mortality) as a major contributor to contemporary increases in life expectancy (Foege, 1987; Vallin & Meslé, 2004).

FIGURE 1
Life expectancy at birth (e_0) for Croatia, Serbia, Slovenia, and EU-28, 2001–2017

This paper investigates the driving forces behind the most recent trends in life expectancy at birth, e_0, in three ex-Yugoslav countries: Croatia, Serbia and Slovenia. The changes in e_0 are shown in Figure 1.



Source: Eurostat, 2019a

Our study builds on the findings of Kunitz (2004), who reported that ex-Yugoslav countries experienced a convergence in e_0 during the 1970s, a stagnation of e_0 during the 1980s, and substantial divergence in e_0 during the 1990s (due to profound social, economic and political change). We update his findings by analysing trends in life expectancy at birth in Croatia, Serbia and Slovenia from 2001 to 2017. The data needed to study e_0 in detail (i.e., data on age-, sex- and cause-specific mortality) are not readily available for all ex-Yugoslav countries; however, they are available for Croatia, Serbia and Slovenia. Comparative research on life expectancy trends within the region is of particular interest because, to the best of our knowledge, no systematic analysis of newer developments in e_0 across ex-Yugoslav countries has been conducted until now.

Conveniently, Croatia, Serbia, and Slovenia represent quite different mortality regimes. Slovenia was the most developed republic within ex-Yugoslavia, and it was well ahead of other republics in many social and economic aspects. Slovenia joined the EU in 2004, and it has had the highest GDP per capita and the highest e_0 compared with all other ex-Yugoslav countries. Compared to other South-Eastern European countries, the health expenditure of the countries that joined the EU in 2004 grew most rapidly over the 1989–2012 period and, coupled with growing societal welfare, ultimately led to longevity gains (Jakovljevic, Vukovic, & Fontanesi, 2016). Slovenian e_0 today surpasses the EU-28 average (see Figure 1). Croatia, an EU member since 2013, experienced war devastation both in terms of lives lost and infrastructure damage during the 1990s. During and after the war, the health care system had to overcome a serious shortage of resources (Kovačić & Šošić, 1998). Serbia has been negotiating its EU accession since 2014. Although Serbia had no direct war conflicts in its territory, it experienced an economic collapse and a deterioration of public health infrastructure, both of which were exacerbated by UN and US sanctions (Garfield, 2001). Serbia is at the bottom end of the e_0 spectrum, with the lowest e_0 in the region (Eurostat, 2019a).

As Figure 1 shows, between 2001 and 2017, life expectancy at birth increased in all three countries, but not to the same extent. Life expectancy at birth increased most for Slovenian men, and least for Croatian women.

In this paper, we not only describe and compare the above-mentioned trends in life expectancy at birth in Croatia, Serbia and Slovenia, but we also broaden the understanding of within- and between-country variations in e_0 by decomposing changes by age and cause of death. Our main goal is to identify age-cause-specific contributions to gains in e_0, separately by sex. Several research questions guide the analysis: What drove the latest increase in life expectancy at birth? More specifically, what age groups and what causes of death account for the largest mortality declines? Have the three countries joined the cardiovascular revolution? Do patterns differ between countries? And is there room for further improvements? We use life tables and decomposition methods to address these questions.

The remainder of this paper is organised as follows. In the next section, we describe the data and methods. Following that, we present the results and in the last section we conclude with a policy-oriented discussion of our main findings.

DATA AND METHODS

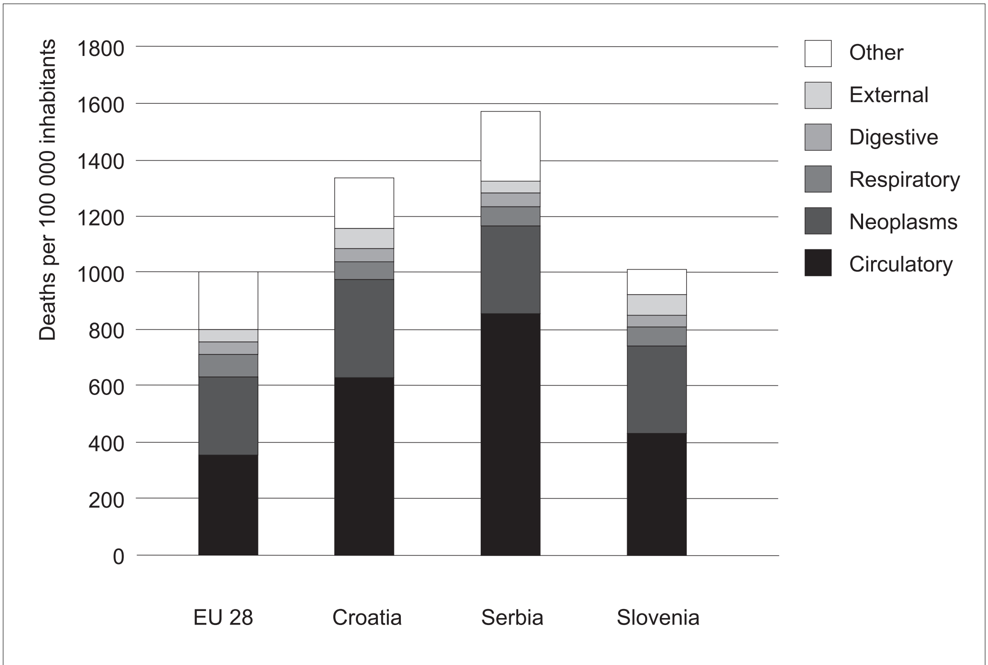
In analysing life expectancy at birth, we used Eurostat data on the Croatian, Serbian and Slovenian populations by age group and sex (Eurostat, 2019b), and data on the number of deaths by sex, age group, and the cause of death provided by national institutes of the three countries (Croatian Bureau of Statistics, 2019; Statistical Office of the Republic of Serbia, 2019;

National Institute of Public Health, Slovenia, 2019). Our analysis begins in the year 2001 when all three countries adopted comparable death recording methodologies, with the latest data on cause of death referring to 2017.

We used data on deaths in 5-year age groups, with the first age group (less than 5 years) split into two (aged less than 1 and aged 1–4), because of the mortality peak in infancy.

We analysed deaths by the five main groups of causes of death (ICD-10), which accounted for more than 80% of all deaths in the EU over the last years (just below 90% in Croatia, around 86% in Serbia, and slightly above 90% in Slovenia): 1) diseases of the circulatory system, 2) neoplasms, 3) diseases of the respiratory system, 4) diseases of the digestive system, and 5) external causes of morbidity and mortality. Age-standardised cause-specific mortality rates for 2016 using the European standard population (Eurostat, 2013) are presented in Figure 2.

FIGURE 2
Age-standardised cause-specific mortality rates (deaths per 100 000 inhabitants) for five major groups of causes of death in 2016 in Croatia, Serbia, Slovenia, and EU-28



Source: Eurostat, 2019c (the latest available data for age-standardised cause-specific mortality rates are for 2016)

All the remaining causes of death are combined in a group called 'other causes of death', where the main causes vary by age and also by country (with the exception of the youngest age, when other causes of death mainly refer to perinatal complications in all analysed countries).

Life tables and life expectancy at birth e_0

We performed the analysis of life expectancy using life tables, which are statistical models describing age-specific mortality rates of an actual population in a given year (Malačič, 2006; Kintner, 2003). A life table is a rectangular matrix which shows how various life table functions, such as probability of dying and number of survivors, change with age (Shkolnikov, 2015) and, as such, imitate the dying-off process. We used abridged period life tables for 5-year age groups. We began by calculating death rates ${}_nm_x$ by age and cause of death, separately for men and women, from which all other functions in the life table were then derived. Life expectancy at birth e_0 shows the average remaining lifetime (in years) for a newborn, assuming that throughout his or her life the mortality pattern would be according to the life table. It is the most synthetic and widely used measure of mortality. Because it is not affected by age distribution and is therefore comparable geographically and across time, it is traditionally also used as one of the indicators of country development.

Decomposition of e_0 change

To distinguish contributions to the observed increase in e_0 due to specific age groups and causes of death, we performed the e_0 decomposition. We decomposed the change in e_0 from the age perspective using the Pressat (1985) formula, which fixes the shortcomings of the underlying approaches by Arriaga (1984) and Pollard (1988):

$$e_0{}^{t+i} - e_0{}^{t} \cong \sum_{x=0}^{\omega}[0.5\ (l_x{}^{t} + l_x{}^{t+i})\ (e_x{}^{t+i} - e_x{}^{t}) - 0{,}5\ (l_{x+n}{}^{t} + l_{x+n}{}^{t+i})\ (e_{x+n}{}^{t+i} - e_{x+n}{}^{t})]\ /\ 100\ 000$$

where notations represent the standard life table functions with a 100 000 radix, and t and $t + i$ denote different points in time, different countries, or any other different populations.

In addition to this decomposition of e_0 change by age, we simultaneously conducted decomposition by cause of death (Arriaga, 1995). This technique requires mutually exclusive and exhaustive causes of death (this is the reason for generating the sixth group of causes of death, called 'other'). Using this procedure, we assumed that the contribution ${}_cSAC_j({}_ne_x)$ of an individual cause of death c to the age specific life expectancy change in each age group j $SAC_j({}_ne_x)$ was proportional to the share of mortality change ${}_cC_j$ due to the relevant cause of death in the relevant age group within the change C_j of the total mortality rate in the same age group:

$${}_cSAC_j({}_ne_x) = SAC_j({}_ne_x)\ {}_cC_j / C_j,$$

where ${}_cC_j = {}_cm_j{}^{t+i} - {}_cm_j{}^{t}$ and $C_j = \sum_c {}_cC_j$.

Potential gains in life expectancy (PGLE)

The approach presented in the previous section can be used also for decomposing potential gains in life expectancy by age (Liu et al., 2014; Tsai, Lee, & Hardy, 1978), after elimination of an individual cause or for decomposing the difference in e_0 between two countries simultaneously by age and cause.

The increase in life expectancy due to reduced mortality from an individual cause of death can be estimated in different ways. It is often assumed that a particular cause of death can be either completely or partially eliminated (Tsai et al., 1978).

To calculate potential gains in life expectancy (PGLEs) for each country sex combination using an individual cause elimination approach, we prepared six separate life tables (one for each of the five major causes of death plus one for 'other' causes). In every life table we eliminated a different cause of death, assuming no changes in the other causes of death. Such life tables are called cause-deleted life tables (Beltrán-Sánches, Preston, & Canudas-Romo, 2008). Compared with the master life table, the only difference is the number of deaths for the analysed cause, which is now set to 0, whereas the number of deaths for the other causes remains unchanged. Cause-elimination life tables thus answer the hypothetical question of how much lower mortality could be expected if a particular cause of death was eliminated. The obtained PGLEs can be therefore considered to be a measure of importance of each cause of death. By constructing cause deleted life tables, it is assumed that there are no interdependencies between the causes of death. In reality, however, eradication of a certain disease is likely to result in an increase in other diseases, especially in older ages, when people often have more than one illness (Kintner, 2003; Manton, Patrick, & Stallard, 1980).

Of course, complete elimination of certain causes of death is unrealistic and PGLE serves mostly as an indicator of the importance of a cause of death. In addition to PGLEs based on cause-deleted life tables, we therefore calculated also the effects of partial reduction in mortality for each cause (Tsai et al., 1978). We decomposed the hypothetical increase in e_0 if the probability of dying of a certain country could decrease to the level of a comparable country with lower mortality.

We took Slovenia as a benchmark because it is comparable with Croatia and Serbia (the three countries shared more than 70 years of common history in the twentieth century) and because it is the best performing country among the three (from 2014 on, its e_0 has been higher than the EU-28 average). We calculated the increase in e_0 for Croatia and Serbia under the assumption that by 2017 the Croatian and Serbian probabilities ${}_nq_x$ would have decreased to Slovenian levels. By decomposing this difference, we identified age groups and causes of death where there are the most possibilities for improvement.

RESULTS

Life expectancy at birth e_0 has been increasing[1] since 2001 in Croatia, Serbia and Slovenia, as presented in Table 1.

Country and Sex	HR (F)	HR (M)	HR (diff)	RS (F)	RS (M)	RS (diff)	SI (F)	SI (M)	SI (diff)
2001	78.1	70.9	7.2	75.0	69.7	5.3	80.5	72.3	8.2
2002	78.3	71.0	7.3	75.0	69.8	5.2	80.5	72.6	7.9
2003	78.1	71.0	7.1	75.1	70.0	5.1	80.4	72.6	7.7
2004	78.8	71.8	7.0	75.5	70.1	5.4	80.8	73.5	7.2
2005	78.8	71.7	7.1	75.5	70.2	5.3	80.8	73.9	6.9
2006	79.3	72.4	6.9	76.1	70.8	5.3	82.0	74.6	7.4
2007	79.2	72.2	7.0	76.4	71.0	5.4	82.0	74.6	7.4
2008	79.6	72.3	7.3	76.5	71.3	5.2	82.6	75.6	7.0
2009	79.6	72.8	6.8	76.7	71.3	5.3	82.6	75.9	6.7
2010	79.9	73.4	6.5	76.9	71.7	5.2	83.0	76.4	6.6
2011	80.3	73.8	6.5	77.2	72.0	5.2	83.3	76.8	6.5
2012	80.6	73.9	6.7	77.4	72.3	5.2	83.3	77.1	6.2
2013	80.9	74.4	6.5	77.9	72.6	5.3	83.6	77.2	6.4
2014	81.0	74.7	6.3	77.9	72.7	5.1	84.1	78.2	5.9
2015	80.5	74.3	6.1	77.8	72.7	5.1	83.8	77.8	6.1
2016	81.3	74.9	6.3	78.2	73.2	5.1	84.2	78.1	6.0
2017	80.9	74.9	6.0	78.1	73.1	4.9	84.0	78.2	5.8
Change	2.8	4.0	-1.2	3.0	3.4	-0.4	3.5	5.9	-2.4

TABLE 1
Life expectancy at birth e_0 (in years) by sex, along with sex differential and 2001–2017 change for Croatia (HR), Serbia (RS), and Slovenia (SI), 2001–2017

Besides the obvious increase in e_0 in all three analysed countries, we also note that the increase in e_0 for men has been larger than that for women, causing the quite large sex differential to reduce, especially in Slovenia, but also in Croatia.

The main goal of our analysis was to identify those age groups and causes of death that contribute most to the observed increase in e_0. In Figure 3, panels a–c, we present the e_0 increase attributed to each age and cause group for each of the three countries.[2]

In all three analysed countries, the greatest contribution in e_0 increase was due to decreased mortality from circulatory diseases in older ages for both sexes. Circulatory diseases in general represented from 35.10% of total e_0 change for Slovenian men to up to 93.33% for Croatian women. In Croatia and Serbia, decreased infant mortality had a strong effect too, especially for Serbian boys and girls in both countries. Another notably high percentage also appears for the oldest old women in Slovenia due to 'other' causes, while there have been obvious improvements in external causes of death for men of ages between 15 and 50 years in all three countries.

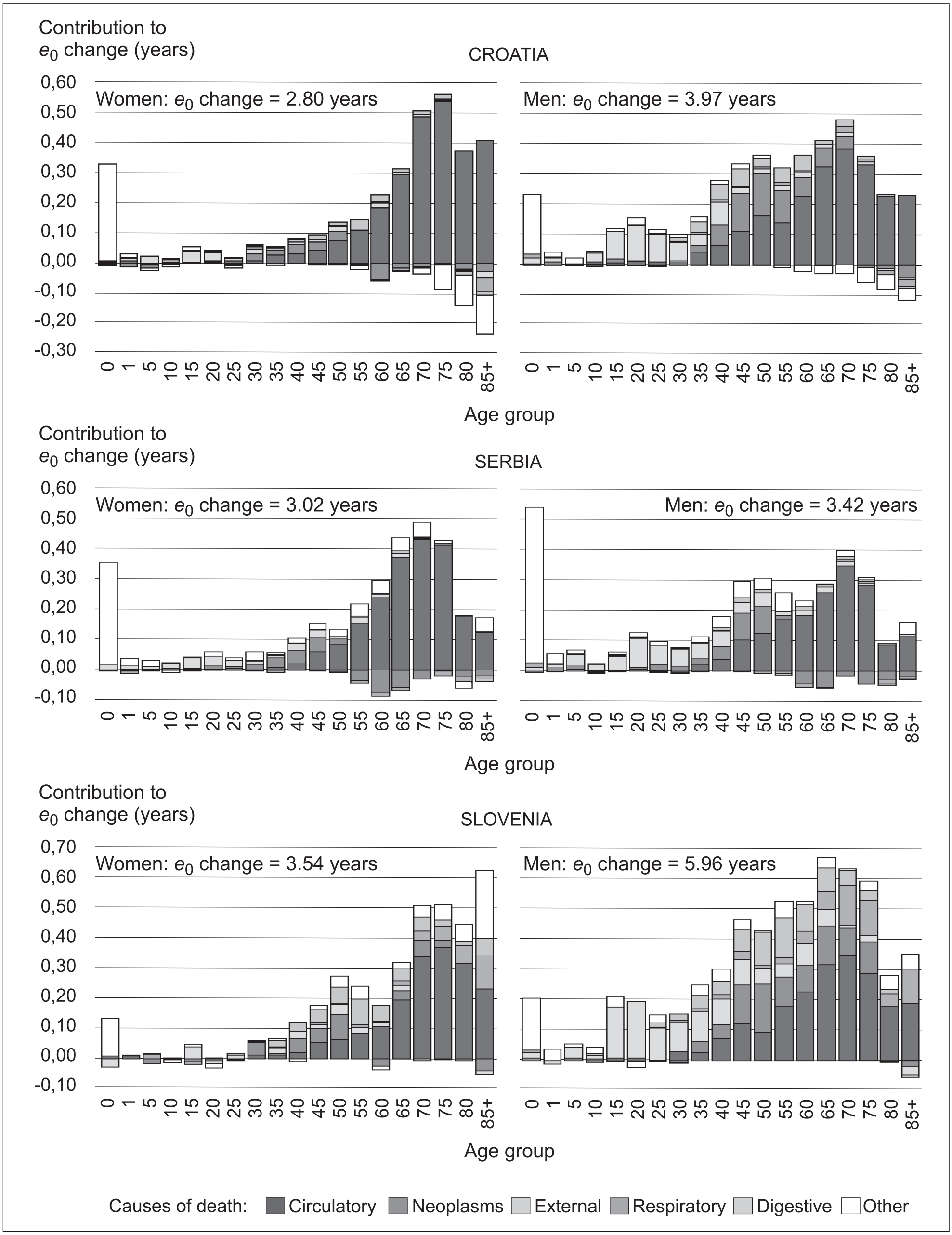


FIGURE 3
Contributions of age groups and different causes of death to the increase in life expectancy at birth e_0 (in years) by sex between 2001 and 2017

We also noticed some negative contributions to the increase in e_0, for example in neoplasms for Croatian and Serbian women (especially above 55 years), which means that the overall mortality rate from neoplasms has actually increased in 2017 compared with 2001. This holds for Serbian men too; however, in Serbia an even greater negative effect was due to respiratory diseases for both sexes.

All in all, despite the significant increase in e_0, possibilities for further improvement still remain. To assess these potential gains in life expectancy (PGLEs), we calculated e_0 from cause-deleted life tables and decomposed the differences to e_0 from the master life table. The results are presented in Table 2 for all ages combined.

➲ TABLE 2
Potential gains in life expectancy at birth e_0 (sum across all age groups, in years) by country and sex in 2017 if a group of causes of death were completely eliminated

	PGLE (years)	Croatia	Serbia	Slovenia
Women	Circ.	8.17	11.86	9.4
	Neo.	3.15	2.84	3.91
	Ext.	0.53	0.32	0.82
	Resp.	0.48	0.48	0.63
	Dig.	0.38	0.28	0.41
	Other	2.02	2.16	1.53
Men	Circ.	5.95	8.97	5.04
	Neo.	4.09	3.3	4.61
	Ext.	1.29	0.97	1.48
	Resp.	0.61	0.63	0.61
	Dig.	0.65	0.43	0.59
	Other	1.78	2.47	1.68

Explanation of abbreviations for causes of death: Circ. – diseases of the circulatory system, Neo. – neoplasms, Ext. – external causes of morbidity and mortality, Resp. – diseases of respiratory system, Dig. – diseases of digestive system, Other – all other causes of death not included in previous five groups.

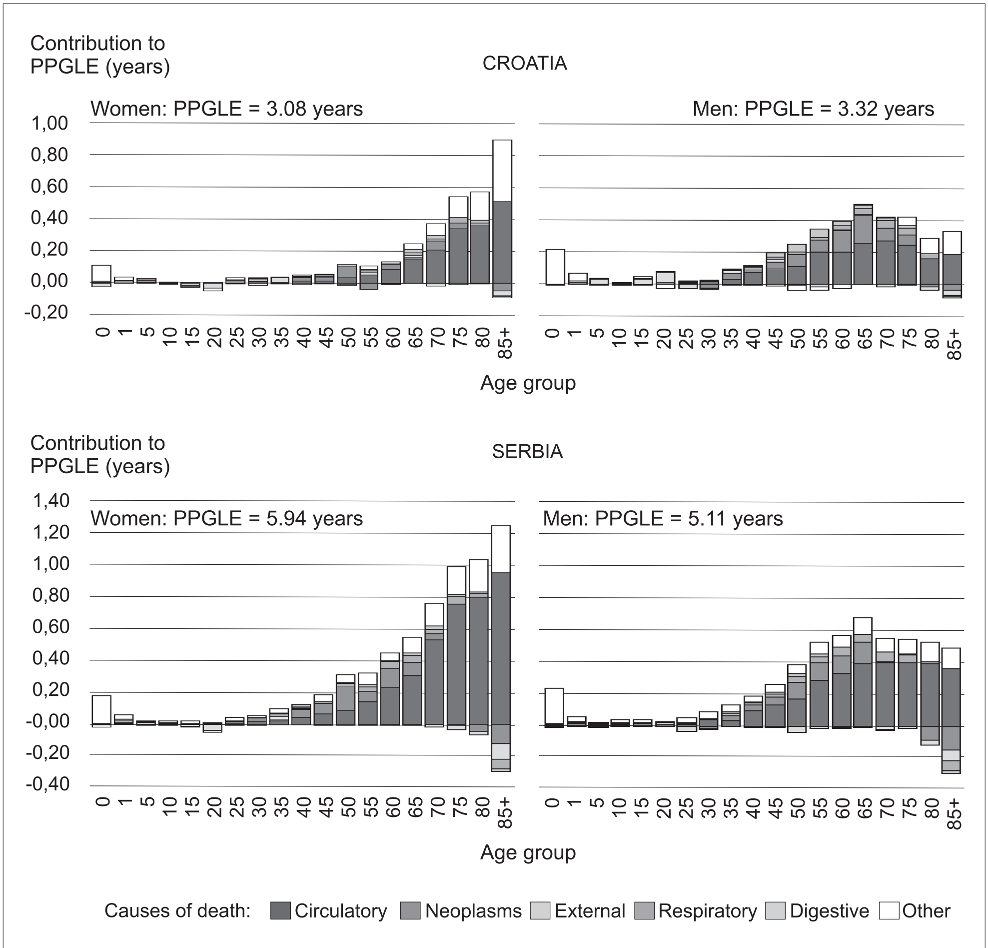
As higher mortality rates yield higher PGLEs, it was therefore expected that the largest PGLEs would result from lowering mortality due to circulatory diseases and neoplasms. PGLEs from external causes of death (especially for Slovenian and also Croatian men) are also quite large, as are PGLEs from 'other' causes of death.

However, we were more interested in the more realistic partial potential gains in e_0. In Figure 4 we present the decomposition of partial potential gains in e_0 (PPGLEs) for Croatia and Serbia, if Croatian and Serbian mortality rates were lowered to Slovenian levels in 2017.[3] Slovenia is used as a benchmark in this comparison because it has the highest life expectancy (in the last few years even higher than the EU-28).

Similar to potential gains in life expectancy at birth, partial potential gains could also be achieved mainly by decreasing mortality from circulatory diseases in older ages and by decreasing infant mortality; the latter holds especially for Croatian boys. Reaching Slovenian mortality levels would actually represent a realisation of over 40% of PGLE from circulatory diseases for most critical ages for Croatia and even more than 50% for Serbia. The percentage of PGLE actually possible for infants exceeds 60% for Serbian boys and is close to 60% for Croatian boys and Serbian girls, when aiming at the Slovenian benchmark.

We, however, also observed the negative PPGLEs for external causes for Serbian women and men (and slightly negative PPGLEs for external causes for Croatian women). This implies that, from the external causes of death point of view, Serbia is performing better than Slovenia.

FIGURE 4
Age group and cause of death decomposition of partial potential gains in life expectancy at birth (PPGLE, in years) for 2017 if Slovenian mortality levels were reached



In addition, we notice that Serbian women have larger PPGLE than men. This is of course related to the considerably smaller sex differential in Serbia compared with Slovenia, but nevertheless shows that Serbian women are lagging almost one additional year behind Slovenian benchmarks compared with Serbian men (5.94 and 5.11 years, respectively).

DISCUSSION

In Croatia, Serbia and Slovenia, life expectancy at birth (e_0) has been increasing rapidly over the last few decades, which is a consequence of lower mortality. At the global scale, progress has been faster than expected on the basis of development measured by the Socio-demographic Index (Wang et al., 2016). According to predictions that, in the future, e_0 could increase even further, although at a slower pace, to close to 100 years (e.g., Ediev, 2011; Mayhew & Smith, 2015), there is still potential for improvement in e_0 for all three countries analysed.

Based on age and cause-specific mortality data, we took a closer look at increases in e_0 between 2001 and 2017, separately by sex, and we calculated the contributions of individual age groups and causes of death to this increase. Slovenia has already been demonstrated (Lotrič Dolinar, Došenović Bonča, & Sambt, 2017) to have entered the 'cardiovascular revolution' stage of epidemiologic transition (Bongaarts, 2014). We also found that in Croatia and Serbia, the greatest effect on e_0 increase can be attributed to lower mortality due to circulatory diseases in ages between around 65 and 80 years for both sexes. However, some negative contributions to change in e_0 are also present, especially due to increased deaths from neoplasms for Croatian and Serbian women above 55 years. Because lung cancer is by far the most common type of cancer in Europe and in the three analysed countries (Eurostat, 2019c), one of the reasons for the increase in cancer death rates, especially in Croatia, can be found in the significant increase in the prevalence of smoking for Croatian women over the last few decades (World Health Organization, 2015).

Another phenomenon observed in all three countries is the reduction in sex differential during the analysed period. The source of greatest disadvantage for men under the age of 45 years are risk-taking behaviours: tobacco (Bobak, 2003), alcohol and other drug abuse, accidents, injuries, and suicides (Phillips, 2013) – these are strikingly male phenomena (Möller-Leimkühler, 2003). When mortality attributable to these sources decreases, the gap between the e_0 of men and women narrows.

Besides being the main driver in increasing e_0 so far, diseases of the circulatory system still offer the largest room for improvement in longevity in all three analysed countries, especially for older ages, and reduction in mortality from neoplasms mainly for older ages. There is also some potential for reducing mortality in external causes of death for Slovenian (and also Croatian) men and in 'other' causes of death, especially for infants in Croatia and Serbia as well as for the oldest age group in all three countries, especially for women. Partial potential gains in e_0, if Croatia and Serbia reached Slovenian mortality rates, show that a great share of hypothetical gains could actually be realised, especially for circulatory diseases and infant mortality.

These results provide detailed information; it is suggested that these can be used by authorities to appropriately focus demographic, health and social policies in light of unavoidable population ageing, especially because sensible choices regarding prevention and disease control programmes have become a core issue. Research (Heijink, Koolman, & Westert, 2013) has reported a negative association between healthcare spending and avoidable mortality (i.e., deaths that should not occur in the presence of timely and effective healthcare). As the pandemic of chronic non-communicable diseases poses substantial challenges to the health financing sustainability (Jakovljevic et al., 2019), a thorough knowledge of mortality trends and patterns is very important when considering the limited resources for healthcare and the various possibilities to invest in the prevention of avoidable deaths, in order to allocate funds in a way which will achieve maximum outcome with minimum expense. All countries could benefit from an exchange of best practices. The successful example of Slovenia might help Croatia and Serbia to be more efficient in implementing strategies and technologies that lead to life expectancy improvements, while Slovenia can look up to Serbia for managing the external causes of death. This suggests that good practices in handling different causes of mortality should be exchanged in both directions, as pointed out already by Jakovljevic et al. (2017).

It needs to be kept in mind, however, that mortality patterns in a given year are usually the consequence of morbidity related to the same disease several years earlier for correspondingly younger people, which is crucial in managing preventable causes of death (Lotrič Dolinar, Sambt, & Korenjak-Černe, 2019). There are findings that, for example, physical activity can reduce up to 10% of mortality for certain cancers (Lee et al., 2012). Because people reach old age healthier (Vaupel, 2010), deaths from certain causes will be delayed and, according to Manton et al. (1980), a moderate delay of death from a certain cause can increase e_0 substantially. This in turn also implies at least some relief for the health and social costs of longevity, because people will also be able to work longer in life.

Despite providing detailed information which could help to formulate and enforce suitable policies in order to improve health situations through the exchange of good practices between the analysed countries, we need to point out some limitations of or possibilities for further upgrades to our paper. One is that the decomposition of life expectancy would be more plausible if we were also able to incorporate information on the education or socioeconomic status of the deceased. In addition, a further extension to all ex-Yugoslav countries and the rest of the Balkans would be beneficial should relevant data become available.

NOTES

[1] However, from 2014 on, the e_0 has been stagnating. A similar picture can be observed throughout most of Europe, especially for women (Eurostat, 2019a; Ho & Hendi, 2018).

[2] Detailed results are available from the authors upon request.

[3] See detailed results in Appendix.

APPENDIX

Age group and cause of death decomposition of partial potential gains in life expectancy at birth e_0 (in years) if Slovenian mortality levels were reached (2017), by sex (PPGLEs higher than 5% of total are highlighted, as are the age group and the cause with the highest PPGLE).

Croatia: PPGLE vs. Slovenia (years)

	Women							Men						
Age group	All causes	Circ.	Neo.	Ext.	Resp.	Dig.	Other	All causes	Circ.	Neo.	Ext.	Resp.	Dig.	Other
0	0.09	0.00	0.00	-0.02	0.01	0.00	0.10	0.21	0.00	0.00	0.00	0.00	0.00	0.21
1-4	0.04	0.00	0.02	0.00	0.00	0.00	0.02	0.06	0.00	0.01	0.01	0.00	0.00	0.04
5-9	0.03	0.00	0.00	0.01	0.00	0.00	0.01	0.03	0.00	-0.01	0.03	0.00	0.00	0.00
10-14	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
15-19	-0.02	0.00	0.00	-0.01	-0.01	0.00	0.00	0.04	0.00	0.00	0.03	0.00	0.00	0.01
20-24	-0.04	0.01	0.00	-0.03	0.00	0.00	-0.02	0.05	0.00	0.01	0.07	0.00	0.00	-0.02
25-29	0.03	0.00	0.02	0.00	0.00	0.00	0.01	-0.01	0.00	0.01	-0.03	0.00	0.00	0.00
30-34	0.02	0.01	0.01	0.01	0.00	0.00	-0.01	-0.01	0.02	-0.02	-0.01	0.00	0.00	0.00
35-39	0.03	0.00	0.00	0.03	0.00	0.00	0.00	0.09	0.03	0.03	0.02	0.01	0.01	0.00
40-44	0.04	0.01	0.02	0.00	0.00	0.01	-0.01	0.10	0.07	0.02	0.01	0.00	0.00	0.00
45-49	0.05	0.01	0.02	-0.01	0.01	0.01	0.00	0.18	0.09	0.04	0.01	0.01	0.03	-0.01
50-54	0.11	0.03	0.07	-0.01	0.00	0.01	0.00	0.21	0.11	0.07	0.00	0.02	0.05	-0.03
55-59	0.07	0.05	-0.04	0.01	0.01	0.01	0.02	0.30	*0.19*	0.07	-0.01	0.02	0.05	-0.02
60-64	0.13	0.08	0.03	0.00	0.00	0.02	0.00	0.35	*0.19*	0.13	0.01	0.02	0.02	-0.03
65-69	0.25	0.15	0.01	0.01	0.02	0.02	0.03	*0.48*	*0.25*	0.17	0.01	0.03	0.02	0.00
70-74	0.35	*0.21*	0.06	-0.02	0.01	0.02	0.07	0.39	*0.26*	0.08	-0.02	0.04	0.02	0.01
75-79	0.53	*0.34*	0.04	-0.01	0.04	0.00	0.13	0.40	*0.24*	0.06	-0.01	0.04	0.01	0.05
80-84	0.57	*0.36*	0.00	0.00	0.02	0.02	*0.18*	0.24	*0.15*	-0.02	-0.02	0.03	0.00	0.09
85+	*0.81*	*0.51*	-0.05	-0.03	0.00	-0.01	*0.39*	0.23	*0.18*	-0.04	-0.03	0.00	-0.01	0.14
All ages	3.08	*1.79*	0.21	-0.07	0.11	0.11	0.92	3.32	*1.79*	0.61	0.05	0.23	0.21	0.44

Explanation of abbreviations for causes of death: Circ. – diseases of the circulatory system, Neo. – neoplasms, Ext. – external causes of morbidity and mortality, Resp. – diseases of respiratory system, Dig. – diseases of digestive system, Other – all other causes of death not included in previous five groups.

Serbia: PPGLE vs. Slovenia (years)

	Women							Men						
Age group	All causes	Circ.	Neo.	Ext.	Resp.	Dig.	Other	All causes	Circ.	Neo.	Ext.	Resp.	Dig.	Other
0	0.16	0.00	0.00	-0.02	0.00	0.00	0.18	0.25	0.00	0.01	0.00	0.01	0.00	0.23
1-4	0.06	0.00	0.01	0.01	0.01	0.00	0.03	0.06	0.01	0.01	0.00	0.01	0.00	0.04
5-9	0.00	0.00	-0.01	0.01	0.00	0.00	0.00	0.01	0.00	-0.01	0.01	0.00	0.00	0.01
10-14	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.01	0.00	0.01	0.00	0.00	0.02
15-19	0.00	0.00	0.00	-0.01	0.00	0.00	0.02	0.04	0.00	0.01	0.01	0.00	0.00	0.02
20-24	-0.04	0.00	0.00	-0.04	0.00	0.00	-0.01	0.03	0.01	0.00	0.01	0.00	0.00	0.00
25-29	0.03	0.00	0.01	-0.01	0.00	0.00	0.02	0.02	0.01	0.00	-0.03	0.01	0.00	0.03
30-34	0.05	0.01	0.02	0.00	0.00	0.00	0.01	0.08	0.04	-0.01	-0.01	0.01	0.00	0.05
35-39	0.10	0.02	0.01	0.02	0.01	0.00	0.03	0.14	0.04	0.03	0.01	0.01	0.00	0.05
40-44	0.12	0.04	0.05	0.01	0.01	0.01	0.01	0.19	0.10	0.04	0.01	0.01	-0.01	0.04
45-49	0.18	0.06	0.07	-0.01	0.01	0.00	0.04	0.27	0.14	0.05	-0.01	0.02	0.01	0.05
50-54	0.31	0.09	0.15	-0.01	0.02	0.01	0.05	0.36	0.18	0.11	-0.04	0.04	0.02	0.06
55-59	0.31	0.14	0.06	-0.01	0.03	0.01	0.07	0.54	*0.31*	0.12	-0.02	0.04	0.02	0.08
60-64	0.45	0.23	0.12	0.00	0.04	0.00	0.05	0.59	*0.35*	0.12	-0.01	0.06	-0.01	0.08
65-69	0.55	*0.31*	0.08	0.00	0.04	0.01	0.10	*0.72*	*0.42*	0.14	-0.01	0.05	0.00	0.11
70-74	0.75	*0.53*	0.04	-0.02	0.03	0.02	0.15	0.56	*0.42*	0.00	-0.02	0.06	-0.01	0.09
75-79	0.96	*0.76*	-0.01	-0.03	0.05	0.01	0.18	0.56	*0.42*	0.00	-0.02	0.05	0.01	0.10
80-84	*0.97*	*0.80*	-0.04	-0.03	0.02	0.01	0.21	0.43	*0.41*	-0.09	-0.03	0.01	0.00	0.13
85+	0.96	*0.96*	-0.12	-0.10	-0.06	-0.02	*0.30*	0.20	*0.39*	-0.16	-0.07	-0.07	-0.02	0.13
All ages	5.94	*3.97*	0.44	-0.23	0.23	0.08	1.45	5.11	*3.26*	0.37	-0.20	0.33	0.03	1.32

Explanation of abbreviations for causes of death: Circ. – diseases of the circulatory system, Neo. – neoplasms, Ext. – external causes of morbidity and mortality, Resp. – diseases of respiratory system, Dig. – diseases of digestive system, Other – all other causes of death not included in previous five groups.

REFERENCES

Arriaga, E. E. (1984). Measuring and explaining the change in life expectancies. *Demography, 21*(1), 83–96. https://doi.org/10.2307/2061029

Arriaga, E. E. (1995). Changing trends in mortality decline during the last decades, App. 5.1. In L. Ruzicka, G. Wunsch, & P. Kane (Eds.), *Differential Mortality* (pp. 105–130). Oxford: Clarendon Press.

Bartels, S. J., & Naslund, J. A. (2013). The underside of the silver tsunami – older adults and mental health care. *The New England Journal of Medicine, 368*(6), 493–496. https://doi.org/10.1056/NEJMp1211456

Beltrán-Sánches, H., Preston, S. H., & Canudas-Romo, V. (2008). An integrated approach to cause-of-death analysis: Cause-deleted life tables and decompositions of life expectancy. *Demographic Research, 19*(35), 1323–1350. https://doi.org/10.4054/DemRes.2008.19.35

Bobak, M. (2003). Relative and absolute gender gap in all-cause mortality in Europe and the contribution of smoking. *European Journal of Epidemiology, 18*(1), 15–18. https://doi.org/10.1023/A:1022556718939

Bongaarts, J. (2014). Trends in causes of death in low-mortality countries: Implications for mortality projections. *Population and Development Review, 40*(2), 189–212. https://doi.org/10.1111/j.1728-4457.2014.00670.x

Canudas-Romo, V., & Schoen, R. (2005). Age-specific contribution to changes in the period and cohort life expectancy. *Demographic Research, 13*(3), 63–82. https://doi.org/10.4054/DemRes.2005.13.3

Croatian Bureau of Statistics, Population Statistics Department (2019). → Data on deaths by sex, age and cause. Data were obtained upon request.

Ediev, D. M. (2011). Life expectancy in developed countries is higher than conventionally estimated. Implications from improved measurement of human longevity. *Journal of Population Ageing, 4*(1-2), 5–32. https://doi.org/10.1007/s12062-011-9040-x

Eggleston, K. N., & Fuchs, V. R (2012). The new demographic transition: Most gains in life expectancy now realized late in life. *Journal of Economic Perspectives, 26*(3), 137–156. https://doi.org/10.1257/jep.26.3.137

Eurostat (2013). *Revision of the European standard population, Report of Eurostat's task force. Eurostat Methodologies and Working Papers, 2013 edition*. Luxembourg: Publications Office of the European Union.

Eurostat (2019a). Available at https://ec.europa.eu/eurostat/data/database → Database by themes → Population and social conditions → Demography and migration → Mortality → Life expectancy by age and sex. Accessed 15 April 2019.

Eurostat (2019b). Available at https://ec.europa.eu/eurostat/data/database → Database by themes → Population and social conditions → Demography and migration → Population → Population on 1 January by age and sex. Accessed 15 April 2019.

Eurostat (2019c). Available at https://ec.europa.eu/eurostat/data/database → Database by themes → Population and social conditions → Health → Causes of death → General mortality → Causes of death – standardised death rate by residence. Accessed 15 April 2019.

Foege, W. H. (1987). Public health: Moving from debt to legacy, 1986 presidential address. *American Journal of Public Health, 77*(10), 1276–1278. https://doi.org/10.2105/AJPH.77.10.1276

Frenk, J., Bobadilla, J. L., Stern, C., Frejka, T., & Lozano, R. (1991). Elements for a theory of the health transition. *Health Transition Review, 1*(1), 21–38. https://dx.doi.org/10.2307/40608615

Garfield, R. (2001) *Economic sanctions, health, and welfare in the Federal Republic of Yugoslavia 1990–2000*. Belgrade: UNICEF.

Grigoriev, P., Meslé, F., Shkolnikov, V. M., Andreev, E., Fihel, A., Pechholdova, M., & Vallin, J. (2014). The recent mortality decline in Russia: Beginning of the cardiovascular revolution? *Population and Development Review, 40*(1), 107–129. https://doi.org/10.1111/j.1728-4457.2014.00652.x

Heijink, R., Koolman, X., & Westert, G. P. (2013). Spending more money, saving more lives? The relationship between avoidable mortality and healthcare spending in 14 countries. *European Journal of Health Economics, 14*(3), 527–538. https://doi.org/10.1007/s10198-012-0398-3

Ho, J. Y., & Hendi, A. S. (2018). Recent trends in life expectancy across high income countries: Retrospective observational study. *BMJ, 362,* k2562. https://doi.org/10.1136/bmj.k2562

ICD-10: International statistical classification of diseases and related health problems, 10th revision (2016). Available at https://icd.who.int/browse 10/2010/en. Accessed 15 April 2019.

Jakovljevic, M., Arsenijevic, J., Pavlova, M., Verhaeghe, N., Laaser, U., & Groot, W. (2017). Within the triangle of healthcare legacies: Comparing the performance of South-Eastern European health systems.

Journal of Medical Economics, 20(5), 483–492. https://doi.org/10.1080/13696998.2016.1277228

Jakovljevic, M., Jakab, M., Gerdtham, U., McDaid, D., Ogura, S., Varavikova, E., Merrick, J., Adany, R., Okunade, A., & Getzen, T. E. (2019). Comparative financing analysis and political economy of noncommunicable diseases. *Journal of Medical Economics, 22*(8), 722–727. https://doi.org/10.1080/13696998.2019.1600523

Jakovljevic, M. B., Vukovic, M., & Fontanesi, J. (2016). Life expectancy and health expenditure evolution in Eastern Europe – DiD and DEA analysis. *Expert Review of Pharmacoeconomics and Outcomes Research, 16*(4), 537–546. https://doi.org/10.1586/14737167.2016.1125293

Kintner, H. J. (2003). The life table. In D. A. Swanson & J. S. Siegel (Eds.), *The methods and materials of demography* (pp. 301–340). San Diego: Elsevier Science. https://doi.org/10.1016/B978-012641955-9/50047-3

Kirk, D. (1996). Demographic transition theory. *Population Studies – a Journal of Demography, 50*(3), 361–387. https://doi.org/10.1080/0032472031000149536

Klenk, J., Keil, U., Jaensch, A., Christiansen, M. C., & Nagel, G. (2016). Changes in life expectancy 1950–2010: Contributions from age- and disease-specific mortality in selected countries. *Population Health Metrics, 14*, 20. https://doi.org/10.1186/s12963-016-0089-x

Kovačić, L., & Šošić, Z. (1998). Organization of health care in Croatia: Needs and priorities. *Croatian Medical Journal, 39*(3), 249–255. Available at https://www.researchgate.net/publication/13544496_Organization_of_health_care_in_Croatia_Needs_and_priorities

Kunitz, S. J. (2004). The making and breaking of Yugoslavia and its impact on health. *American Journal of Public Health, 94*(11), 1894–1904. https://doi.org/10.2105/AJPH.94.11.1894

Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Katzmarzyk, P. T. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *Lancet, 380*(9838), 219–229. https://doi.org/10.1016/S0140-6736(12)61031-9

Liu, P., Li, C., Wang, Y., Zeng, W., Wang, H., Wu, H., Lu, J., Sun, M., Li, X., Chang, F., & Hao, M. (2014). The impact of the major causes of death on life expectancy in China: A 60-year longitudinal study. *BMC Public Health, 14*(1193), 2–8. https://doi.org/10.1186/1471-2458-14-1193

Lotrič Dolinar, A., Došenović Bonča, P., & Sambt, J. (2017). Longevity in Slovenia: Past and potential gains in life expectancy by age and causes of death. *Zdravstveno varstvo, 56*(2),124–130. https://doi.org/10.1515/sjph-2017-0016

Lotrič Dolinar, A., Sambt, J., & Korenjak-Černe, S. (2019). Clustering EU countries by causes of death. *Population Research and Policy Review, 38*(2), 157–172. https://doi.org/10.1007/s11113-019-09518-1

Malačič, J. (2006). *Demografija – teorija, analiza, metode in modeli* [Demography – Theory, analysis, methods and models]. Ljubljana: Ekonomska fakulteta.

Manton, K. G., Patrick, C. H., & Stallard, E. (1980). Mortality model based on delays in progression of chronic diseases: Alternative to cause elimination model. *Public Health Reports, 95*(6), 580–588. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1422793/

Mayhew, L., & Smith, D. (2015). On the decomposition of life expectancy and limits to life. *Population Studies – A Journal of Demography, 69*(1), 73–89. https://doi.org/10.1080/00324728.2014.972433

Möller-Leimkühler, A. M. (2003). The gender gap in suicide and premature death or: Why are men so vulnerable? *European Archives of Psychiatry and Clinical Neuroscience, 253*(1), 1–8. https://doi.org/10.1007/s00406-003-0397-6

National institute of public health, Health Data Center, Slovenia (2019). → Data on deaths by sex, age and cause. Data were obtained by request.

Oeppen, J., & Vaupel, J. W. (2002). Broken limits to life expectancy. *Science, 296*(5570), 1029–1031. https://doi.org/10.1126/science.1069675

Ogura, S., & Jakovljevic, M. M. (2018). Global population aging – health care, social and economic consequences. *Frontiers in Public Health, 6*, 335. https://doi.org/10.3389/fpubh.2018.00335

Omran, A. R. (1971). The epidemiologic transition: A theory of the epidemiology of population change. *The Milbank Memorial Fund Quarterly, 49*(4-1), 509–538. https://doi.org/10.2307/3349375

Phillips, S. P. (2013). Risky business: Explaining the gender gap in longevity. *Journal of Men's Health and Gender, 3*(1), 43–46. https://doi.org/10.1016/j.jmhg.2005.08.004

Pollard, J. H. (1988). On the decomposition of changes in expectation of life and differentials in life expectancy. *Demography, 25*(2), 265–276. https://doi.org/10.2307/2061293

Pressat, R. (1985). Contribution des écarts de mortalité par âge à la différence des vies moyennes [The significance of variations in mortality by age on differences in life expectancy]. *Population, 40*(4/5), 766–770. https://doi.org/10.2307/1532986

Shkolnikov, V. (2015). *Methodology note on the Human Life-Table Database (HLD)*. Available at http://www.lifetable.de/methodology.pdf

Statistical Office of the Republic of Serbia, Demography Division (2019). → Data on deaths by sex, age and cause. Data were obtained by request.

Timonin, S., Shkolnikov, V., Jasilionis, D., Grigoriev, P., Jdanov, D. A., & Leon, D. A. (2016). Disparities in length of life across developed countries: Measuring and decomposing changes over time within and between country groups. *Population Health Metrics, 14*(29), 1–19. https://doi.org/10.1186/s12963-016-0094-0

Tsai, S. P., Lee, E. S., & Hardy, R. J. (1978). The effect of a reduction in leading causes of death: Potential gains in life expectancy. *American Journal of Public Health, 68*(10), 966–971. https://doi.org/10.2105/AJPH.68.10.966

Vallin, J., & Meslé, F. (2004). Convergences and divergences in mortality. A new approach to health transition. *Demographic Research,* special 2(2), 11–44. https://doi.org/10.4054/DemRes.2004.S2.2

Vaupel, J. W. (2010). Biodemography of human aging. *Nature, 464*(7288), 536–542. https://doi.org/10.1038/nature08984

Wang, H., Naghavi, M., Allen, C., Barber, R. M., Bhutta, Z. A., Carter, A., ..., & Coggeshall, M. (2016). Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: A systematic analysis for the Global Burden of Disease Study 2015. *The Lancet, 388*(10053), 1459–1544. https://doi.org/10.1016/S0140-6736(16)31012-1

World Health Organization (2015). *WHO global report on trends in prevalence of tobacco smoking 2015.* Geneva: WHO.

Porast očekivanog trajanja života s obzirom na dob i uzroke u Hrvatskoj, Srbiji i Sloveniji

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Očekivano trajanje života raste u svim zemljama bivše Jugoslavije. Ovaj rad opisuje i uspoređuje recentne trendove u očekivanom trajanju života u Hrvatskoj, Srbiji i Sloveniji. Što je potaknulo najnoviji porast? U kojim se dobnim skupinama i kod kojih se uzroka smrti bilježi najveći pad mortaliteta? Jesu li se tri zemlje pridružile kardiovaskularnoj revoluciji? Postoje li razlike među zemljama? Ima li prostora za daljnji napredak? Kako bismo ponudili odgovore na ova pitanja, u istraživanju upotrebljavamo tablice doživljenja i dekompozicijsku analizu. Ključni su nalazi: 1) pad smrtnosti od bolesti cirkulacijskoga sustava među starijim stanovništvom najviše je pridonio rastu očekivanoga trajanja života 2001–2017 kod obaju spolova u svim trima zemljama, 2) očekivano trajanje života u Sloveniji raslo je najbrže i povećao se jaz među zemljama, 3) pod slovenskim stopama kardiovaskularnoga mortaliteta prema dobi, u Hrvatskoj bi očekivano trajanje života poraslo za 1,79 godina i kod žena i kod muškaraca, a u Srbiji za 3,97 godina kod žena, odnosno za 3,26 godina kod muškaraca.

Ključne riječi: očekivano trajanje života, smrtnost prema dobi i uzroku, prošli i budući rast očekivanog trajanja života, dekompozicijska analiza, zemlje bivše Jugoslavije