Premature cancer morbidity and mortality conditions through the epidemiological transitions and the global smoking epidemic

The case of Hungary, Austria and Denmark

Dissertation for the degree of Doctor of Philosophy

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Pécs, Hungary
March 2020

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I. Acknowledgements

First of all, I would like to express my gratitude for Prof. Péter Józan and Prof. Éva Kriszt Sándorné, to my supervisors, who constantly encouraged me in the last eight years to obtain scientific level and gave guidance in difficult situations.

Thanks to my friends Maciej Potyra, Cosmo Strozza, Maarten Wensink, who always provided me professional help, if I needed.

I'm thankful to Miklós Faragó for his assistance in performing the statistical calculations of smoking-attributable mortality.

Lastly, I gratefully acknowledge the support of Prof. James W. Vaupel and Dr. Zsolt Spéder, who created the opportunity for scientific development and research conditions at home and abroad.

This research was funded by the project entitled "EFOP-3.6.3-VEKOP-16-2017-00007 – Young researchers from talented students – Fostering scientific careers in higher education", which is co-financed by the European Union (European Social Fund) within the framework of the Széchenyi Program 2020.

II. Abstract in English

Background: Hungary has the highest mortality rates in cancer all over the World and this goes along with high-ratio of premature deaths in the middle-aged population, in which smoking plays a proven and significant role. This imposes not just heavy emotional and financial burdens on the society, but also considerably slows down the upward trend in life expectancy The aim of this dissertation is to better understand this unfavorable health situation in Hungary especially in the epidemiological renewal from 1994 to 2015. All of this is based on the available data, applying statistical methods and using Austria and Denmark as a benchmark.

Methods: The dissertation begins with a review of the theoretical background and classifies the countries according to the human longevity considerations. Then applies explorative and descriptive data analysis with international outlook: Preston-curve for 2015 and time-path plots (life expectancy vs life-span equality) by sex and age from a historical perspective between 1950 and 2014. This is followed by the examination of the potential years of life lost indicator and the life table decomposition, all by sex, age and main and cancer causes of death. The survival analysis follows all of the cancer cases from 2013 to mid-2015 by sex, age and exact localizations of cancer and then with the help of curve fitting defines the life expectancy at diagnosis for the same breakdowns. The runoff of the global smoking epidemic is examined by the historical time series data of smoking prevalence and mortality for USA, Hungary and Austria. Thereafter, the smoking-attributable excess mortality is calculated for Hungary by sex, age and causes of deaths in the period 2000-2015.

Results: In Hungary the GDP is half as much compared to the Austrian and Danish value and the life expectancy is approx. 5 year shorter, which can be considered a bad legacy of the socialist system. The cardiovascular revolution which appeared more than three decades later in Hungary than in Austria and Denmark, led the masses with vulnerable health status towards the cancer mortality in the epidemiological renewal. In the period 1994-2015, there was improvement in the under age 50 population in smoking related cancers, no changes in the high mortality of breast, colon and gynecological cancers, in contrast with the decline in Austria and Denmark and significant deterioration can be observed in smoking-related cancers among 50-75 year-old women. At the same time, among others, the women in their 50s who were diagnosed with breast cancer in 2013, lived only the two-third of the older 60-79 year-old female patients' life. Meanwhile, both the prevalence and mortality of women in the global smoking epidemic increased in Hungary and Austria, in contrast with men. According to the calculation of the smoking-attributable mortality, the smoking-attributable standardized death rate due to trachea, bronchus and lung cancers per 100 000 women grew drastically, by 60% from 2000 to 2014 and it is explained by the worsening mortality rate of 50-70-year-old women.

Conclusions: The epidemiological crisis character of socialist systems and its negative wave caused the cancer crisis in Hungary in the new health era. Between 1994 and 2015 a significant catch-up in middle-age mortality (mostly related to smoking) can be observed compared to Austria and Denmark, but no sign of similar process in old-age. The 'triangle' of breast, lung, and colon cancers are the major contributors to the high premature cancer mortality. The indicator of life expectancy at diagnosis is able to identify early invasive cancers by sex, age and localization of cancer. The global smoking epidemic was the most destructive among Hungarian men and in case of women increasing values and strong negative cohort effects among Hungarian and Austrian middle-aged population is identified due to smoking and also a full recovery from this in Denmark. Nevertheless, compared to the USA, Austrian and Hungarian societies may be characterized by more traditional gender roles and associated cultural norms, all of this may have reduced the harmful effects of the cigarette epidemic to Central European women.

III. Absztrakt magyarul

Háttér: Magyarországon a legmagasabb a daganatos halandóság az egész Világon és ez nagyarányú korai mortalitással jár együtt a középkorú népességben, amiben a dohányzás is bizonyítottan meghatározó szerepet játszik. Ez nemcsak súlyos érzelmi és pénzügyi terhet is ró a társadalomra, hanem a várható élettartam emelkedő tendenciáját is lényegesen fékezi. Az értekezés célja jobban megérteni ezt a kedvezőtlen egészségügyi helyzetet Magyarországon különösen az epidemiológiai megújulás időszakában 1994-től 2015-ig. Mindezt a rendelkezésre álló adatok alapján, statisztikai módszereket alkalmazva, Ausztriával és Dániával összehasonlítva.

Módszerek: Az értekezés az elméleti háttér áttekintésével kezdődik, és az európai országokat népességeik életkilátásai szerint osztályozza. Ezután feltáró és leíró adatelemzést alkalmaz nemzetközi kitekintéssel: a Preston-görbe a 2015-ös évre és az idő-ösvény görbék (várható élettartam vs. élettartam-egyenlőség) nem és életkor szerint, történelmi időtávon 1950 és 2014 között. Ezt követi a potenciálisan elveszített életévek mutatójának tárgyalása és a halandósági tábla dekompozíciója, nem, életkor, haláloki főcsoportok és daganatos halálokok alapján. A túlélési elemzés az összes rákos esetet követi 2013 és 2015 közepe között nem, életkor és a daganat pontos lokalizációja szerint, majd görbe illesztés segítségével meghatározza a diagnóziskor várható élettartamot azonos bontásokban. A globális dohányzási járvány lefolyását a dohányzási prevalencia és mortalitás történelmi idősoros adatai alapján vizsgáljuk az Egyesült Államokra, Magyarországra és Ausztriára nézve. Ezt követően kerülnek kiszámításra a dohányzásnak tulajdonítható többlethalálozások a 2000-2015 közötti időszakra, nem, életkor és halálok változók szerint.

Eredmények: Magyarországon a GDP értéke fele akkora, mint Ausztriában és Dániában és a várható élettartam is körülbelül 5 évvel rövidebb, amiket a néhai szocialista rendszer rossz örökségének lehet tekinteni. A kardiovaszkuláris forradalom, ami több mint három évtizeddel később jelent meg Magyarországon, mint Ausztriában és Dániában, az epidemiológiai megújulás során a sérülékeny egészségi állapotú tömegeket a rákos halálozás felé terelte. Az 1994-2015 közötti időszakban javult az 50 év alatti népesség dohányzással összefüggő daganatos halandósága, nem változtak a magas mortalitású emlő-, vastagbél- és nőgyógyászati rákok, ellentétben az osztrák és dán csökkenéssel és a dohányzással összefüggő tumorok halandósága jelentősen romlott az 50-75 év közötti nők körében. Ugyanakkor többek között az 50-es éveikben járó nők, akiknél 2013-ban diagnosztizáltak mellrákot, az idősebb 50-79 éves nőbetegeknek csak a kétharmadát élték meg. Mindeközben a nők dohányzási prevalenciája és mortalitása nőtt a globális dohányzási járványban Magyarországon és Ausztriában, szemben a férfiakéval. A dohányzásnak tulajdonítható többlethalálozások számítása szerint a 100 000 nőre jutó légcső-, hörgő- és tüdőrák miatti dohányzásnak tulajdonítható standardizált halálozási arány drasztikusan, 60%-kal emelkedett 2000-től 2014-ig, és ennek hátterében legnagyobb mértékben az 50 és 70 év közötti nők növekvő mortalitása áll.

Következtetések: A szocialista rendszerek tipikus jellemvonása: az epidemiológiai válság és annak negatív hulláma daganatos válságot idézett elő Magyarország új egészségügyi korszakában. 1994 és 2015 között a középkorú mortalitás jelentős felzárkózása figyelhető meg (leginkább a dohányzással összefüggésben) Ausztriához és Dániához, ám az időskori halandóságban nem látható hasonló folyamat. Az emlő-, tüdő- és vastagbélrák „háromszöge” a korai daganatos mortalitás fő tényezői. A diagnóziskor várható élettartam mutatója képes azonosítani a korai invazív rákot nemek, életkor és a rák lokalizációja szerint. A globális dohányzási járvány a magyar férfiak körében volt a legpusztítóbb, és a nők esetében növekvő értékek és erős negatív kohorsz hatások igazolhatók a magyar és az osztrák középkorú népességben, mindemellett Dániában pedig az ebből történő teljes kilábalás. Mindazonáltal az Egyesült Államokéhoz viszonyítva az osztrák és a magyar társadalmakat tradicionálisabb nemi szerepek és a hozzájuk kapcsolódó kulturális normák jellemzik, mindez csökkentheti a cigarettajárvány közép-európai nőkre gyakorolt káros hatásait.

IV. List of tables and figures

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V. Abbreviations and acronyms

ÁEEK	National Healthcare Services Center
	Állami Egészségügyi Ellátó Központ
CDC	Centers for Disease of Control for Prevention
COPD	Chronic Obstructive Pulmonary Disease
cv0, 40, 60	Coefficient of variation at birth, age 40 and 60
e0, 40, 60	Life expectancy at birth, age 40 and 60
EHIS	European Health Interview Survey
GDP	Gross Domestic Product
HCSO	Hungarian Central Statistical Office
HDRI	Hungarian Demographic Research Institute
HMD	Human Mortality Database
HNCR	Hungarian National Cancer Registry
ICD	International Classification of Diseases
IME	Journal of Hungarian Interdisciplinary Medicine
	Interdiszciplináris Magyar Egészségügy
MNB	The Central Bank of Hungary
	Magyar Nemzeti Bank
NHIS	National Health Interview Survey
OECD	Organisation for Economic Cooperation and Development
	Organisation Européenne de Cooperation Économique
PPP	Purchasing Power Parity
PYLL	Potential Years of Life Lost
SAM	Smoking Attributable Mortality
SAMMEC	Smoking Attributable Morbidity Mortality and Economic Costs
SDR	Standardized Death Rate
USDHHS	US Department of Health and Human Services
WHO-HFA	World Health Organisation – Health for All Database

VI. Papers in the dissertation

Paper I

Wéber, A. (2019). Hungarian trends and gender differences in the global smoking epidemic. *Demografia*, 2019. Vol. No. 5. English Edition, pp. 5-43.

Paper II

Wéber, A. (2017). The effect of smoking on mortality in Hungary between 2000 and 2014. *Statisztikai Szemle,* 95 (K21), pp. 3-28. (re-published in English)

Wéber, A. (2016). A dohányzás halandóságra gyakorolt hatása Magyarországon 2000 és 2014 között. (The effect of smoking on mortality in Hungary between 2000 and 2014.) *Statisztikai Szemle*, 2016\6. szám, pp. 585-610.

Paper III

KSH (2016). A halálozások és a halandóság alakulása. (Trends of Mortality and Deaths), In: *Népesedési Helyzetkép 2015. (Demographical Status, 2015)*, Központi Statisztikai Hivatal, Budapest, 2016, pp. 34-47.

Paper IV

Surján, Gy., Wéber, A. (2016). *Jelentés a 2015 év első negyedében észlelt megemelkedett halálozási számok vizsgálatáról. (Report on the investigation of increased mortality in the first quarter of 2015.)* ÁEEK-KSH, Budapest, 2016. Manuscript.

Paper V

KSH (2015). *A középkorú népesség halandósága az epidemiológiai krízist követő két évtizedben (The Mortality of the Middle-aged Population After Two Decades of the Epidemiological Crisis)* Statisztikai tükör, Központi Statisztikai Hivatal, Budapest, 2015

Paper VI

KSH (2014). *A haláloki struktúra változása Magyarországon, 2000-2012 (The Change of the Causes of Death Structure in Hungary from 2000 till 2012)*, Központi Statisztikai Hivatal, Budapest, 2014

1. Introduction

1.1. Background and motivation

The life expectancies of the Hungarian people are particularly short, not just compared to the Western societies but, also compared to the country's economic development (KSH, 2016) and smoking plays a proven and significant role in this. (Józan and Radnóti, 2002, Vitrai et al., 2012, Gárdos, 2013) According to the Global Burden of Disease Study supervised by the WHO, where they analyzed a database covering almost every country in the world, it was shown, that tobacco consumption is the most important cause for diseases and deaths, among all of the healthy-life risk factors. (GBD, 2018) Researches has demonstrated that smoking is not only associated with lung cancer, but also that its deleterious effects are more general, extending to the whole body. Consequently, the addiction has a determining role in the development of not one, but several, chronic diseases that can lead to death, e.g., ischemic heart disease or chronic obstructive pulmonary disease (COPD) (USDHHS, 1989, 2014). In the second half of the 20th century almost all of the socialist countries and as a prime example Hungary from 1966 faced with an epidemiological crisis to varying degrees and this was due to the rising mortality of chronic diseases: cardiovascular and cancer illness, particularly in the middle-aged population. (Józan, 2008, Carlson and Hoffman, 2011, Bálint, 2016, Meslé and Vallin, 2017) This had many micro (smoking and alcohol consumption) and macro (closed society, absence of the middle class) level reasons, but in the epidemiological development the cardiovascular revolution or its failure in socialist societies played the key role. (Cockerham, 2007) This means the steep decline in cardiovascular mortality attributable to the increase in the quality of medical care, the emergence of new therapeutic innovations, implementation of effective preventive interventions and the changes in individual behaviors: the appreciation and spread of a healthy lifestyle. (Bálint, 2010, Jousilahti et al., 2016) This phenomenon occurred in the Western countries in the mid60s, while in Hungary only three decades later in 1994, which year was the starting point of the epidemiological renewal. Nevertheless, not this illness-group is the biggest challenge for contemporary Hungarian and international epidemiology. (Józan, 2005) In case of neoplasms, the trends are not that obviously improving and in the countries with advanced health culture the social burden of cancer disease becomes one of the largest healthcare expenditures and the biggest challenges to overcome recently. For the deep understanding of this unfavorable situation Hungary is a particularly suitable country, because it has the highest mortality rates in cancer for both sexes all over the World (OECD, 2017) and this goes along with high-ratio of premature deaths in the middle-aged population. (Kamarás, 2013, KSH, 2014) We define the middle-age from 40 to 69 years and consider it as a default in the research. This imposes not just heavy emotional, but financial burdens on the society, because this disease affects mostly economically actives, family bread-winners and taxpayers. All of this deserves special attention, because, this middle-aged generation is in double grip, it wears the greatest burden by supporting the younger, older and needy strata of the society and the only reserves of the increasing life expectancy for Hungary are lies in the mortality of the middle-aged population. (KSH, 2015)

Basically, the fundamental premature morbidity and mortality tendencies and the situation of Hungary are impossible to understand in itself. The comparison in life expectancies by sex, age group and causes of death is based on the example of Austria and Denmark. Austria is a well-established and the most popular benchmark for Hungary, not just on the field of economy, but on the quality of life as well. (MNB, 2018) We often hear the question: when we will reach the standards of Austria? We share centuries of coexistence and historical past and possess very similar geopolitical situation. Moreover, the different societal development in the second half of the 20th century can be well defined by time and regions, for instance continuous for Austria, and interrupted for Hungary. The author argues that Denmark is also suitable for comparison and its example has many instructive lessons for Hungary. This country has an advanced epidemiological status with effective public health care system and interventions. With the help of these, Denmark reduced the premature cancer mortality rate in the female population from the 1994 Hungarian to the 2015 Austrian level. At the same time, leading demographic studies analyzed in details (Lindahl-Jacobsen et. al., 2016 and Lindahl-Jacobsen et. al., 2016, Aburto et al., 2018) the epidemiological history of the Danish society: the negative cohort effect in the Danish female population, which is still the case in the Hungarian and Austrian populations to this day. Furthermore, the author had the opportunity to participate in a long-term scholarship to study and work at a demographic research institute in Denmark, where he could gather personal experiences on the scientific and social conditions there. Last, but not least the results of the quantitative methods applied in the dissertation can also be verified on this basis. In parallel, we must draw the attention to the limits of this approach: the national borders, which this dissertation is not able to exceed, because of its scarce resources. This means that the detailed demographic analysis covers only these three countries and no conclusions can be drawn at any global level nor on the community of the Visegrad countries or the post-socialist block. The nations under study will only be placed within the global and international macro-theoretical frameworks presented by this research.

The fundamental aims of this dissertation can be divided into four main parts. To get acquainted with the fundamental theories of the epidemiological transitions. (a) To describe the historical demographical and epidemiological circumstances in Hungary, Austria and Denmark by quantitative descriptive statistical tools with particular attention to the premature cancer. (b) To examine the survival of Hungarian cancer patients. (c) Understand and quantify the global smoking epidemic and the linkage between this risk factor and the high mortality in Hungary. (d)

1.2. Research questions

a. Fundamental theories
    - The epidemiological transition theory of Omran: interpretation, supplementation and criticism.
    - Divergence-convergence framework, exemptions and vanguards globally and nationally.
    - How the epidemiological transition has evolved in Hungary, Austria and Denmark?
    - How well fits the Hungarian mortality into the theories of the epidemiological transition? (Bálint, 2016)
    - How all of this can be linked to the development of (premature) cancer mortality?

b. Explorative and descriptive data analysis:
    - What is the relationship between life prospects and economic development in selected European countries, particularly focusing on Hungary, Austria and Denmark?

- Describing with the life expectancy and lifespan inequality indicators the historical demographical life prospects and epidemiological background of Hungary, Austria and Denmark from 1950 till 2014 by sex and age.

- Understanding the premature cancer mortality situation in Hungary, Austria and Denmark in the period 1994-2015, by sex, age and causes of death.

- What role did the 5-year-old age-groups played in changes in life expectancy at birth in the period 1994-2015 by main causes of cancer deaths and how did they contribute to it in the selected countries?

- What demographic groups improved or deteriorated in terms of cancer epidemiology in the observed period?

- What kind of results could achieve countries with more advanced epidemiological situation than Hungary (Austria and Denmark) in reducing premature cancer mortality?

- Based on the above, which high mortality early cancers could and should be reduced in Hungary?

c. Survival analysis of Hungarian cancer patients and life expectancy at diagnosis:

- What are the basic statistics of the followed-up cancer localizations, 2013-2015 based on the NCR?
- What are the differences in the survival of (early) cancer morbidity and mortality by sex, age group and cancer localization from 2013 to 2015?
- Which groups of the population are particularly exposed to premature invasive neoplasms?
- Introduction of the indicator life expectancy at diagnosis: for how many lived-days can a patient expect, if we know his/her sex, age and diagnosed cancer localization?
- How and in which direction this indicator could be further developed?

d. Global smoking epidemic and the smoking-attributable mortality in Hungary:

- What are the historical trends, the present status and the expected future of the smoking epidemic in the USA, Hungary and Austria?

- How well fit the prevalence and mortality of Hungarian smoking into the global smoking epidemic?
- How have the smoking-related men and women figures (gender differences) in prevalence and premature mortality evolved during the examined period?
- How strong was the effect of smoking on Hungarian mortality between 2000 and 2015, broken down by sex, age and causes of death?
- What is the linkage between smoking-attributable mortality and the deaths caused by premature cancers in Hungary?

2. Theoretical framework

2.1. Fundamental theories

Based on Omran's epidemiologic transition theory the history of mankind is going through three different stages. In the age of pestilience and famine the mortality is high and fluctuating, while the life expectancy is low. Then, due to mostly the improvement of medical sciences and the sanitation conditions, the period of receding pandemics occured, which is followed by the phase of degenerative and man-made diseases, where the successful combat against infectious diseases ended up in low and stable level of mortality and high life expectancy. (Omran, 1971) The countries of the World can be located in different positions in this evolutionary mechanism with different conditions, which is the reason for that their trajectory can diverge either converge compared to each other, although different groups of countries can be clearly distinguished due to their similar characteristics. Of course, such a macro-theory like the epidemiologic transition theory received many more interpretations, extensions and critics later. For instance in the 1980s it became clear that, the process of decreasing mortality was far from exhausting all its reserves. The gain in life expectancy during the 20th century is increasingly coming from older age groups and their improvement in mortality rates. This section was called the fourth epidemiological era. (Olshansky and Ault, 1986; Kovács, 2012) After three decades Omran reconsidered his earlier theory and also recommended to introduce the new fourth epidemiological phase: "Decreasing cardiovascular mortality, aging, lifestyle changes, emerging and recurrent diseases". The review of the theory was primarily due to the rise in the life expectancy of women over the age of 80–85, the aging of the population and the decline in cardiovascular mortality seen since the 1970s. These favorable processes started due to the medical successes in lifestyle changes (reduction of smoking, low-fat diet, regular exercise), early diagnosis of cardiovascular disease and treatment of diseases (development of cardiac surgery, intensive and emergency care technology, and preventive cardiology) and the treatment of existing risks (hypertension, stress, diabetes). (Omran, 1998; Bálint, 2016) At the same time, critical comments on the theory have also occurred. Carolina and Gustavo asked the question, that do we really need the concept of the epidemiological transition, when it can often interpret the mortality profiles of individual countries as an exception. According to their opinion, this theory is a fundamentally linear concept based on a linear approach to underdevelopment, development, and modernization in general. “Adapting the linear view of social time may give rise to a notion that each societies, at different rates, are passing on a determined path towards the fourth stage of the epidemiological transition and the happy ending, in which infectious diseases play a negligible role and mortality rates are improving, due to the fatal stages of chronic diseases shifting to ever-later ages. If this is not the case, does the epidemiological transition theory have a deeper meaning than mortality patterns vary by place and time?” (Carolina and Gustavo, 2003; Kovács, 2012) In 2002, Salomon and Murray attempted to answer the legitimate question using the World Health Organization mortality database as part of the Global Disease Burden Program. (Kovács, 2011) It has been investigated whether there are regularities in the rates of age- and cause-specific mortality and in the trends that are in the same direction in a large number of countries. It was found that the pattern of cause specific mortality in the countries studied, at least until the end of the 20th century, was determined by a specific order, which could be found in connection with the total level of mortality and, on the other hand, in relation to national income. (Salomon and Murray, 2002; Kovács, 2012) At the same time as the "fragmentation" of the epidemiological theory and its partial validity, hypotheses about certain disease groups have also appeared. In connection with the infectious diseases the “Old friends” (Rook, 2010) and the Nutritional hypothesis (McKeown, 1976) tries to reflect on the recent epidemiological conditions. In today's most prevalent cardiovascular diseases, the "multi-generational risk model" (Harper et. al., 2011) explains the dominant role of this major group in the causes of death structure. Finally, the most important theory in terms of the topic of this dissertation is called the: “Tumor transition” by Gersten and Wilmoth (2002). This hypothesis states, that during the process, the number of cancer deaths which associated with infectious diseases decline, while the number of tumors, which are attributable to “lifestyle factors”, such as smoking, increase. (Kovács, 2012)

2.2. Divergence-convergence framework, exemptions and vanguards, globally

According to Vallin and Meslé (2017), “several authors argued, that Omran’s epidemiologic theory was too strongly influenced by the rapid success of antibiotics in vanquishing infectious diseases and therefore failed to take into account the non-medical aspects of health development”. Because of this, they proposed to include the concept of the health transition into the theory. This means, that the countries are able to apply by different timing any new major innovative health tools depending on their different economical, political and societal positions. This fact certainly leads to certain separations of groups of countries in time by life prospects, which phenomena were called simply divergence-convergence cycles (Vallin and Meslé, 2004). These divisions were generalized by the authors in the three following ways. In the first cycle, divergence can be experienced between developed (North-Western European countries) and underdeveloped (rest of Europe) countries by the success of combating infectious diseases with the contribution of powerful tools such as vaccines and antibiotics. By the end of the twentieth century, these events had given rise to the widest worldwide range of life expectancies ever observed, despite the fact that many developing countries had almost caught up with the most advanced ones. In the second cycle, the divergence of the Western developed countries and the Central Eastern European countries can be observed. In the mid-1960s, while the Western-developed countries entered the cardiovascular revolution, but the Eastern European socialist systems failed to follow them into the new era. Furthermore, they suffered by increasing mortality of man-made, chronic (cardiovascular and cancer) diseases, mainly derived from unlimited alcohol and tobacco consumption and the underdeveloped health consciousness in general. (Caselli et. al., 2002) The social explanation for this phenomenon could be, that socialist systems brought up the negative side effects of the Industrial Revolution and its societal consequences, such as violent deaths, alcoholism, smoking and drug addiction. (Vallin and Meslé, 2017) This is called simply the East-West divergence. The third divergence cycle started in the most advanced countries, where the temporary slowing down of the improving female life expectancies can be discovered. For instance, the identifiable impact of the smoking epidemic among the mid-war Danish female cohorts, which topic is well-processed by Lindahl-Jacobsen et al. (Lindahl-Jacobsen et. al., 2016 and Lindahl-Jacobsen et. al., 2016, Aburto et al., 2018)

Meanwhile, during the twentieth century, the records of life expectancy have constantly exceeded in the advanced Western Atlantic states and there has been no sign of slowing down in this aging process. This has forced more and more researchers to investigate the (further) growth potential of human life. Oeppen and Vaupel (2002) in their famous research, taking into account the best-performers of the prolonged life prospect populations, proved that ceiling of the human life expectancy does not exist. They stated, looking at the linearly growing life prospects, that "if life expectancy were close to a maximum, then the increase in the record expectation of life should be slowing and for 160 years, best performance life expectancy has steadily increased by a quarter of a year per year, an extraordinary constancy of human achievement. (Oeppen and Vaupel, 2002) Besides this, looking into the depth of these (seemingly-eternal) growing tendencies by the researching of the changing age-profile of death in these populations, several studies, using various measures in the length of life, reveal that as life expectancy increases, lifespan inequality tends to decrease, albeit with considerable variation across populations and over time and the strong relationship between life expectancy and lifespan inequality. (Németh, 2017; Wilmoth et. al., 1999; Shkolnikov et. al., 2011, Vaupel et. al, 2011) Nevertheless, there were authors, who examined that how this development evolved within the society. Jasilionis et. al. studied three Nordic countries (Finland, Norway and Sweden) where the quality of databases allowed this. They constructed a pioneer group is made up of married, high educated individuals, who were considered to be the longest living groups. The researchers compared trends in life expectancy and mortality by cause of death between this vanguard group and the rest of the population from the 1970s to the 1990s. Their study shows that besides simply following directions shown by the vanguard groups, non-vanguard groups have their own pathways to low mortality which are related to specific determinants of mortality changes. "Furthermore, unexpected worsening trends in cancer mortality for both vanguard and non-vanguard groups in Norway also suggests that each country has its own pathways and contextual factors shaping the ongoing health transition. Our findings illustrate that changes in the course of the health transition can be very complex, even with a single country. The timing and speed of mortality reductions may vary dramatically across population groups, and some groups may enter new stages of epidemiological development without completing previous stages. (Vallin and Meslé, 2004)" (Jasilionis et. al., 2014)

2.3. Divergence-convergence framework, exemptions and vanguards, nationally

Carlson and Hoffmann concentrates on the second divergence-convergence cycle according to the theory of Meslé and Vallin, namely the East-West divergence and describes the State Socialist Mortality Syndrome from a labor market perspective. (Carlson & Hoffmann, 2011) According to their findings: "The magnitude of structural labor force changes across countries correlates with lagged increases in death rates for men in the working ages. This pattern is consistent with a hypothesis that hyper-development of heavy industry and stagnation of the service sector created anomic conditions leading to unhealthy lifestyles and self-destructive behavior among men moving from primary-sector to secondary-sector occupations." and show that this phenomenon was affected the most Hungary. This has already been described by Józan earlier, in his in-depth research. (Józan, 1994, 2008) He analyzes the chronic, qualified epidemiological crisis between 1966 and 1993 in the Hungarian society, when the frequency of cardiovascular and cancer deaths determined the increasing level of mortality. This was mostly the case among middle-aged men who had the greatest negative impact on their life expectancy at this stage, the term "qualified" also referring to this. The reasons for this are, among other things, the characteristics of the dictatorial system. Partly in the individual lifestyle factors, especially in the case of excessive smoking and alcohol consumption (Józan, 2002; Bálint, 2010) in the lower social economical status, and at system level in a closed society where the necessary conditions for reducing mortality were not available. "The resources needed to change lifestyle, the improvement of the physical environment and the introduction of up-to-date and costly medical technology, the Hungarian economy in crisis was unable to realize." As a result, the cardiovascular revolution occurred with a significant delay (nearly three decades) compared to the Western countries. Confirming this, the large community-based cardiovascular diseases prevention program in Finland the so-called North Karelia Project launched in 1972, proved that the extremely high coronary heart disease through behavioral change and reduction of the main cardiovascular disease risk factors can be significantly reduced. (Jousilahti et al., 2016) From 1994 an epidemic renewal can be observed in Hungary, as a result the life expectancy is the highest in Hungarian history, but the society inherited high mortality from cancers and cardiovascular diseases from the state socialist system. The change of the regime has made possible the emergence of market economy and the open society. In Hungary, this was a turning point and a new direction in the epidemiological development. As a result, the life expectancy increased due to the competitive, opened society and more important health-conscious behavior. Additionally, Scheiring et al. (2018) in their study examined the health outcomes of globalization through the economic transition in Hungary between 1995 and 2004. Accordingly, they tried to establish relationship between the ownership (state, private or foreign) and mortality, and found that “prolonged state ownership was associated with protection of life chances during the post-socialist transformation for women.” (Scheiring et al., 2018)

In title of his research Bálint asks the question that, how well fits the Hungarian mortality into the theories of the epidemiological transition? According to his examinations we must answer clearly yes in case of women (but not men), despite the fact that development was more modest than in Western Europe. However, as a conclusion he adds that: “the current Hungarian epidemiological development has stepped into the fourth cardiovascular stage. The transition has started earlier for women and has proved to be more significant than men. The data suggest that a breakthrough has been achieved both in the prevention of circulatory diseases and in the treatment of these diseases.” (Bálint, 2016) Although, the improvement is much more smaller and dangerously slower in cancer mortality. “At the beginning of the 21st century, new epidemiological conditions developed in Hungary. Mortality caused by infectious diseases has no longer of public health importance and there has been a breakthrough in the prevention and treatment of cardiovascular diseases. As a result, the relative importance of cancer mortality has also increased, and it is very likely that one of the greatest epidemiological challenges of the 21st century in Hungary will be the cancer mortality.” (Józan, 2005)

If we examine in detail the case of Denmark, which is a good example for the third divergence-convergence cycle, we are able to find instructive parallels for the unfavorable Hungarian situation. Lindahl-Jacobsen et. al. tried to find the cause for the stagnation in life expectancy of Danish women between 1977 and 1995. After investigating the effects of smoking on mortality and comparing the results to the similar figures of Norway and Sweden, they found that in the greatest extent the tobacco consumption of Danish mid-war female cohorts (born between 1919-1939) are responsible for this unfavorable process. (Lindahl-Jacobsen et. al., 2016) Their explanation of why Danish women's life expectancy began to rise around 1995, on one hand, that the "entire interwar generations were dying out, such a selection effect contributed to their decreased influence on total life expectancy", on the other, "the adoption of healthier lifestyles with respect to smoking, alcohol consumption and physical activity as well as the implementation of the "Heart Plan" in Denmark in the mid-1990s." (Lindahl-Jacobsen et. al., 2016) This strong cohort effect is resembling the problematic health status and the shortening life expectancies due to smoking of the Hungarian female cohorts born between 1945 and 1965. (Wéber, 2017, 2019)

2.4. From divergence to convergence?

It is clear from the description above that the fall of the communism (and the Berlin wall) in 1990, was the trigger that caused the epidemiologic renewal in the post-social countries. Shortly after a few years of the historical changes, the life expectancies of the countries in question were shortening, leading to a more deepening and prolonging epidemiological from west to east, but generally life expectancies started to rise steeply after this transition period. (KSH, 2016) Observing this phenomenon, Meslé and Vallin (2017) in their comprehensive overview analyzing the second divergence-convergence cycle more closely asks the question, that could eastern countries catch up with western countries in the near future? They found out, that: "the fall of communism resulted in two major changes: brutal transition to new political and socio-economic regimes and the opening of national borders. Both had a positive and negative impact on the health status of populations and on life expectancy. In particular, these changes increased poverty and vulnerability among a large share of the population. However, the introduction of new medical techniques, the implementation of new health systems and the adoption of new individual behaviors led to major health and life expectancy improvements. They undoubtedly reflect massive progress in terms of cardiovascular and man-made diseases." (Meslé and Vallin, 2017; Grigoriev et al. 2010; Jasilionis et al. 2011) According to their examinations they conclude the following answer for their very complex research question: "In total, although it is obvious that huge and favorable changes have characterized a new historical phase of rapid progress in Central Europe since 1991 and in Eastern Europe since 2005, the extent to which these parts of Europe are on a path towards catching up with Western countries remains unclear. In the case of Central

Europe, however, it seems that the gap could close quite soon with the USA but not with France or Japan. The countries of Central and Eastern Europe face different future challenges. For countries like Poland or Czech Republic (including Hungary, Romania and Bulgaria as well), the main uncertainty no longer concerns cardiovascular and/or man-made diseases at working ages but rather their capacity to follow Western countries like France or Japan which are starting to reduce mortality at old and very old ages. This will call for further adaptation of their health systems to address the needs of the elderly population, in terms of both living arrangements and health care provision."

In their recent research, Jasilionis et al. asks the question, that is East-West life expectancy gap narrowing in the enlarged European Union? According to their findings, the fall of the Berlin wall and EU enlargement in 2004 were the main events that affected the improving life prospects in Eastern Europe. The collapse of the communism was accompanied with immediate positive changes in the Central European countries (Czech Republic, Poland, Slovakia and Hungary), but in all new EU member states, further progress requires much more systematic efforts in combatting cardiovascular diseases and persisting burden of excess male mortality at adult ages. They also add to this, "that although almost all countries showed some progress in reducing the mortality disadvantage for external causes of death, similar achievements in alcohol-related male mortality concerned only Estonia and Hungary. Despite important improvements, the burden alcohol-related mortality remains exceptionally high in Lithuania and Hungary." (Jasilionis et al., 2018) Confirming this, by the recent Hungarian research, which takes into account the educational attainment as well and draws the attention for the inequalities in the society (more on inequalities see also: Kovács, 2011): "that life-year loss of directly attributable to alcohol has decreased significantly in all education groups. Meanwhile, the life expectancy gap between at least high school graduates and those with a lower level of education has increased further during this period, further deepening the already significant diversification by social status in the early nineties." (Bálint and Németh, 2018) This situation is obviously not improved by the fact that the Hungarian health government continues to classify home-cooked spirits as legal and tax-free. But taking all this into consideration there is still a converging in the life expectancies of Hungarian males can be observed, but a stabilization of the gap can be experienced for women compared to Western societies, which call the attention for a further and probably a bigger problem. Namely, the cancer mortality of the middle-aged and older women (KSH, 2016)

3. Explorative and descriptive statistical data analysis

3.1. Introduction

The purpose of this chapter is to review the process of the epidemiological transitions from 1950 to 2015 in Hungary, Austria and Denmark along the dimension of sex, age and causes of death, mostly focusing on premature cancer. The straightforward logic of this chapter is going from complex to simple demographical units by descriptive statistical tools.

Firstly, we take a look on the so-called Preston-curve: the relationship between the life prospects for the total populations and the economic development) in selected European countries for 2015. Secondly, historical data analysis shows the different and similar epidemiological trajectories of Hungary, Austria and Denmark from 1950 to 2014 with the help of the time-path plots, take into account three age thresholds: 0, 40 and 60. Thirdly, the premature mortality, which means the early death below age 70 is analyzed in the reference period called epidemiological renewal in the Hungarian demographic history, from 1994 to 2015 by sex, which in itself includes the examination of age-groups. Here, among others we are looking for the answer of the question: What role did the 5-year-old age-groups played in changes in life expectancy at birth in the period 1994-2015 and how did they contribute to it? Fourthly, a quick look happens at the infant mortality, which is a very special case of premature mortality. Fifthly, starts the research of causes of deaths by the two most common types: the cardiovascular and the cancer causes by sex and age in the three countries in focus. This is followed by a detailed analysis using all of the possible variables, which the framework of this dissertation allows (sex, age, causes of deaths), answering to the already known expanded question: What role did the 5-year-old age-groups played in changes in life expectancy at birth in the period 1994-2015 by six main causes of deaths and how did they contribute to it? Then in the last section, sixthly, we focus on (premature) cancers concretely. We get to know the five most common underlying cancer cause of death in ages 40-69 and by sex in Hungary, Austria and Denmark and in the end the we zoom into the cancers, answering to our ordinary question: What role did the 5-year-old age-groups played in changes in life expectancy at birth in the period 1994-2015 by five main causes of cancer deaths and how did they contribute to it? It is worth to mention here, that by the proper classification of the given ICD codes we can also express the role of the malignant neoplasms related to smoking as well.

All in all, this chapter would like to fulfill the task of providing a complete overview of the full-scale of three dimensions: 1. Time, from 1950 to 2015; 2. Statistical tools, from absolute numbers to lifespan inequalities; 3. Mortality, from total deaths to the most specific cancer cause of deaths. In order to report comprehensively and in detailed enough on the premature cancer mortality conditions through the epidemiological transitions in Hungary, Austria and Denmark.

3.2. Methods

Data

For the Preston-curve, life expectancies at birth for the total population and GDP per capita (based on the Purchasing Power Parity) in selected European countries are from database from the World Bank. The countries are categorized by the type of their socio-economic and political system: capitalist, post-socialist and post-soviet.

Historical data analysis is based on the life expectancies at birth, age 40 and 60 and coefficients of variation at birth, age 40 and 60 by sex from 1950 to 2014 are calculated from the period life tables of the HMD for Hungary, Austria and Denmark. "The HMD database contains carefully checked life tables that have been compiled using strict standards and similar procedures. Vital statistics provide raw data, birth and death counts, while population counts are derived from periodic censuses or official population estimates. Sources of raw data and exact methodology of specific adjustments for each population are well documented" (Németh, 2017)

Premature mortality absolute numbers between 1994 and 2015 are from the Eurostat database, for which the national statistical offices reporting the data broken down by sex, age groups, causes of death. The classification of deaths was based on the detailed list of the International Classification of Diseases, 10th revision (ICD-10), A00-Y98. The used life-tables there, are also calculated from these numbers. The maximum age-group of the examination of the life table decomposition is 80+, due to the limitation in the database of Eurostat for causes of deaths in 1994. It must be mentioned, that Bogos et al. (2019) draw the attention to the possible overestimation of the lung cancer deaths. There are breaks can be experienced in time series of the Hungarian causes of death data between 2004 and 2005. This phenomenon is due to the changing in the data processing method of the HCSO, when the selection of the underlying causes of deaths was switched to automatic. It is very likely that the cancer figures for Hungary before 2005 are overestimated.

Categorization for main causes of deaths is according to the ICD-10 codes in figures 12,13,14: Cancers – C00-C97, Diseases of the circulatory system - I00-I99, Diseases of the respiratory system - J00-J99, Diseases of the digestive system - K00-K93, External causes of morbidity and mortality - V01-Y89

Categorization for cancer causes of deaths is according to the ICD-10 codes in figures 15,16,17: Trachea, bronchus and lung – C33-C34, Colon – (colon, recto sigmoid junction, rectum, anus and anal canal) C18-C21, Pancreas – C25, Liver – (liver and intrahepatic bile ducts) C22, Lip, oral cavity, pharynx – C00-C14, Breast – C50, Ovary – C56, Prostate – C61, Stomach – C16

Categorization for cancer causes of deaths is according to the ICD-10 codes in figures 18, 19, 20: Malignant neoplasm related to smoking - Trachea, bronchus and lung – C33-C34, Lip, oral cavity, pharynx – C00-C14, Larynx – C32, Malignant neoplasm of breast - C50, Malignant neoplasms of gynecological organs - Malignant neoplasm of cervix uteri – C53, Malignant neoplasm of other parts of uterus – C54-C55, Malignant neoplasm of ovary – C56, Other cancers - Other malignant neoplasms (remainder of C00-C97), Malignant neoplasm of colon - (colon, recto sigmoid junction, rectum, anus and anal canal) C18-C21, Malignant neoplasm of stomach – C16, Malignant neoplasm of pancreas - C25

Statistical methods

The value of life expectancy tells that, if the mortality conditions of a given year would remain permanently unchanged in the future, then for how many life years can the individual expect at birth or at different ages. This hypothetical indicator shows the mortality status of a given year summarized in a single number in a standardized and comparable way. All this information are coming from the life-table, which is one of the most used statistical tools to measure mortality. Based on this, there are also a branch of methods, to measure lifespan disparities. Besides the life expectancy, this research will apply the so-called coefficient of variation[1], which means simply the deviation of deaths around life expectancy and calculated for every year. If the value is lower, then the dispersion of deaths is less, if the value is higher the dispersion of deaths is more significant in an observed population for a given year.

Putting the life-expectancy at birth to the horizontal axis, and the life-table coefficient of variation on the vertical axis, time-path plots were created, to explore the epidemiological transitions in Austria, Denmark and Hungary by sex. This means that, if the line is going to the top-left corner, it is a clear deterioration in the life prospects, but if it is going to the right-bottom corner it represents improvement. The labels in the figures are showing the cornerstone years of the Hungarian epidemiological development. If we calculate both indicators to age 40, we eliminate the effect of the rapidly improving infant and juvenile mortality, consequently get more reflective indicators for middle-aged mortality. Similarly to this, if we calculate both indicators to age 60, we focus on old-age life prospects.

Mortality conditions can be characterized not only by specific mortality rates or life expectancies. The Potential Years of Life Lost indicator, which is widely used in statistics, summarizes the remaining non-lived lifetime of the dead members of the population, with a reference of a specific age. Consequently, it is particularly suitable for demonstrating and interpreting the premature mortality of a population. The age limit is chosen arbitrarily, in this research we use 70 years similarly to the international practice. Thus, if someone dies younger than the reference age (70 in this case) at age x, the number of lost years of life is in case of $x < 70$ is $70 - x$. If the individual dies older, than the age of 70, the value of the indicator is logically 0. We calculate the indicator for every 5-year age group per hundred thousand inhabitants and then standardize the results based on the Eurostat population standard[2] according to the official recommendations. As a result, we get a standardized indicator, which is sensitively quantify the premature mortality in a given population. We are going to apply this method for the data of Austria, Denmark and Hungary from the Eurostat database and based on this we are able to show the results by sex.

[1] See Appendix A for the formula of the calculation

[2] See Appendix B for the formula of the calculation and the official population standard.

What role did the 5-year-old age-groups played in changes in life expectancy at birth in the period 1994-2015 and how did they contribute to it? To this question we are able to answer by the decomposition of the life tables (Preston et al., 2001) by Arriaga's method (Arriaga, 1984). Figure 7 is a bar chart, which positive domain shows the positive contribution, the negative domain means the pulling back in the development of the life expectancy. It will appear later, we are able to broken down by specific causes of deaths these contributions.

Infant mortality can be treated separately in the area of premature death as usual. The infant mortality rate describes well a country's health culture, standard of pregnant and newborn care, health care system its efficiency and development and it is also an ideal indicator for international comparison. Naturally it has a downward basic trend in the newest epidemiological era for every developed countries. Unlike other vital event rates in population statistics, it is calculated not per 1000 persons, but per 1000 live births.

The rule of thumb regarding the causes of deaths structure in the total populations with advanced health culture is, that half of the annual number of the deceased died due to cardiovascular diseases, quarter of the deaths are attributable to cancers and the other quarter are caused by other causes, i.e. respiratory, digestive diseases or external reasons, roughly for both sexes. (HCSO, 2014) These proportions are modified in the case of premature deaths in a way, that approx. 3 men out of 10 and 3 women out of 10 deceased died due to cardiovascular causes of death. In case of cancer diseases, the situation is worse for women: 3 men out of 10 and 4 women out of 10 deceased died caused by neoplasms. For this reason, we are going to examine the potential years of life lost indicator broken down by these two main causes of death.

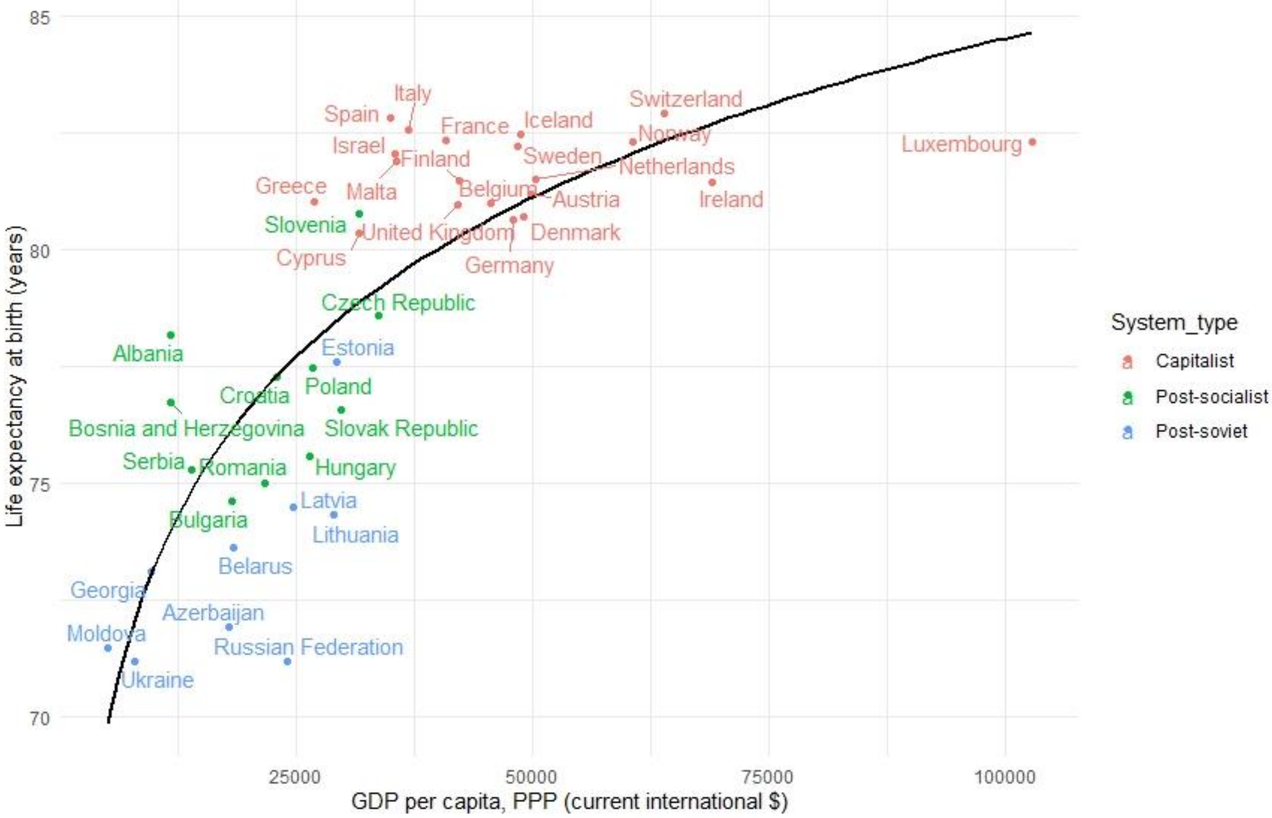
So it is possible to break down Figure 7 by main causes of deaths, so the created bar charts will answer the question, that what role did the 5-year-old age-groups played in changes in life expectancy at birth by also underlying main causes of death in the period 1994-2015 and how did they contribute to it? Of course, it is possible to ignore other main causes of death and only just focus on deaths due to specific cancer localizations in the contribution analysis of life expectancy improvement. For this reason, Figure 18-19-20 zoom in only on the red part of the appropriate diagrams of Figure 12-13-14 and break them down by tumor localizations. It is must be mentioned, that according to reasonable scientific simplifications trachea, bronchus, lung and lip, oral cavity, pharynx and larynx cancers are belong to the smoking related neoplasms (USDHHS, 1989; 2014), while the cancer of cervix uteri, other parts of uterus, ovary are part of the category of malignant neoplasms of gynecological organs.

3.3. Results

International outlook

Figure 1 shows an international outlook for the year 2015: the results of epidemiological development over the decades, across the countries of Europe by the type of their socio-economic and political system. While Austria's and Denmark's GDP per capita almost reaches 50 thousand dollars, Hungary's value is nearly the half of this 26 thousand dollars. It's also visible, that lower-level economic development goes along with shorter life expectancy. While the life expectancies of Austrian and Danish people already crossed the age 80 threshold a Hungarian baby could expect approximately by 5 years shorter life, 75 years in 2015.

Figure 1: Relationship between life prospects described by life expectancy at birth and economic development described by GDP per capita (on purchase power parity) in selected countries of Europe, 2015

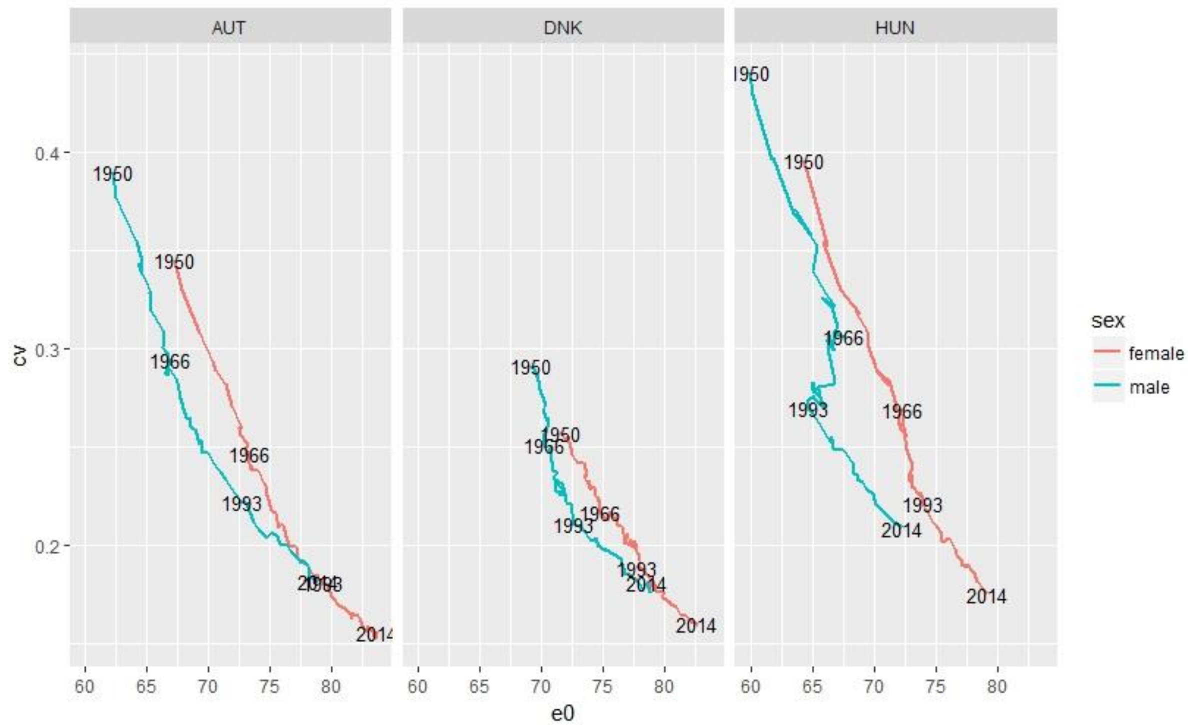


Source: World Bank database

Historical data analysis

According to the historical data analysis the Austrian epidemiological transition shows a fast and continuous improvement from 1950 till 2014 for both sex, but in Denmark this progress was much more slower. In case of Hungary the chronic, qualified epidemiological crisis is visible between 1966 and 1993 for Hungarian men, where the development of life prospects stopped in the mid-60s and their life expectancy decreased, although at the same time the coefficient of variation was declined.

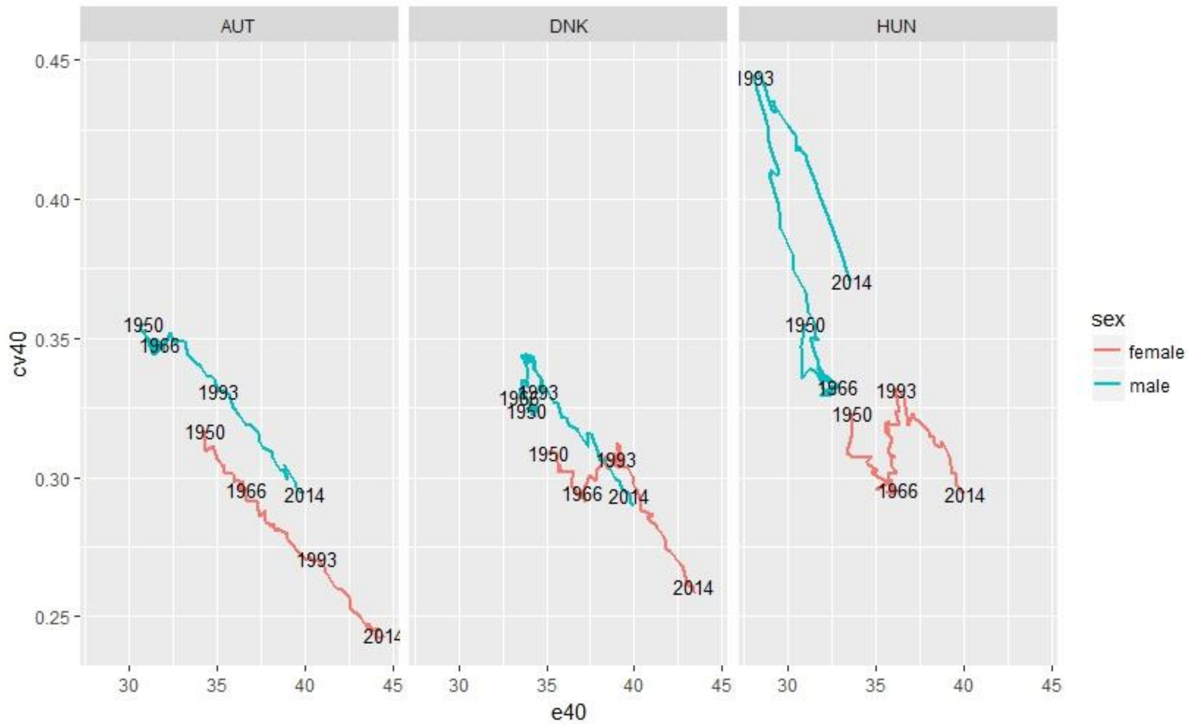
Figure 2: Total life-expectancy at birth in years against the value of life-table coefficient of variation at birth in Austria, Denmark and Hungary, 1950-2014



Source: HMD, own calculations

The Austrian data show again a continuous development of the life prospects of the mid-age population, while in the Danish society there are smaller stoppages in the epidemiologic development for both sexes, especially for female, in the second part of the 20th century. For both sex the life expectancy increased that time, but the variance of death between ages rose. In Hungary a huge deterioration is visible for men in the time of the epidemiological crisis (declining life expectancy and rising coefficient of variation), meanwhile the mortality conditions of the female population also worsened: their life expectancy at 40 stagnated and their variance of death between ages was increased. It is interesting to see that in the beginning year of the Hungarian epidemiological crisis in 1966, the life prospects of the Hungarian middle-aged men were longer than the Austrian, but then the two developments took a completely opposite direction.

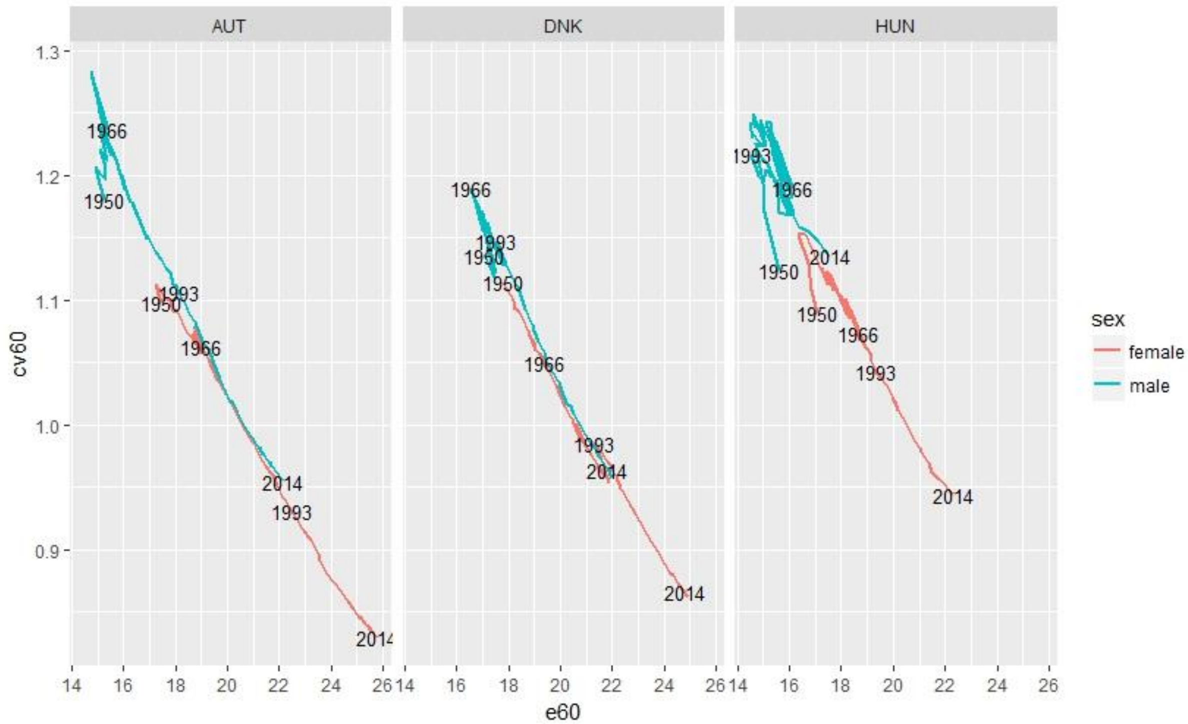
Figure 3: Life expectancy at 40 in years against the value of life-table coefficient of variation at age 40 in Austria, Denmark and Hungary, 1950-2014



Source: HMD, own calculations

There are stoppages for Austrian and Danish male population from 1950s till the mid-60s, in the old-age epidemiological development, which means that during the problematic period in question, there was no temporary improvement mainly in the mortality of the elderly. In the 1970s the life expectancy of the elderly started to rise again in Austria and Denmark, but in Hungary much later and in smaller extent. A “spool of thread”, is visible for Hungary between 1966 and 1993, which means that the life expectancy of the elderly (particularly men) did not improve significantly at that time.

Figure 4: Life expectancy at 60 in years against the value of life-table coefficient of variation at age 60 in Austria, Denmark and Hungary, 1950-2014



Source: HMD, own calculations

Premature mortality in the epidemiological renewal by sex

Table 1 shows the descriptive figures of the Hungarian, Austrian and Danish premature mortality, by sex. All populations in the comparison could achieve significant development in the observed period. It is easy to see, that Hungarian life expectancies are the shortest, because in 1994 nearly 6 male out of 10 died before age 70, which meant almost 45 thousand deceased men only in one year. This catastrophic value shows improvement after two decades, approx. 29 thousand men died in 2015, which meant 45% of the total number of deaths in 2015, so there was an 11 percentage point development. For Hungarian women the absolute numbers are approx. the half that of men, which means that in 1994 3 females and then in 2015 2 died out 10 before age 70, which was almost a 10% improvement. All the other figures are way more favorable for Austria and Denmark. It is important to emphasize, that in case of the female premature mortality Denmark is more affected, than Austria in 2015 (20 vs. 15%) and this could possibly be the negative effect of the third divergence cycle.

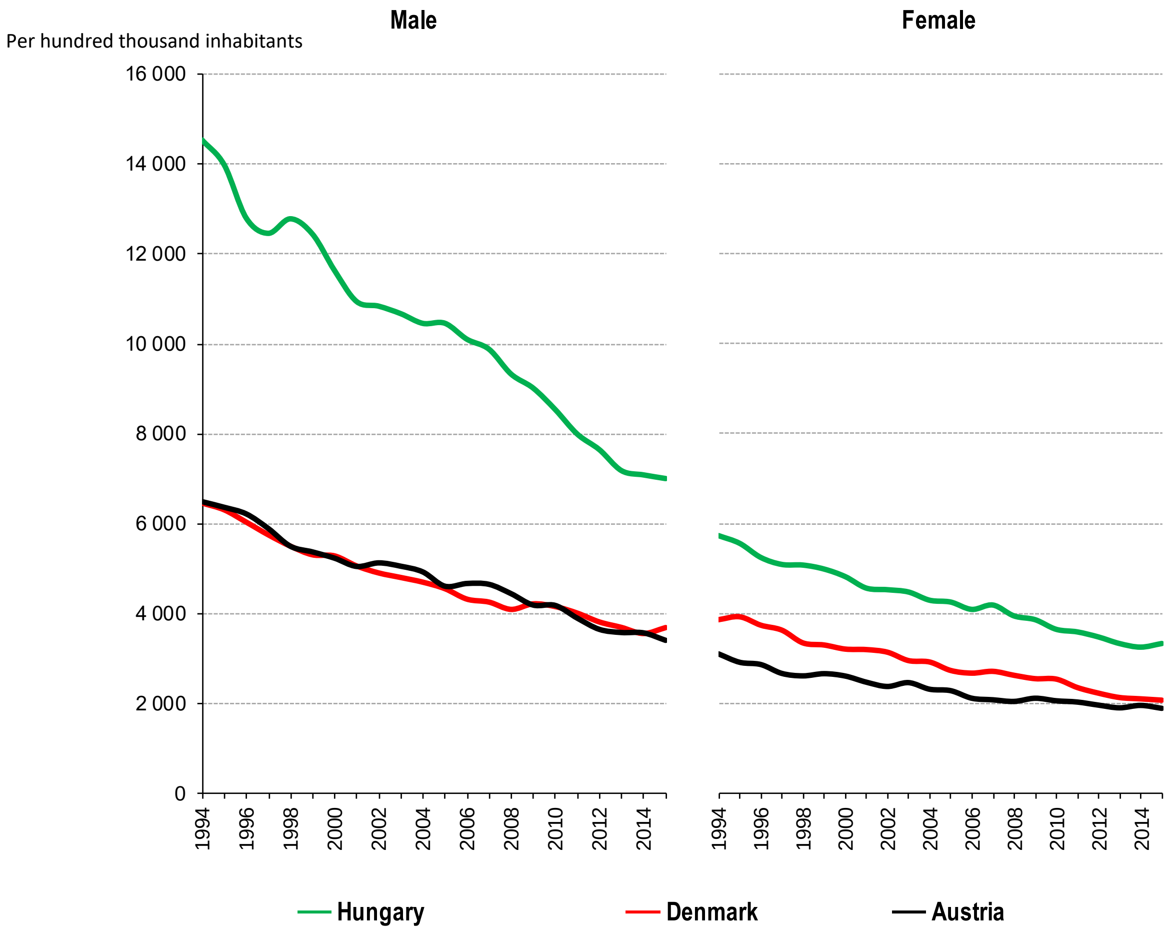
Table 1: Changes in the premature mortality of under age 70 between 1994 and 2015, in Hungary, Austria and Denmark

	Number of deaths under age 70		Percentage of deaths below 70 years of total death in percentage	
	Male	Female	Male	Female
1994	44 646	21 850	56,8	32,0
2015	28 794	15 879	45,4	23,3
Change (absolute number, percentage point)	-15 852	-5 971	-11,4	-8,7
1994	15 665	8 241	42,1	19,0
2015	11 966	6 069	30,0	15,3
Change (absolute number, percentage point)	-3 699	-2 172	-12,0	-3,7
1994	11 087	7 198	36,3	23,6
2015	8 133	5 213	30,9	19,8
Change (absolute number, percentage point)	-2 954	-1 985	-5,4	-3,7

Source: Eurostat database, own calculations

The level of premature mortality is around twice in the Hungarian population, than in the Austrian and the Danish. Between 1994 and 2015 in all countries the value of the indicator steeply declined, which means, that at the same time the life expectancy also increased significantly as well. As long as Hungarian men are obviously catching up with the reference populations - the gap shrunk from 225% to 190% compared to Austria - in case of women the trend rather keeping the differences from 186% to 176% and didn't changed so much in the observed period. Between 1994 and 2015, the Hungarian, Austrian and Danish level of male premature mortality decreased by: 52%, 43% and 48% respectively, while in case of women by 42%, 38% and 46% respectively.

Figure 5: Standardized potential years of life lost to age 70 per 100,000 inhabitants for all deaths by sex in Austria, Denmark and Hungary, 1994-2015

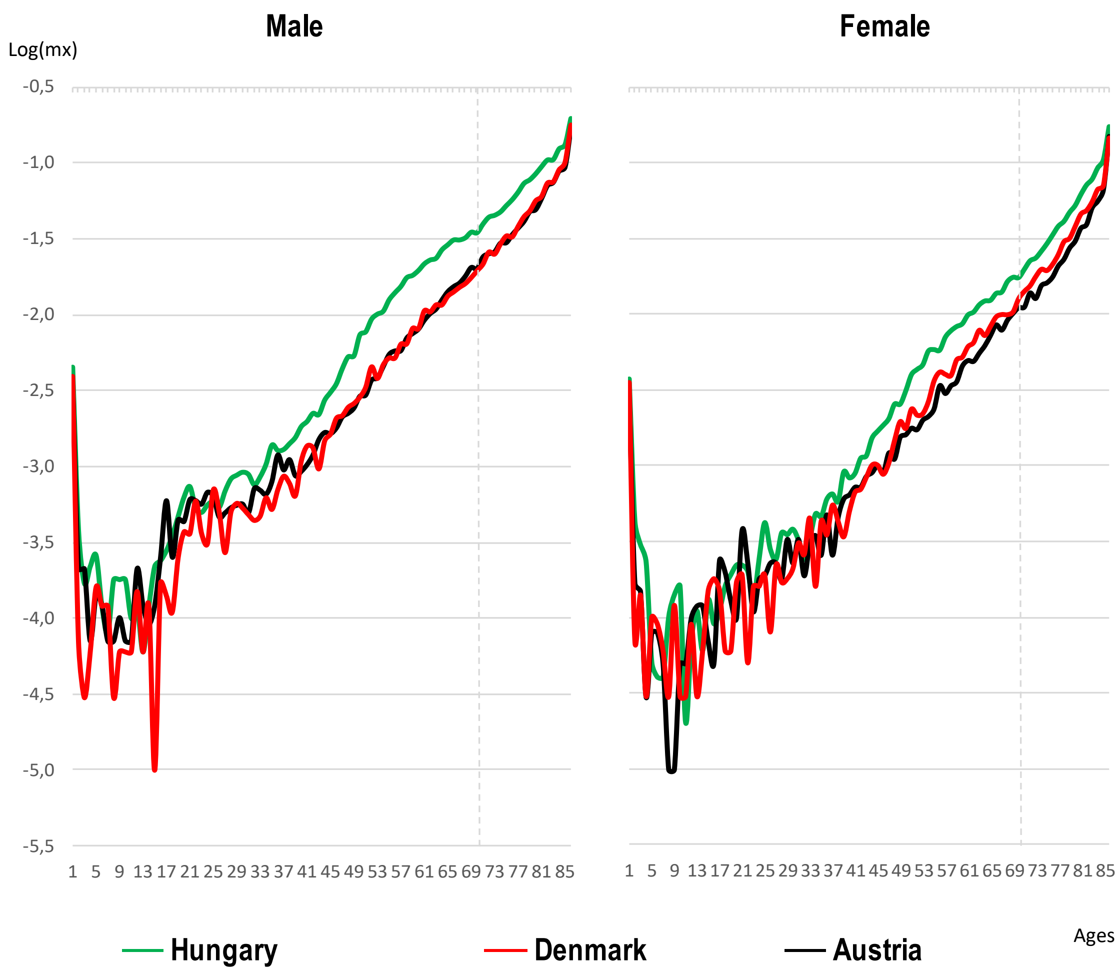


Source: Eurostat database, own calculations, smoothing: spline interpolation

Figure 6 clarifies the mortality differences by sex, single ages in the countries in focus, for the year 2015. According to traceability reasons the age-specific mortality rates were switched to log-scale. Not surprisingly, in the first year of life the mortality is generally higher, and in this there are no reasonable differences between countries. Then, the death rate in young ages start to fall steeply and remain on the lowest level till around the age of 20. After this the rates are starting to increase, in a greater extent for men, creating the so-called “mortality hump”, which is in the vast majority due to external causes of deaths for instance homocides, suicides and motor vehicle accidents. It is easy to see on the chart, that the Hungarian mortality figures starting to diverge around at age 40 for both sexes from the values of the benchmark countries and stabilize on a higher level in the premature ages. According to the age-profile, it is worth to mention, that in

Hungary the level of the mortality rate at age 0 is reached again at age 48, in case of Austria and Denmark later, for both at age 52.

Figure 6: Logarithm of the age-specific mortality ratio by sex, in Hungary, Austria and Denmark, 2015



Source: Eurostat database, smoothing: spline interpolation

Examining between 1994 and 2015 the life expectancies at birth, age 40 and 60 in Hungary, Austria and Denmark, an ambivalent picture reveals. If we take into account the life prospects of the whole populations (life expectancies at birth), it is visible that Hungarian male are catching up with the Austrian and Danish men, for the reason that their expected length of life extended to a greater extent than in the benchmark populations: 7,3 vs 5,6 and 6,0 years. On the contrary, there is no such converging for Hungarian women compared with Denmark (4,5 vs 4,5 years) and there is only a smaller extent compared with Austria (4,5 vs 3,9 years) respectively. At this point it must be mentioned, that an Austrian girl baby in 2015 could expect 5 more years of lived life, than a Hungarian so this fact clarifies, that the mentioned converging is almost negligible. If we look better behind these macro values broken down by age, the life expectancy at 40 shows similar tendencies. While in case of Hungarian men a clear catching up is observable (5,4 vs 4,5 and 5,0 years), the Hungarian women's life expectancies not converging to the similar values of the benchmark countries at all (3,3 vs 3,3 and 4,0 years). At the same time the story is different in the older ages, looking on the figures of life expectancy at age 60: for both sexes in Hungary a clear diverging can be experienced in the life expectancies.

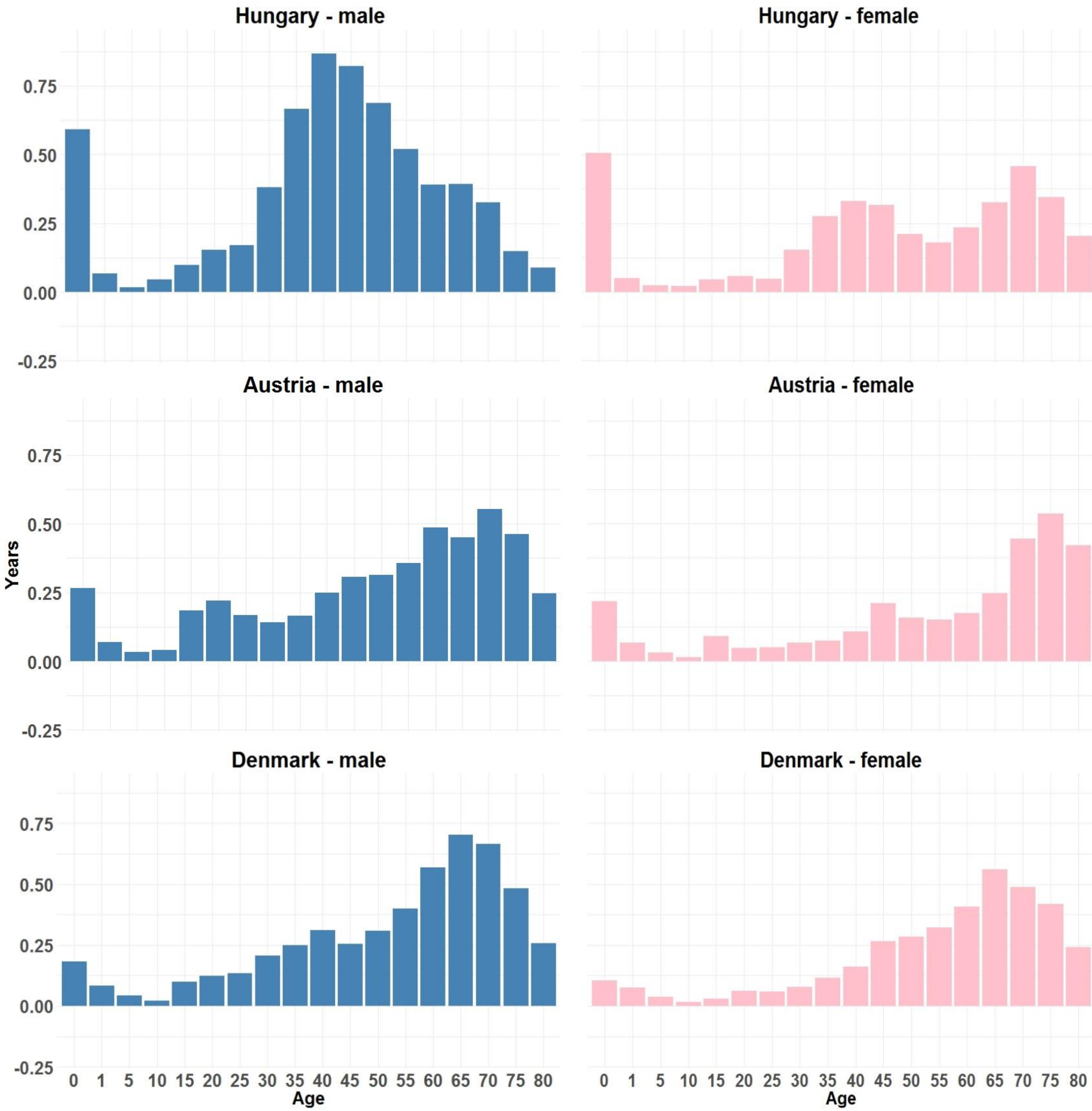
Table 2: Life expectancy in years and its changes between 1994 and 2015, in Hungary, Austria and Denmark

	Life expectancy at birth		Life expectancy at age 40		Life expectancy at age 60	
	Male	Female	Male	Female	Male	Female
1994	65,0	74,5	28,3	36,5	14,8	19,6
2015	72,3	79,0	33,7	39,8	17,5	22,1
Change (years)	7,3	4,5	5,4	3,3	2,7	2,5
1994	73,2	79,8	35,5	41,1	18,5	22,9
2015	78,8	83,7	40,0	44,4	22,0	25,7
Change (years)	5,6	3,9	4,5	3,3	3,5	2,8
1994	72,8	78,2	34,8	39,4	17,8	21,7
2015	78,8	82,7	39,8	43,4	21,9	24,9
Change (years)	6,0	4,5	5,0	4,0	4,1	3,2

Source: Eurostat database

In all countries every age groups contributed to the increase of the life expectancy at birth, but in varying degrees. In Hungary the decline in the infant mortality contributed with a significant half-year to the overall life expectancy increase between 1994 and 2015 for both sexes, but in the other countries in focus this was not so relevant. In case of Hungarian male population a notable improvement can be observed between the ages 30 and 69 (mostly contributed to the life expectancy increase). The structure of improvement for Austrian and Danish men is totally different compared to Hungarians. On one hand, in younger ages 30-59 there is no such large development, on the other, in older ages (60-80+) the improvement accelerates in Austria compared to Hungary. Considering Hungarian women we can point out a setback in the development in the life expectancies between ages 50-64, which is in smaller extent is also true for the Austrian women. This phenomenon cannot be detected in the similar Danish female population. Nevertheless, except the situation of Hungarian males, in all the other populations the aged 60+ elderly gave the most significant contribution to the to extend life expectancies between 1994 and 2015.

Figure 7: Contribution of age-specific mortality changes to life expectancy at birth in Hungary, Austria and Denmark, 1994-2015



Source: Eurostat database, own calculation

Infant mortality

In 1994 the value of the Hungarian infant mortality was much higher than that of the developed European countries, like Austria and Denmark, but in the observed two decades Hungary significantly reduced its disadvantage. The tangible result of this was - as we have seen it before - the around half-year contribution to the increase of the life expectancy at birth for both sexes.

Table 3: Changes in the infant mortality of under age 1 between 1994 and 2015, in Hungary, Austria and Denmark

	Number of deaths under age 1	Infant mortality rate per thousand live births	Percentage of deaths below age 1 in the total premature death in
1994	1 335	11,5	2,0
2015	383	4,2	0,9
Change (absolute number, rate, percentage point)	-952	-7,3	-1,2
1994	578	6,3	2,4
2015	259	3,1	1,4
Change (absolute number, rate, percentage point)	-319	-3,2	-1,0
1994	380	5,5	2,1
2015	216	3,7	1,6
Change (absolute number, rate, percentage point)	-164	-1,8	-0,5

Premature mortality in the epidemiological renewal by main causes of death

In all examined populations the absolute number of premature cardiovascular deaths dropped significantly in the period 1994-2015. What is worth to mention here, that the percentage of cardiovascular deaths in the total premature deaths for Hungarian male only declined by 1.2 percentage point while in Austria and Denmark by 9 percentage points.

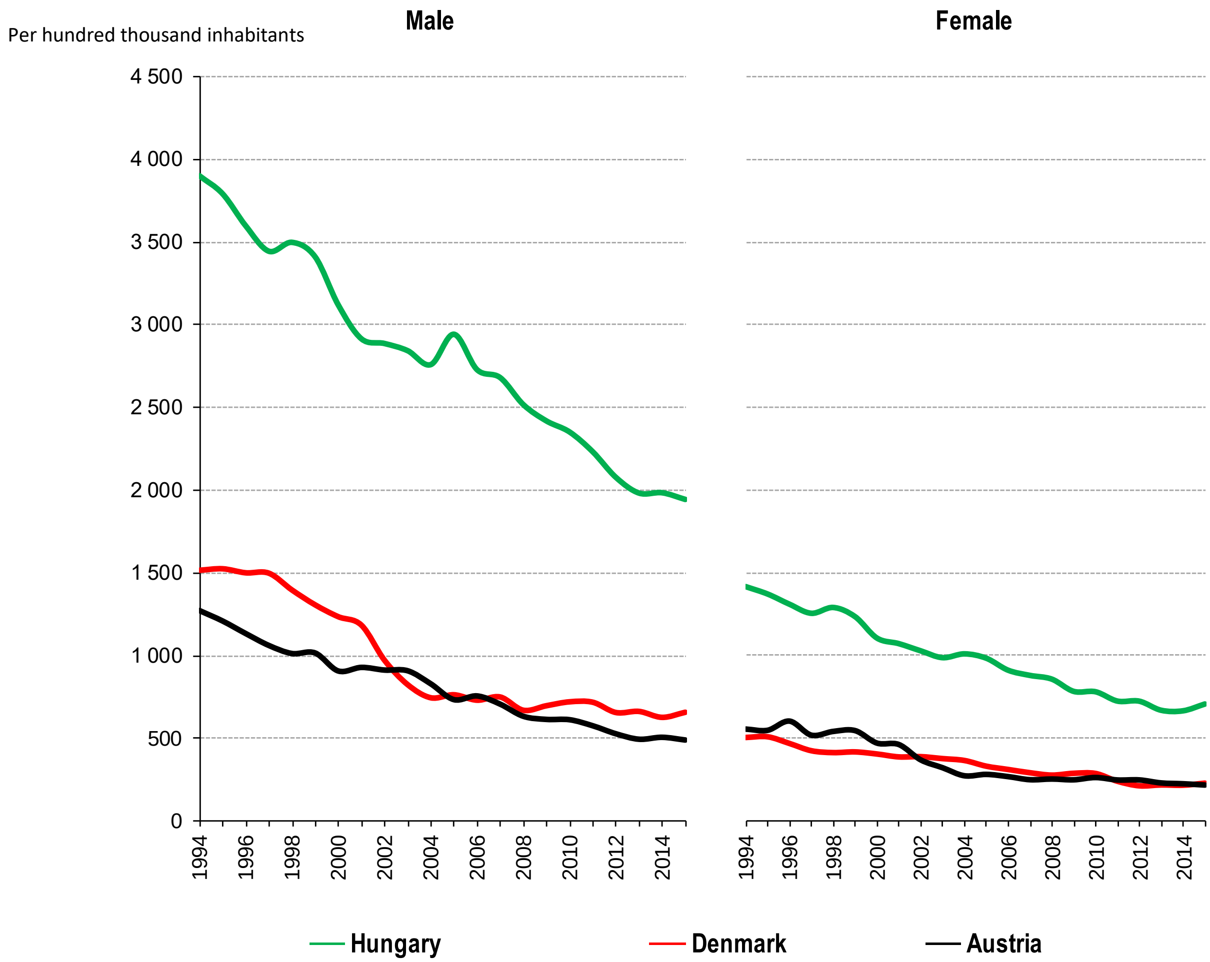
Table 4: Changes in the cardiovascular mortality of under age 70 between 1994 and 2015, in Hungary, Austria and Denmark

	Number of cardiovascular deaths under age 70		Percentage of cardiovascular deaths in the total premature death	
	Male	Female	Male	Female
1994	15 407	7 846	34,5	35,9
2015	9 606	4 439	33,3	27,9
Change (absolute number, percentage point)	-5 801	-3 407	-1,2	-8,0
1994	5 074	2 290	32,4	27,8
2015	2 837	1 091	23,4	16,5
Change (absolute number, percentage point)	-2 237	-1 199	-9,0	-11,3
1994	3 053	1 333	27,5	18,5
2015	1 484	653	18,4	12,6
Change (absolute number, percentage point)	-1 569	-680	-9,2	-5,9

Source: Eurostat database

In case of cardiovascular diseases the situation looks similar as the indicator of all premature deaths. The gaps between Hungary and the reference countries are significant, however for both sexes are clearly shrinking. In the observed period, the Hungarian, Austrian and Danish level of male premature cardiovascular mortality significantly decreased by 50%, 56% and 61% respectively, while in case of women by 50%, 61% and 55% respectively.

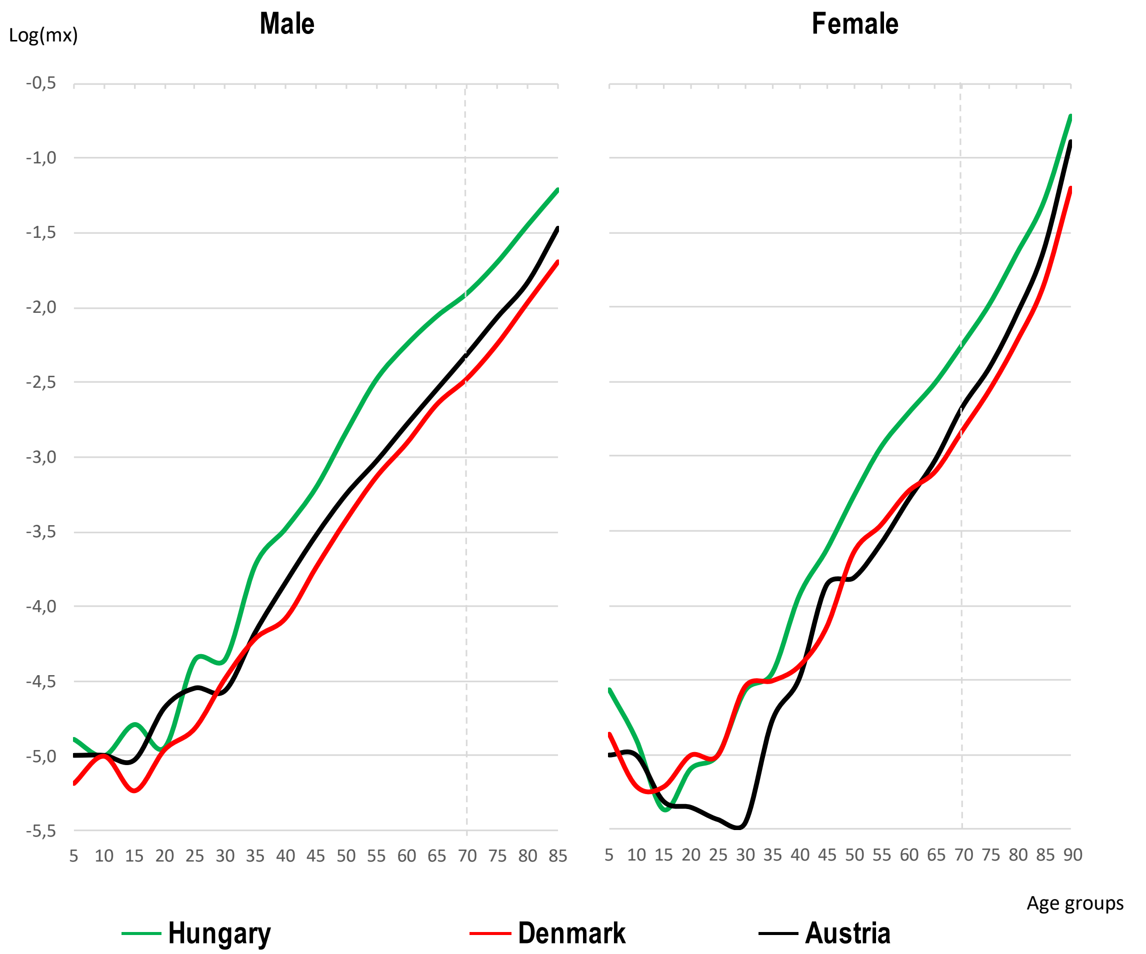
Figure 8: Standardized potential years of life lost to age 70 per 100,000 inhabitants for cardiovascular deaths by sex in Austria, Denmark and Hungary, 1994-2015



Source: Eurostat database, own calculations, smoothing: spline interpolation

Placing the 5 year-age-specific cardiovascular mortality ratio (mx) on a log-scale by sex, it is visible, that around from age 35 starting to diverge in a negative sense the Hungarian cardiovascular mortality from the other two countries. It must be mentioned, that from this threshold-age the differences by age-groups are increasing till the age 55 for male, when they reach 3.5-4.5 fold surplus, for women the Hungarian excess mortality reaches the top at around the age 55-65, where approx. 4 times higher the mortality, then in Austria and Denmark. After reaching these plateaus (the largest gaps) for both sexes the gaps are shrinking in the older ages till around 2 and 3 times more respectively.

Figure 9: Logarithm of the 5 year-age-specific cardiovascular mortality ratio by sex, in Hungary, Austria and Denmark, 2015



Source: Eurostat database, smoothing: spline interpolation

Table 5 reflects well the critical premature cancer situation of the Hungarian female in the period of epidemiologic renewal. Despite all the declining early mortality tendencies seen so far, it is visible that between 1994 and 2015 increased the absolute number of premature cancer deaths from 6837 to 6883 by 46 deaths, although for Hungarian male a significant improvement can be observed. What is common in all countries that the percentage of cancer deaths in total premature deaths are apparently increased in the observed period. Particularly the Hungarian women should be emphasized, where it has risen critically by 12 percentage points. Nevertheless, for Hungarian men also a large increase of 9 percent points was recorded in the period 1994-2015. Compared to this, the rise in Austria and Denmark was moderated.

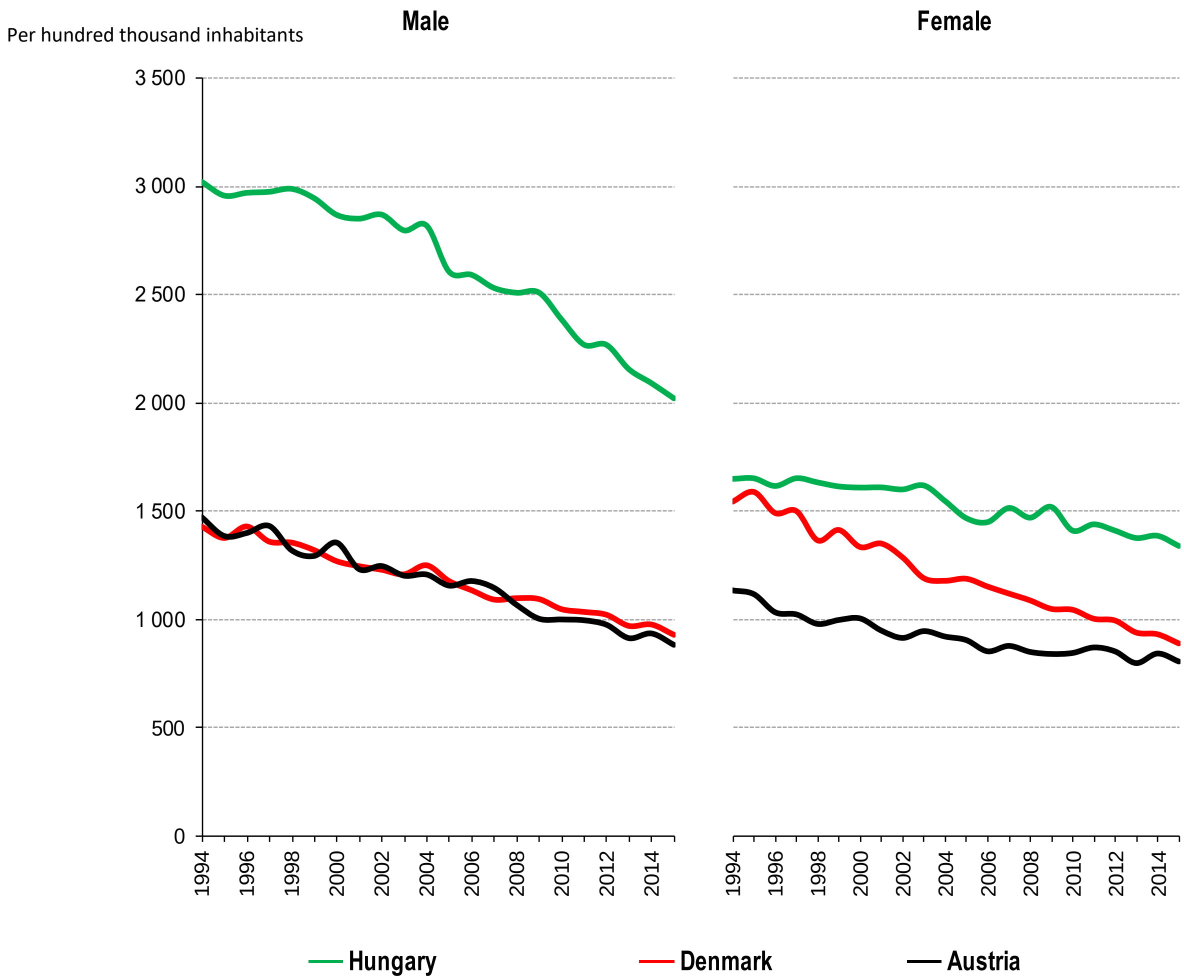
Table 5: Changes in the cancer mortality of under age 70 between 1994 and 2015, in Hungary, Austria and Denmark

	Number of cancer deaths under age 70		Percentage of cancer deaths in the total premature death	
	Male	Female	Male	Female
1994	11 195	6 837	25,1	31,3
2015	9 838	6 883	34,1	43,3
Change (absolute number, percentage point)	-1 357	46	9,1	12,0
1994	4 444	3 418	28,4	41,5
2015	4 078	3 197	33,7	48,2
Change (absolute number, percentage point)	-366	-221	5,3	6,7
1994	3 267	3 156	29,5	43,8
2015	2 862	2 556	35,4	49,2
Change (absolute number, percentage point)	-405	-600	6,0	5,4

Source: Eurostat database

On Figure 10 the Hungarian level of premature male cancer mortality in the period of epidemic renewal is 2.3-2.5 times, for female is 1.5-1.8 times more, than in Austria. It is important to highlight that from 1994 till 2004 a very slight decline can be observed in the early cancer mortality of the Hungarian population and then a clear drop afterwards. In the observed period, the Hungarian, Austrian and Danish level of male premature cancer mortality dropped by 33%, 35% and 40% respectively. It is also true that the Hungarian male mortality is showing a fast converging tendency to the level of Austria and Denmark. Between 1994 and 2015, the Hungarian, Austrian and Danish level of female premature cancer mortality decreased by 18%, 29% and 42% respectively. Unfortunately, the Hungarian values were declined the least and the data clearly show a non-converging trend with the countries compared. The situation in Denmark is exemplary, because the middle-aged female cancer mortality dropped, from the level of the Hungarian mortality in 1994 to the Austrian in 2015.

Figure 10: Standardized potential years of life lost to age 70 per 100,000 inhabitants for cancer deaths by sex in Austria, Denmark and Hungary, 1994-2015



Source: Eurostat database, own calculations, smoothing: spline interpolation

Placing the 5 year-age-specific cancer mortality ratio (mx) on a log-scale by sex, it is visible, that around from age 40 the Hungarian cancer mortality starting to diverge from Austria and Denmark in a negative sense. From this threshold-age the differences by age-groups are increasing till the age 50 for male, when they reach approx. 3 fold surplus, for women the Hungarian excess mortality reaches the top at around the age 55-60, where around 2 times higher the mortality, then in Austria and Denmark. After reaching these plateaus (the largest gaps) for both sexes the gaps are shrinking in the older ages till null. It must be highlighted, that the age-specific cancer mortality from age 40 till age 70 increases by more than 50 fold in case of Hungarian, a little bit less for Austrian and Danish males (46, 47, respectively). Considering women the similar odds are smaller:

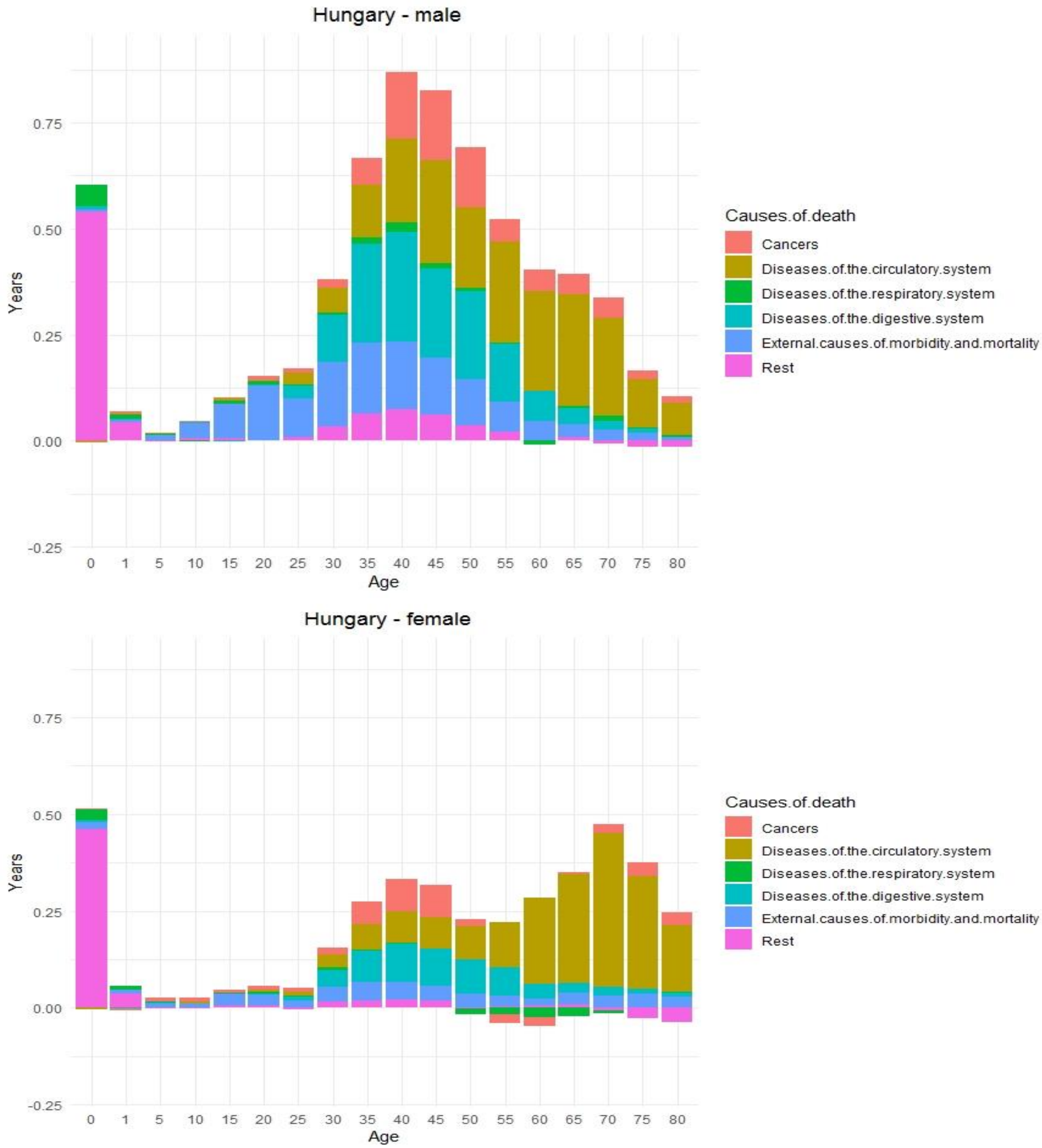
22, 17, 25, respectively. This also means that, according to the basic objective of the study, most early cancer deaths occur between 40 and 69, so the research will continue to focus on cancer mortality cases in this age interval at chapter 3.6.

Figure 11: Logarithm of the 5 year-age-specific cancer mortality ratio by sex, in Hungary, Austria and Denmark, 2015

Source: Eurostat database, smoothing: spline interpolation

Figure 12 shows, that in case of Hungarian male population notable improvement can be observed between the ages 30 and 69 and in this development the cardiovascular diseases played the most important role (approx. 1.5 years), then secondly the diseases of the digestive system (approx. 1.3 years), thirdly external causes of mortality (approx. 0.9 years), fourthly malignant neoplasms (approx. 0.7 years) and at last the respiratory causes of death (approx. 0.05 years). We are also able to identify that between age 35 and 49 large improvement in cancer mortality by a significant a half a year contributed to the development of the life expectancy at birth, in the examined period. Regarding Hungarian females, on one hand in the same age-groups also a relevant improvement (0.2 years) can be observed in cancer mortality, on the other, there is no positive contribution of neoplasms in the older ages 50-69, they are only holding back the development, such as respiratory diseases.

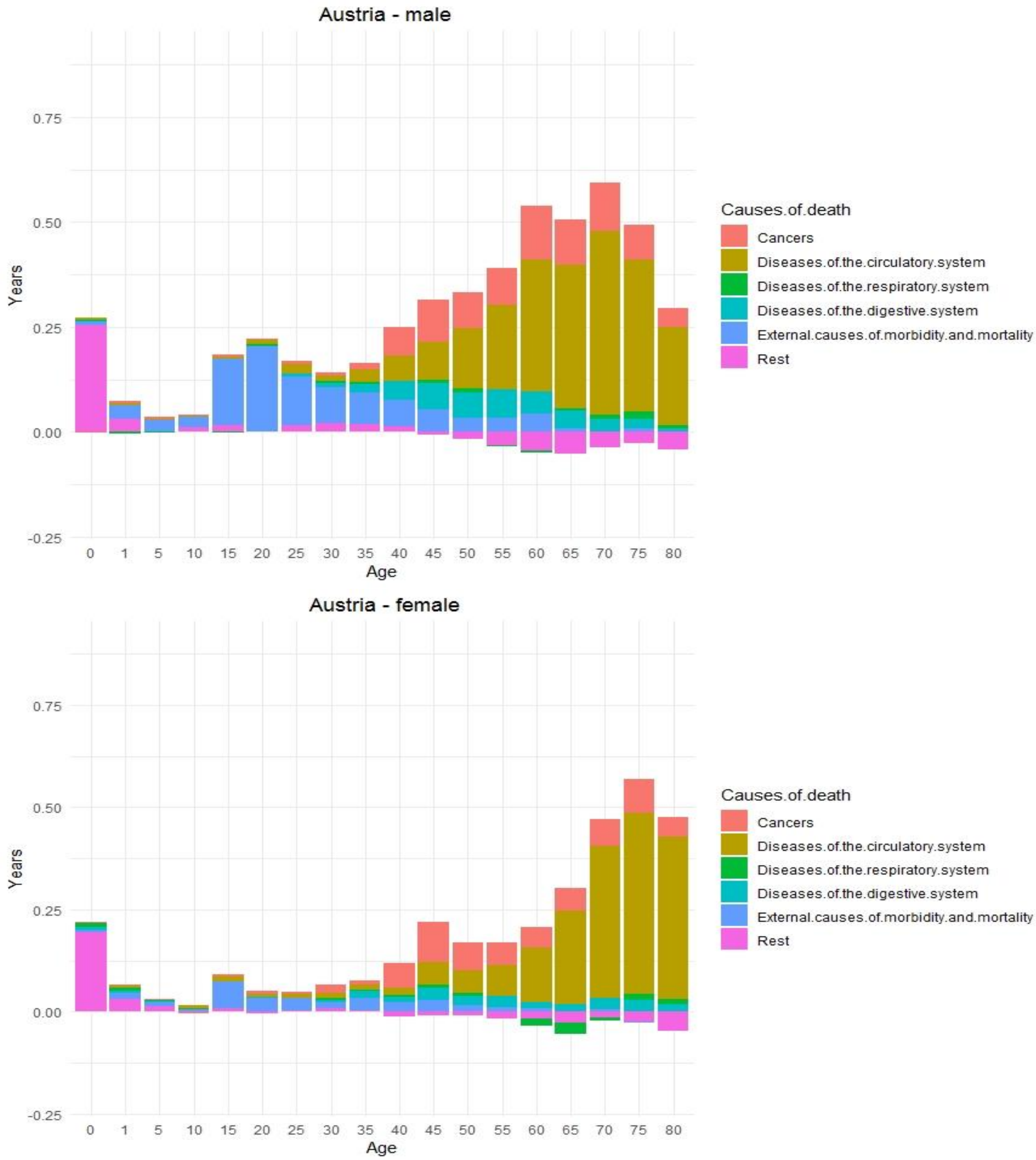
Figure 12: Contribution of age-, and cause-specific mortality changes to life expectancy at birth in Hungary, 1994-2015



Source: Eurostat database, own calculation

The causes of deaths structure of improvement for Austrian men (in the life expectancies at birth by age groups and causes of death between 1994 and 2015) is different compared to Hungarians. On one hand, in younger ages 30-59 there is no such large development, on the other, in older ages (60-80+) the improvement accelerates in Austria compared to Hungary and this is due to the improving tendency of chronic diseases for instance cancers and circulatory diseases. Comparing women's population in the two countries, there is also a larger development in the Hungarian younger age groups 30-49, but in a smaller extent than in case of men. The situation is more problematic for 55-69 aged Hungarian women, because they haven't gained any life-years due to cancer diseases between 1994-2015 (they even lost!), while Austrian female have obtained 0.2 years meanwhile. At the same time, both Hungarian and Austrian middle-aged female populations have lost smaller amount of life-years due to respiratory diseases.

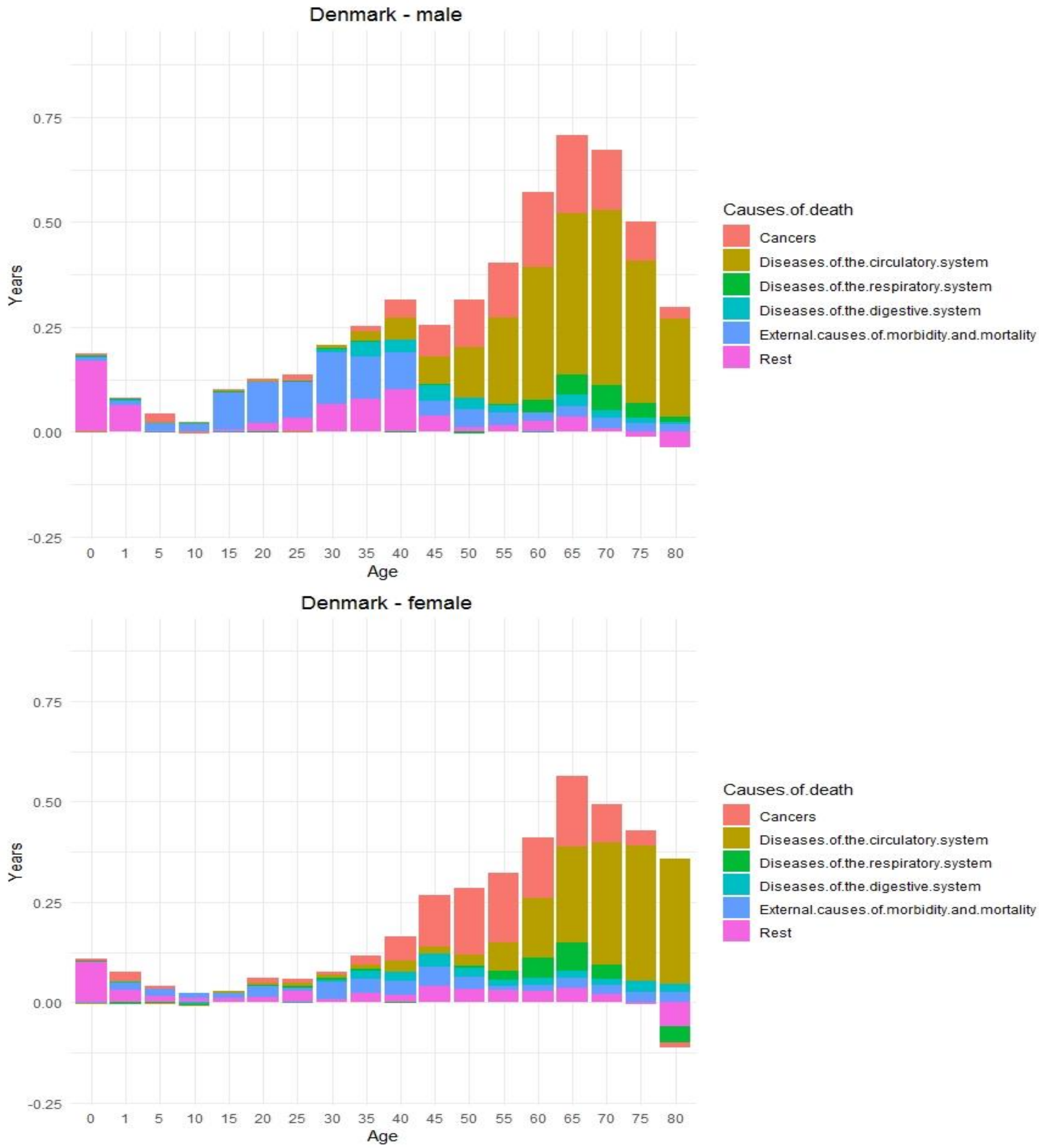
Figure 13: Contribution of age-, and cause-specific mortality changes to life expectancy at birth in Austria, 1994-2015



Source: Eurostat database, own calculation

Comparing Figure 12-13-14, we can see that Denmark is performing the best in epidemiological development in the examined period. Both sexes in all main causes of deaths could significantly improve their life expectancies, there are no sign of younger vulnerable cohorts like in case of Hungary and Austria the 50-69 year-old middle-aged women. Moreover, we can see a notable increase in life expectancies due to the development in cancer mortality among 45-69 year old women. However, on the oldest cohort of women over 80 still can be recognized the impact of the negative cohort effect, which will soon disappear. All in all, for both men and women the neoplasm cause of deaths contributed with additional around 1-1 year to the improvement of the life expectancy at birth between 1994 and 2015 in Denmark.

Figure 14: Contribution of age-, and cause-specific mortality changes to life expectancy at birth in Denmark, 1994-2015



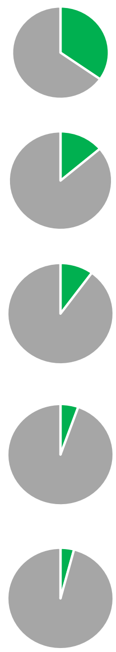
Source: Eurostat database, own calculation

Premature mortality in the epidemiological renewal by cancer causes of death

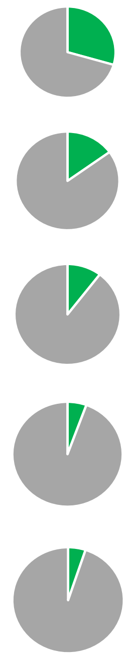
In Hungary for both sexes the trachea, bronchus and lung cancers are on the top of the list of the 5 most common underlying cancer cause of death in ages 40-69 in 2015 by 35% for men and 30% for women. The third are the lip, oral cavity and pharynx for male by 10%. All of this means a significant presence of smoking-attributable deaths in the Hungarian premature mortality: roughly every second man (35+10=45%) and every third woman who died in premature cancer is due to smoking. At the same time, there were 1000 deceased caused by breast cancer, which is the second most common neoplasm cause of death among Hungarian females (15%). Premature colon cancer deaths are second for men (14%) and third for women (10%) in the ranking by 2000 deceased in sum. All the cases mentioned above, covered more than 9000 early deaths due to cancer in Hungary in 2015.

Figure 15: The 5 most common underlying cancer cause of death in ages 40-69 and by sex in Hungary, 2015

Localization	Male Absolute number	%
All cancers	9 600	100,0
Trachea, bronchus and lung	3 336	34,8
Colon	1 324	13,8
Lip, oral cavity, pharynx	964	10,0
Pancreas	521	5,4
Stomach	395	4,1



Localization	Female Absolute number	%
All cancers	6 666	100,0
Trachea, bronchus and lung	1 965	29,5
Breast	1 003	15,0
Colon	694	10,4
Pancreas	371	5,6
Ovary	338	5,1

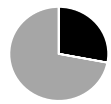
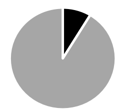
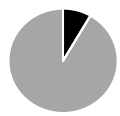
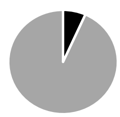
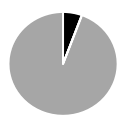


Source: Eurostat database

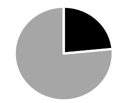
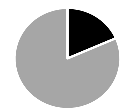
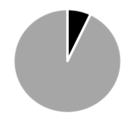
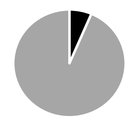
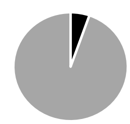
In the order of rankings of cancer causes of deaths Austria is similar to Hungary, but not in the extent of number of deceased, many less people are affected by early cancer mortality in Austria than in Hungary. Trachea, bronchus and lung cancers are on the top of the list of the 5 most common underlying cancer cause of death in ages 40-69 in 2015 by 28% for men and 24% for women. Together with the lip, oral cavity and pharynx cancers, every third Austrian man who died in early cancer is due to smoking. Adding up the smoking-related cancers, breast cancers and colon neoplasm deaths, we get approx. 2800 preventable deaths in Austria, in 2015.

Figure 16: The 5 most common underlying cancer cause of death in ages 40-69 and by sex in Austria, 2015

Male

Localization	Absolute number	%	
All cancers	3 955	100,0	
Trachea, bronchus and lung	1 107	28,0	
Colon	343	8,7	
Pancreas	331	8,4	
Liver	265	6,7	
Lip, oral cavity, pharynx	222	5,6	

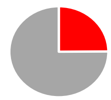
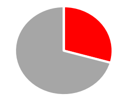
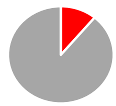
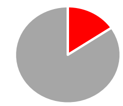
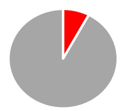
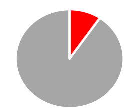
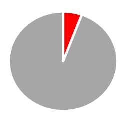
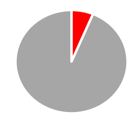
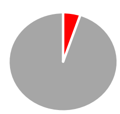
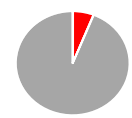
Female

Localization	Absolute number	%	
All cancers	3048	100,0	
Trachea, bronchus and lung	715	23,5	
Breast	562	18,4	
Pancreas	215	7,1	
Colon	195	6,4	
Ovary	163	5,3	

Source: Eurostat database

In Denmark also trachea, bronchus and lung cancers are on the top of the list of the 5 most common underlying cancer cause of death in ages 40-69 in 2015 by 25% for men and 29% for women. Together with the lip, oral cavity and pharynx cancers, also around every third Danish man who died in early cancer is due to smoking, like in Austria. Adding up the smoking-related cancers, breast cancers and colon neoplasm deaths, we get approx. 2500 preventable deaths in Denmark, in 2015.

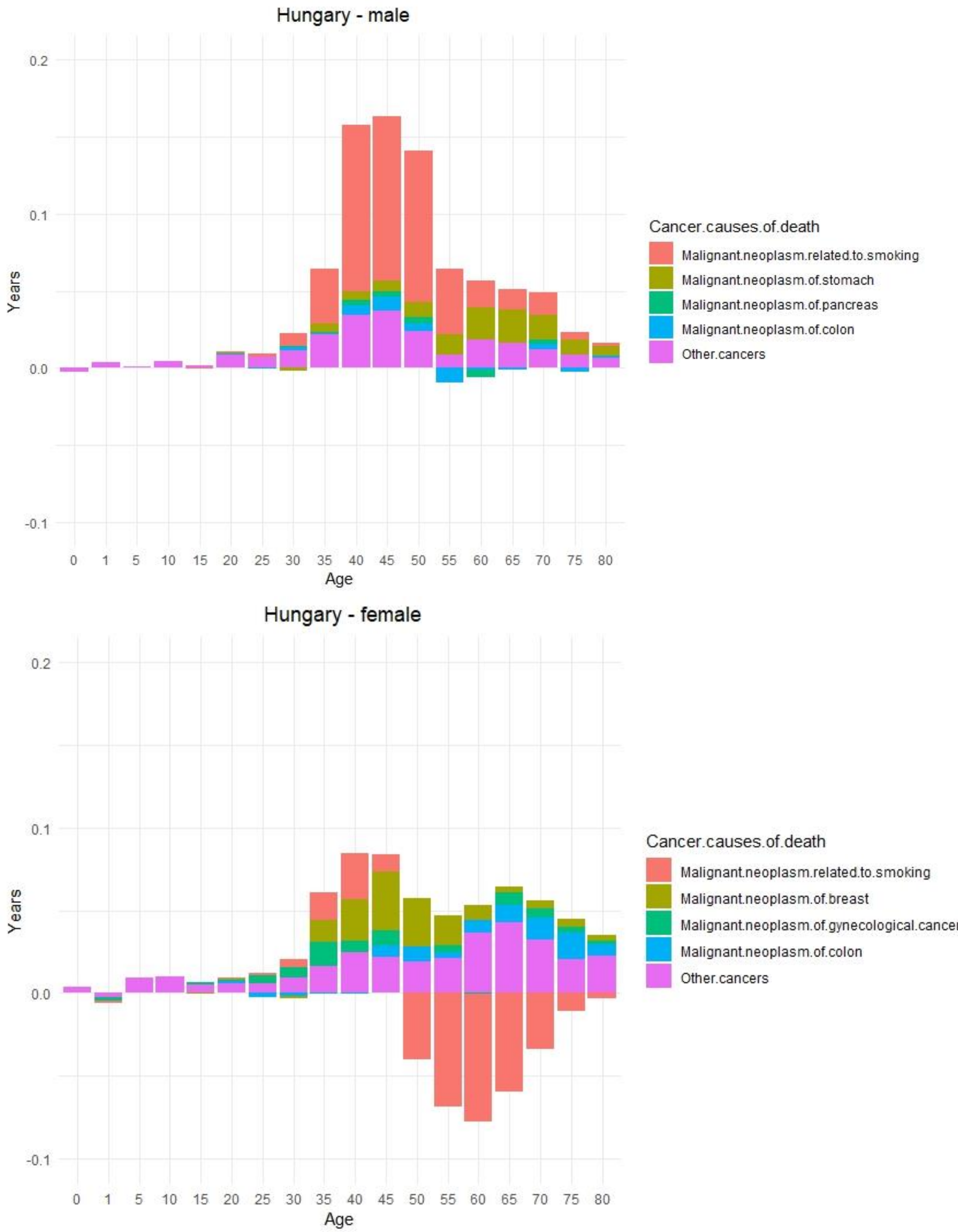
Figure 17: The 5 most common underlying cancer cause of death in ages 40-69 and by sex in Denmark, 2015

Male: Localization	Male: Absolute number	Male: %		Female: Localization	Female: Absolute number	Female: %	
All cancers	2 789	100,0		**All cancers**	2 483	100,0	
Trachea, bronchus and lung	695	24,9		**Trachea, bronchus and lung**	730	29,4	
Colon	308	11,0		**Breast**	386	15,5	
Pancreas	218	7,8		**Colon**	236	9,5	
Prostate	156	5,6		**Pancreas**	156	6,3	
Lip, oral cavity, pharynx	143	5,1		**Ovary**	149	6,0	

Source: Eurostat database

On Figure 18, on one hand a massive improvement is visible in male malignant neoplasms due to smoking between age 40 and 59 and a modest between age 60 and 69. On the other, there is no such reasonable development in colon cancer mortality concerning all age groups, except stomach cancers show some improvement in the ages 55-74. The counterpoint of this positive development is that tobacco-related neoplasm deaths braked heavily the female life expectancy improvement in ages 50-79. The situation of Hungarian women is ambivalent and their population can be broken down into two parts in the aspect of health consciousness. While their cancer mortality situation clearly improved in the younger ages 0-49 (mostly due to the smoking-related and breast cancers), the older women's cancer health situation worsened between ages 50-79, because smoking-related tumors. It must be added, that apart from the younger age groups, there is no significant improvement in all ages for the gynecological cancers, which are widely avoidable for the recent medical sciences.

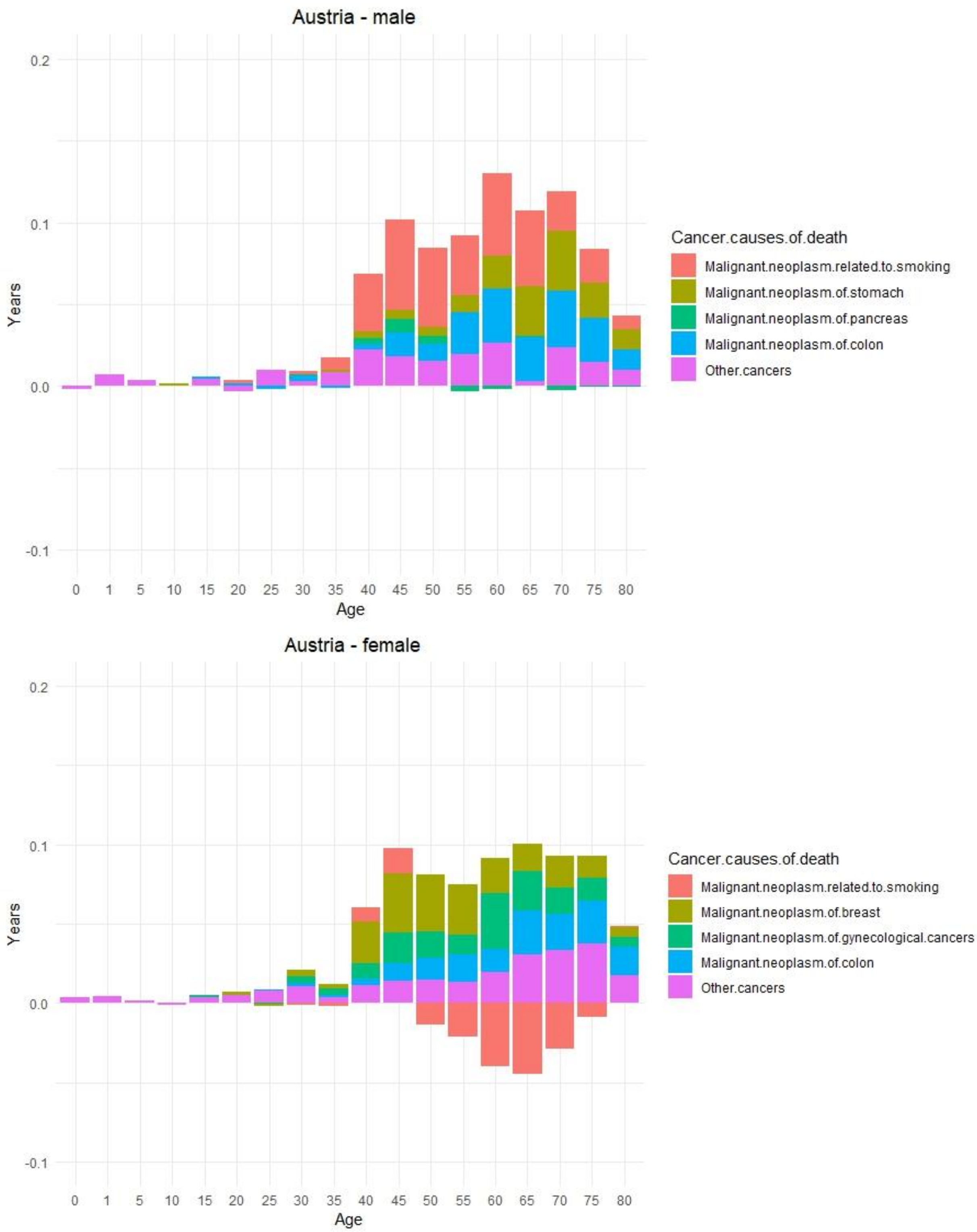
Figure 18: Contribution of age-, and cancer-specific mortality changes to life expectancy at birth in Hungary, 1994-2015



Source: Eurostat database, own calculation

Austrian men could also prolong their life expectancy due to tumors in almost all age groups. Relevant difference is that the improvement attributable to the malignant neoplasms related to smoking, stomach and colon almost without exception ‘stretches’ significantly over the ages above 40 years. Considering Austrian women between age 40 to 79 notable improvement can be observed regarding malignant neoplasms of breast, gynecological organs and colon, although there is a smaller but significant deterioration in the ages of 50 and 74 related to smoking compared to the Hungarian older women cohorts.

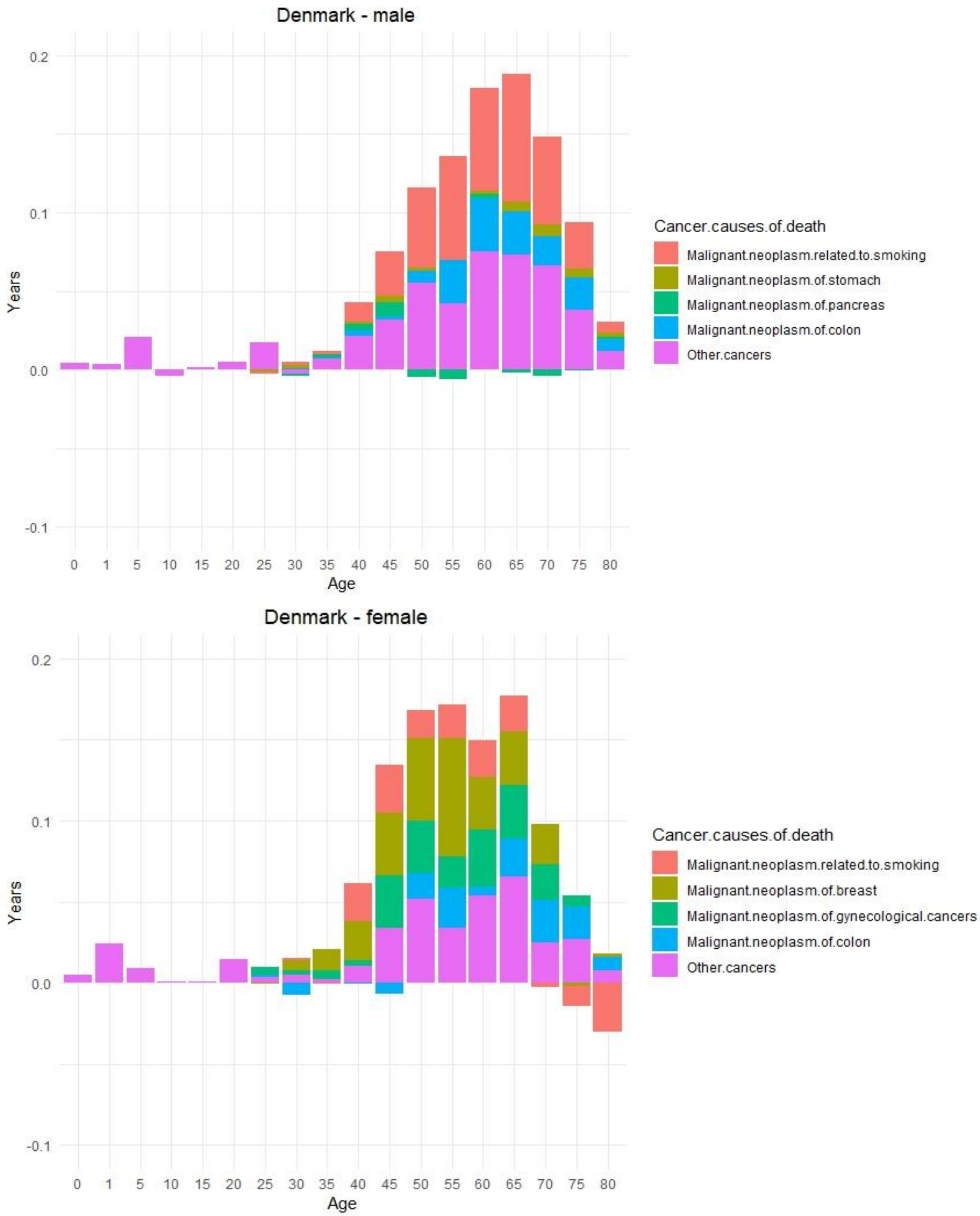
Figure 19: Contribution of age-, and cancer-specific mortality changes to life expectancy at birth in Austria, 1994-2015



Source: Eurostat database, own calculation

Figure 20 shows that Danish cancer situation is exemplary in the epidemiological renewal for both sexes. Above age of 40 there is huge improvement in the cancer mortality related to smoking and colon neoplasms for men and in case of women also neoplasms related to smoking, breast, gynecological organs and colon cancers contributed to the positive development of the Danish female life expectancies. However, from age 70 can be noticed the late impact of the negative cohort effect related to smoking on women.

Figure 20: Contribution of age-, and cancer-specific mortality changes to life expectancy at birth in Denmark, 1994-2015



Source: Eurostat database, own calculation

3.4. Discussion

The international outlook confirmed the obvious East-West divide in life prospects and socioeconomic development between the European countries. It is clearly visible, that if we are going from West to East the life expectancies are gradually getting shorter in close correlation with the declining performance of the economy. This East-West divide clearly shows the second cycle of divergence mentioned by Vallin and Meslé and it draws attention to the unfavorable heritage of the communist and socialist systems. The epidemiological crisis was a fundamental feature of these artificially created social and economic structures and this is also true of the situation in Hungary, in contrast with Austria and Denmark.

In addition to the method of historical data analysis, it is important to draw attention to the fact, that the change in the lifespan inequality (such as the CV indicator) is not a cause, but a stochastic feature of improvement or deterioration in life expectancy. Several studies attempted to explore this relationship in depth i.e. Shkolnikov et al. (2011), Engelman et al. (2010), Vaupel et al. (2011). Besides this, the used time-path plots are expressively able to demonstrate the epidemiological transitions. These show most importantly the second cycle of divergence in Hungary caused by the chronic, qualified epidemiological crisis and at the same time the third cycle of divergence among Danish female, which is caused by the impact of smoking epidemic on mid-war generations. It must be mentioned, that in the beginning year of the Hungarian epidemiological crisis in 1966, the life prospects of the Hungarian middle-aged men were longer than the Austrian, but then the two developments took a completely opposite direction. This observation directs the attention to the phenomenon, that in the beginning of the 1960s also the wealthiest countries were faced with the noticeably stagnating life prospects, but this didn't last too long. Somewhat related to this, after the examination of elderly populations we can possibly draw the conclusion, that the science of medicine has not been able to prolong the longevity of the older people till around the 1960s. However with the advent of the 1970s tangible results were already evident: the life expectancy of the elderly started to rise again in Austria and Denmark, but in Hungary this happened decades later and in smaller extent. The explanation for this can possibly be, that the health care system of the socialist economy, contrary to the capitalist, was incapable to prolong the lives of large number of old people presumably suffering in chronic diseases. This means, that the epidemiological crisis was also affected not just the middle-aged, but the older men as well, however in a smaller extent and these findings are possibly serve additional information to the better understanding of the chronic, qualified epidemiological crisis.

According to the section premature mortality in the epidemiological renewal by sex, in the beginning it must be mentioned that in the first quarter of 2015 a significant mortality surplus hit most of the European countries, which is mostly caused by the influenza pandemic (KSH, 2015). It is known from the detailed descriptive mortality statistics, that it affected exclusively the older population, so it had a negligible effect on premature mortality, therefore, the year 2015 does not need to be treated separately in this respect (Surján and Wéber, 2016).The level of premature mortality is around twice in the Hungarian population, than in the Austrian and the Danish. This could mean, that there are still a larger amount of resources in the longevity of the Hungarian (especially in women's) population, to suppress the premature mortality. It is important to emphasize, that the situation of Danish women is exemplary, because from 1994 to 2015 they could totally eliminate their disadvantage in premature mortality compared to Austria. Based on the table of life expectancy in years and its changes between 1994 and 2015, in Hungary, Austria and Denmark, we are able to draw the conclusion, that all of these numbers provide evidence to the presence of a strong cohort effect in the Hungarian population namely, that the older cohorts possibly brings with themselves not appropriate health consciousness and harmful habits from the socialist era like smoking or unlimited alcohol consumption. The decomposition of the life tables, when we are looking for the answer for the question: "What role did the 5-year-old age-groups played in changes in life expectancy at birth in the period 1994-2015 and how did they contribute to it?" gave the following results. Firstly, in all countries every age groups contributed to the increase of the life expectancy at birth, but in varying degrees for both sexes. The massive improvement of the Hungarian male life prospects observed between ages 30 and 69 (mostly contributed to the life expectancy increase) means a very important feature of the epidemiologic renewal, because these (middle) ages were the most vulnerable in time of the crisis between 1966 and 1993 and meant a critical stage of the Hungarian male mortality that time. According to the research the catastrophic epidemiological situation has been greatly improved since 1994 and Hungarian men seems to catch up in premature mortality compared to Western countries. Considering Hungarian women we can point out a setback in the development in the life expectancies between ages 50-64, which is in smaller extent is also true for the Austrian women, but not for the Danish female population. In contrast with the Hungarian men, there is no tendency for women to catch up.

From the short overview of infant mortality our conclusion is that it had a significant half-year contribution to the increase of the life expectancy at birth for both sexes in the examined period. More, than in Austria and Denmark, so in this field catch up is also experienced to the Western societies. All of this means, that the further reduction of infant mortality in the future will reduce its positive effect on life expectancy at birth, as it is already seen in Austria and Denmark. In sum, these life expectancy increase reserves in the infant mortality are tending towards almost total depletion already in the near future due to the rapid development of medical sciences and treatment opportunities and therapies.

The part of premature mortality in the epidemiological renewal by main causes of death based already on the absolute numbers and percentage ratios shows informative results. In Hungary, Austria and Denmark the cardiovascular deaths decreased in larger numbers than the neoplasms below age 70, between 1994 and 2015. This means, that the percentage of cancer deaths in the total premature mortality (the relative relevance) for both sexes increased in the examined countries, which is one of the biggest epidemiological challenges in all developed countries in the near future. In this aspect, the particularly dangerous situation of the Hungarian women must be emphasized. Despite all of the numerical declines, in 2015 more females died due to early cancers than in 1994, and from all of the populations in focus the increase in percentage was by far the highest here. Consequently, Hungary also has successfully implemented the remedy of the cardiovascular diseases since 1994, e.g. the healthier lifestyle, health prevention campaigns and up-to-date medical interventions and treatments in the healthcare, but this not a case in the field of cancer. The situation in Denmark is exemplary, because the middle-aged female cancer mortality dropped, from the level of the Hungarian mortality in 1994 to the Austrian in 2015. The main explanation for this could possibly be that the extent of the vulnerable Danish female cohorts were more narrower and they sooner extinct, than the Hungarian. Nevertheless, it is also true, that Danish health campaigns, prevention and the accessibility to the health care system are in the background as well. If we take a look on the age and cause specific change in life expectancy at birth in the Hungarian male population the circulatory diseases contributed to the largest extent to the increase of the life expectancy, moreover the diseases of the digestive system also played a significant role. In the background of this the decreasing relevance of alcohol-related mortality could be, because this ICD main category contains the declining numbers of e.g. liver cirrhosis causes of deaths. It is important to mention other important feature of these charts. If there is no significant contribution to the life expectancy from a specific cause of death and at the same time it is responsible for a relevant number of deaths in the cause of death structure, then no improvement in that time interval has occurred. Consequently, this means a negative development according to the known processes of latest epidemiological era. Considering Hungarian female population, there is no positive contribution of neoplasms in the older ages 50-69, they are only holding back the development, such as respiratory diseases. This is most likely due to the negative impact of smoking on these cohorts. (Bálint and Kovács, 2015) All in all, in the period of epidemiologic renewal Hungary has significantly reduced its disadvantage in the middle-aged death conditions, at the same time it has not achieved relevant results in improving old-age mortality. The latter is a clear obstacle to the further increase in life expectancy at birth in Hungary, and the perceptible improvement is unattainable without investing into the Hungarian public healthcare concentrating on elderly. We are able to draw conclusions for Denmark as well. It has completely overcome the third divergence cycle, namely the identifiable impact of the smoking epidemic among the mid-war Danish female cohorts and performing the best in epidemiological development in the examined period. Both sexes in all main causes of deaths could significantly improve their life expectancies, there are no sign of vulnerable cohorts exposed to cancer for instance in case of Hungary the 50-69 year-old middle-aged women.

Lastly, based on the section called: premature mortality in the epidemiological renewal by cancer causes of death, we can conclude, that there was more than 9000 early deaths due to cancer in Hungary in 2015. Most of which could be prevented by suppress of smoking, nationally extensive colonoscopy programs, mammography and medical examinations, bearing in mind the importance of the early detection. It is important to emphasize, that approximately every second premature male cancer deaths in Hungary, every third in Austria and in Denmark is directly smoking related, which means that the middle-aged Hungarian men are affected the most by the smoking epidemic. In case of female, the ratio of trachea, bronchus and lung cancers from the premature cancers are 30% for Hungary and Denmark and approx. 24 for Austria respectively, so Hungarian and Danish women are also very vulnerable to smoking compared with Austria. Nevertheless, a so-called “Premature cancer mortality triangle” can be identified with lung, colon, and breast tumors, which are the key elements and challenges in the newest epidemiological era for the countries with advanced health culture. At the same time, statistics for a particular year are not sufficient to understand the trends and changes in the cancer deaths structure. According to Kovács and Bálint (2018), examining the period 2005-2016 they didn't identify significant changes in case of lung, colorectal and prostate cancer mortality concerning Hungarian men. At the same time, the death rate due to stomach and other tumors decreased. Considering women, they found very uncertain and slight improvement in the tendency of colorectal, breast cancers, moreover a significant increase in lung cancer mortality. The life table decomposition method used in this dissertation is able to considerably detail these results by age. Based on this, on one hand there was improvement can be experienced: in case of Hungarian men under age 50 in smoking related cancers and above age 50 in stomach neoplasms. In case of Hungarian women under age 55 in breast cancers and under age 45 in smoking related cancers. On the other, deterioration can be observed: for both sexes in all age groups in colon cancers, in gynecological cancers in all age groups and above age 55 breast cancers no improvement detected, in contrast with Austria and Denmark. Furthermore, women between age 50 and 75 were dangerously exposed to smoking related cancers both in Hungary and Austria. This means that in these female cohorts experienced a strong cohort effect and the presence of the smoking epidemic. In contrast, in Denmark there is no such thing can be discovered in the middle-aged population and Danish women were almost totally cured from the disease of the third divergence cycle. However, it is visible that there are vulnerable elderly women exiting from the age structure.

4. Survival analysis of Hungarian cancer patients and the life expectancy at diagnosis

4.1. Introduction

Hungary has the highest cancer mortality rates all over the world (OECD, 2017). The high incidence of neoplasms in the population means more premature invasive tumors in parallel. The objective of this research is to understand the nature and the epidemiological properties of the early and dangerous cancers by survival analytic and mathematical demography statistical tools. This study reports on the status of the most numerous and prevalent cancer localizations: breast, lung, colon and pancreas as a control case between 2013 and 2015 in the Hungarian population, based on the data of the National Cancer Registry and Death Register of the Hungarian Central Statistical Office. The research includes examinations by the dimensions of sex, age and the mentioned localizations.

The traditional cancer survival analysis, the classic Kaplan-Meier method provides a cumulative probability of survival in a group of patients with a given tumor at a defined interval after diagnosis, taking into account that the death of the individual was due to the specific neoplasm. Each patient is followed from the diagnosis of the tumor to the conclusion of the record for some reason. Cancer-specific survival is defined as the death is solely caused by the cancer. The traditional survival assumption requires that we know information about the cause of deaths. (Tusnády et al., 2008) These results can be plotted, as gradually decreasing or maximum stagnating functions in the best case by time, which are the so called survival curves. It is possible to smooth these lines by fitting a curve on them, based on the methodology of Madigan (2004). This has many more advantages, for instance the proof of the fact that the relative survival is not always lower as age at diagnosis increases. Another benefit is the connecting link to the indicator 'Life expectancy at diagnosis' by applying mathematical demographical tools, based on the laws of the life-table (Preston et al, 2001). This novel statistical tool is a standardized, meaningful, easy to understand indicator, such as life expectancy at birth in demography. It shows, that how many days a patient can expect who is diagnosed with a specific illness (in this case cancer), taking into account his/her particular demographical characteristics. It is also able to identify the vulnerable groups in the population exposed to premature cancers and determine the concrete target groups of the health interventions against cancer and has many more useful properties.

4.2. Methods

Database

The preliminary investigation of Tusnády et al. (2008) showed, that the real cancer diagnosis of patients and the associated ICD code is not fully consistent: the type I. and type II. error of the coding is equally large. The type I. error is when the hospital does not code some cancer patients and therefore does not report. Type II. error is when non-malignant cases are coded as malignant. (Tusnády et al., 2008)

Alongside this, Inotai et al (2015) compared the newly diagnosed breast, colorectal and lung cancer cases between the National Health Insurance Fund (NHIF) and the National Cancer Registry (NCR) for 2011 and found significantly more diagnosis in the latter, which gives rise the suspicion of overestimation. For 2011 the NHIF database registered 6381 new breast, 8457 colorectal, 8902 lung cancer cases, in contrast with the data collection of the NCR: 7329, 10685, 11706 events, which means +15%, +26% and +31% higher incidence, respectively. However they found, that the 5-year survival estimates based on the two databases were in accordance with each other and with further international references. (Inotai et al., 2015)

Between 2013 and 2015 in the period of the observation, the compliance of the National Cancer Registry data was compared with the data of the HCSO Death Register along the personal identification number (TAJ), which means a relevant development in the quality of the Registry.

Subjects

The follow-up, individual-level dataset, contains all of the patients who were registered in 2013 with breast: 6333 females; lung: 2444 females, 3699 males; colon: 2175 females, 2524 males and pancreas: 565 females, 575 males; cancers. Their status were followed until 31.03.2015 for maximum 820 days. This means that the Registry records the date of diagnosis, last status (living or dead) and the last date, moreover, the diagnosis by ICD-10, age, stage of cancer, sex and the cause of death. Subtracting the last followed-up date from the date of diagnosis, we get the survival time of each patient in days. We took into account only the cases where the diagnosis was the same as the cause of death. Patients with negative or zero survival time were excluded from the analysis.

The Cancer Registry records the exact age of each patient, so it is possible to break down the overall Kaplan-Meier curves of the different localizations of cancers by 10 year age-groups (-49, 50-59, 60-69, 70-79, 80-).

Statistical methods

We used descriptive survival analysis techniques to plot the Kaplan-Meier curves by sex and localizations of cancer and then by age. (Dos Santos Silva, 1999) The calculations and visualizations were performed in R statistical program (R x64 3.5.1) using the Survival package. With the help of the estimation of parametric survival functions, which means a fitted curve for each previous Kaplan-Meier curve (Madigan, 2004), we are able to overcome the major problems of the short follow-up time, the occasionally small case numbers in the age-groups and smooth our data. For instance, when we following rare tumors with small number of cases, or when by the end of the follow-up period the number of cases may significantly decrease, also for larger groups. Also in the case, when breaking down by numerous variables (sex, age, localization) can greatly fragment the subgroups being followed. Lastly, when 5-year tracking is not always available in developing databases such as the National Cancer Registry at that time. In this survival analysis method, we are using maximum likelihood estimation in order to receive the intercept and the scale parameter of the survival functions. (Madigan, 2004) We assume that the time-to-event follows Weibull distribution and use right-censoring. All in all, we are able to give the best estimation for the 5-year survival (1825 days) instead of the 820 days limited observation.[3] If we perform the fitting, it makes even easier to identify the cases that really interest us, when a survival curve of a younger age-group falls under an older one. We suggest, that if this is the case, there are more rapid-spreading, dangerous invasive cancer localizations in the younger patients than among the older ones.

If we have survival curves by age, sex and localization of cancer, we can calculate their definite integral to infinite, in other words, the area under the curve. With this step, we acquire the indicator: life expectancy in days at diagnosis by sex, age-group and localization of cancer. We make the same hypothetical assumption here as in case of the life expectancy at birth, namely, that it is the value that how many days a patient can expect who is diagnosed with a specific illness (in

[3] See Appendix C for the formula of the concrete calculation.

this case cancer), taking into account his/her particular demographical characteristics, when the conditions of mortality in the specific period don't change.

4.3. Results

The basic statistics shows the significant danger of the leading cause of cancer death, the lung malignant tumors. Their lethality is above 60% for women and higher more than 70% for men in the observation. At the same time, the female breast cancer shows high-survival, its mortality rate is 10%. In the 820 days follow-up, one-third of all patients are the victims of colorectal neoplasms, regardless of sex. The pancreas malignant tumors are the most deadly ones, 8 out of 10 diagnosed patients died during the observation. Examining the median ages at diagnosis it is visible that the frequent lung cancers generally appear in younger ages: 63 and 64, but for instance the colon cancers emerge more among elderly: 71 and 69. If we round all of the average extent of the discovered cancer localizations, we get stage 4, which means quite late detection.

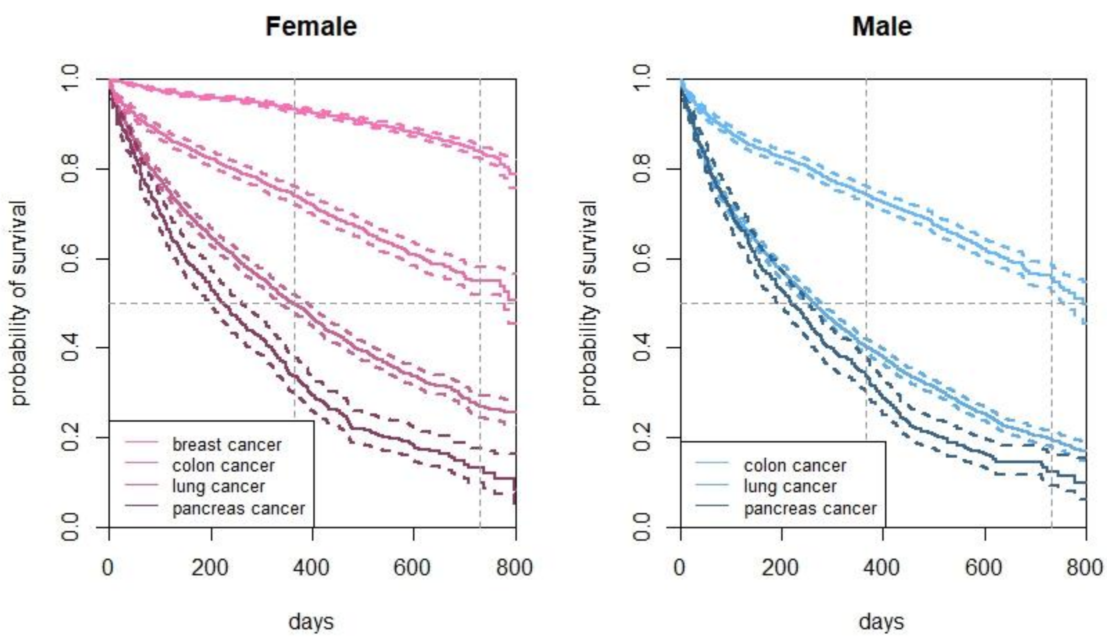
Table 6: The basic statistics of the followed-up cancer localizations, 2013-2015

	Female				Male		
	Breast	Lung	Colon	Pancreas	Lung	Colon	Pancreas
ICD-10	C50	C34	C18	C25	C34	C18	C25
Ratio in total deaths, by sex (percent, 2013)	3,3	4,9	3,5	1,6	8,8	4,6	1,5
Ratio in the total cancer deaths, by sex (percent, 2013)	14,5	21,2	15	6,9	30,4	16,1	5,3
Number of cases followed	6 333	2 444	2 175	565	3 699	2 524	575
Of which number of deaths	628	1 493	683	444	2 602	795	459
Of which in percentage	9,9	61,1	31,4	78,6	70,3	31,5	79,8
Median age observed all records (years)	63	63	71	68	64	69	65
The average extent of the discovered cancer localizations	4,28	3,9	3,97	3,72	3,93	4,04	3,58

Source: Hungarian National Cancer Registry, HCSO – Death Register, own calculations

With the plotting of the Kaplan-Meier curves, we are able to track the hazard of the different tumor localizations relative to each other. The conclusions from the basic statistics are confirming the results of the survival functions. It is visible that, how much more dangerous the female lung cancers are for life, than breast cancers. After one year of observation (which is showed by the first vertical grey dashed line) more than 9 out of 10 patients survived breast cancer, meanwhile, half of the women died who were diagnosed with lung cancer (showed by the crossing of the first vertical and the horizontal grey dashed line). Nevertheless, it is also conspicuous, that the male lung cancer survival is worse than the female, while the hazard of colon malignant neoplasms is almost the same for both sexes and regardless of sex, half of diagnosed patients die after 2 years. Nevertheless, the life prospects in case of the pancreas tumors are clearly the worst.

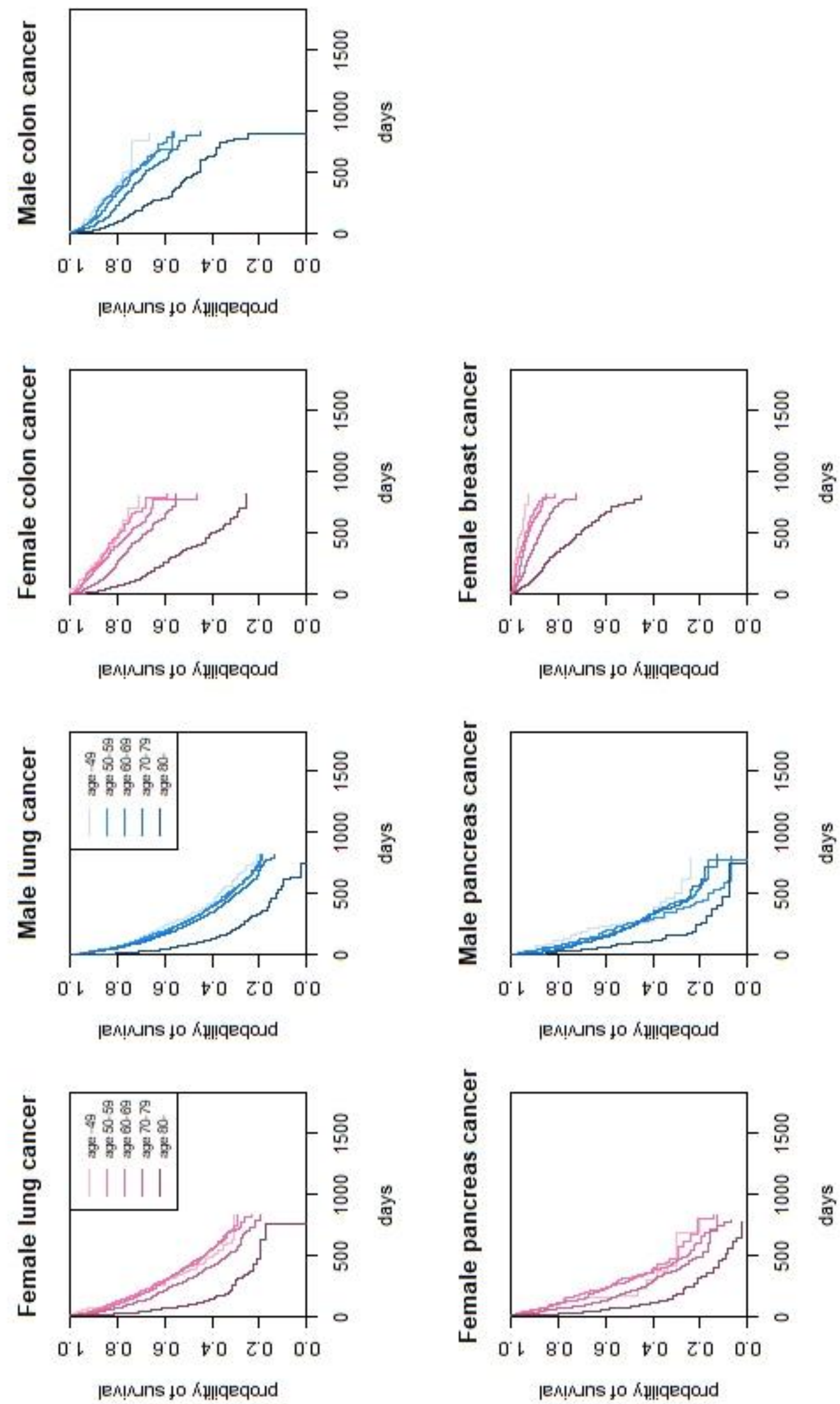
Figure 21: Kaplan-Meier curves of different cancers in Hungary, 2013-2015 (with 95% confidence intervals)



Source: Hungarian National Cancer Registry

We get the following results, if we broken down the Kaplan-Meier curves by 5 categories of age-groups (-49, 50-59, 60-69, 70-79, 80-). The lighter colors represent younger age-groups, while the darker ones refer to older groups of patients. It is easy to recognize that e.g. how much more dangerous female pancreatic cancers are than breast cancers in all age groups. At the same time, through the groups of low number of cases and as the time passes, the rectangularization of the curves can also be observed.

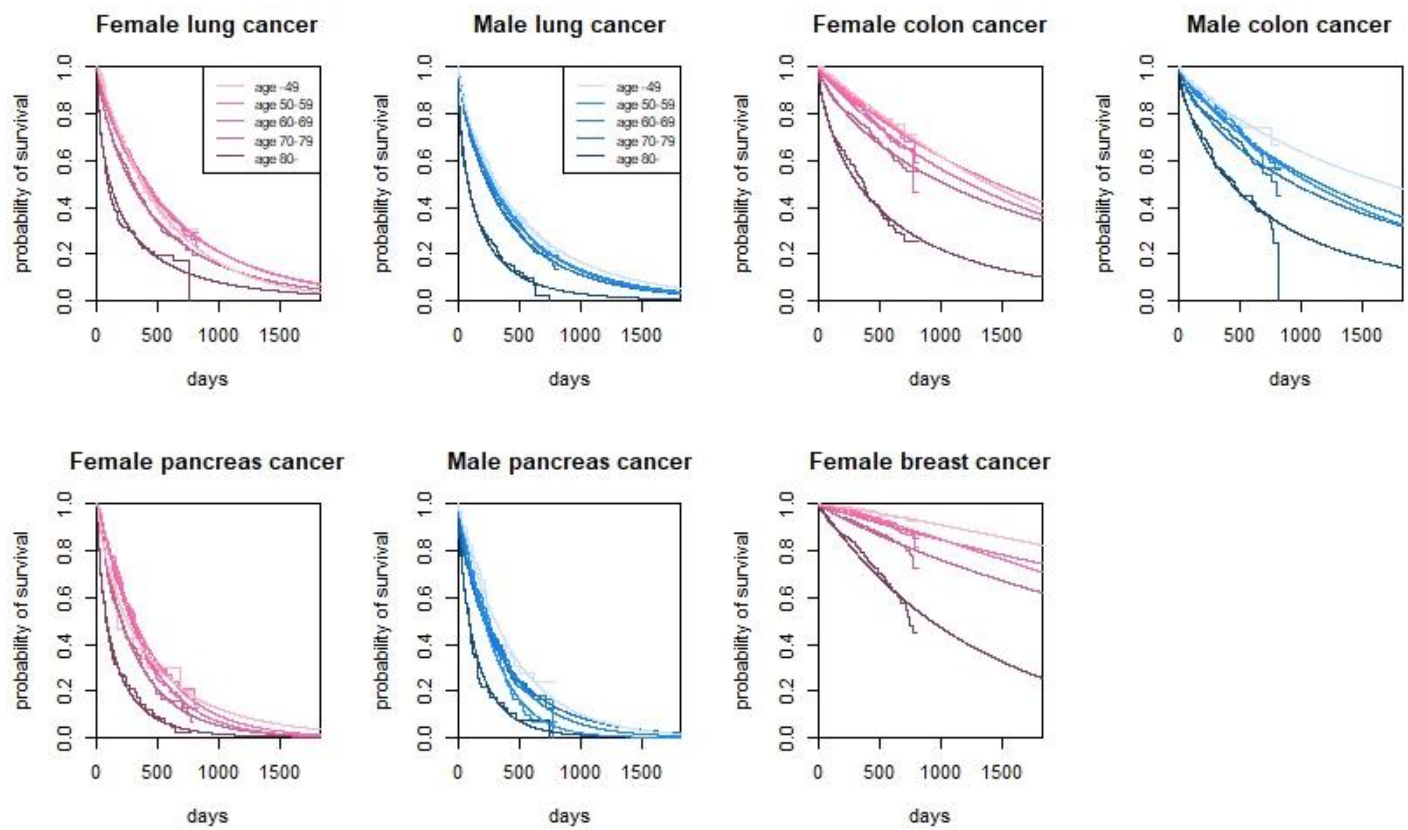
Figure 22: Kaplan-Meier curves of different cancers in Hungary by age, 2013-2015



Source: Hungarian National Cancer Registry

After fitting survival curves, we are able to identify the problematic cohorts due to cancer in the population: 1. youngest age-group of female lung cancer patients. 2. youngest age-group of female colon cancer patients. 3. breast cancer patients who are in their 50s. 4. male colorectal tumor patients in their 50s. Their survival curve of a younger age-group falls under an older one.

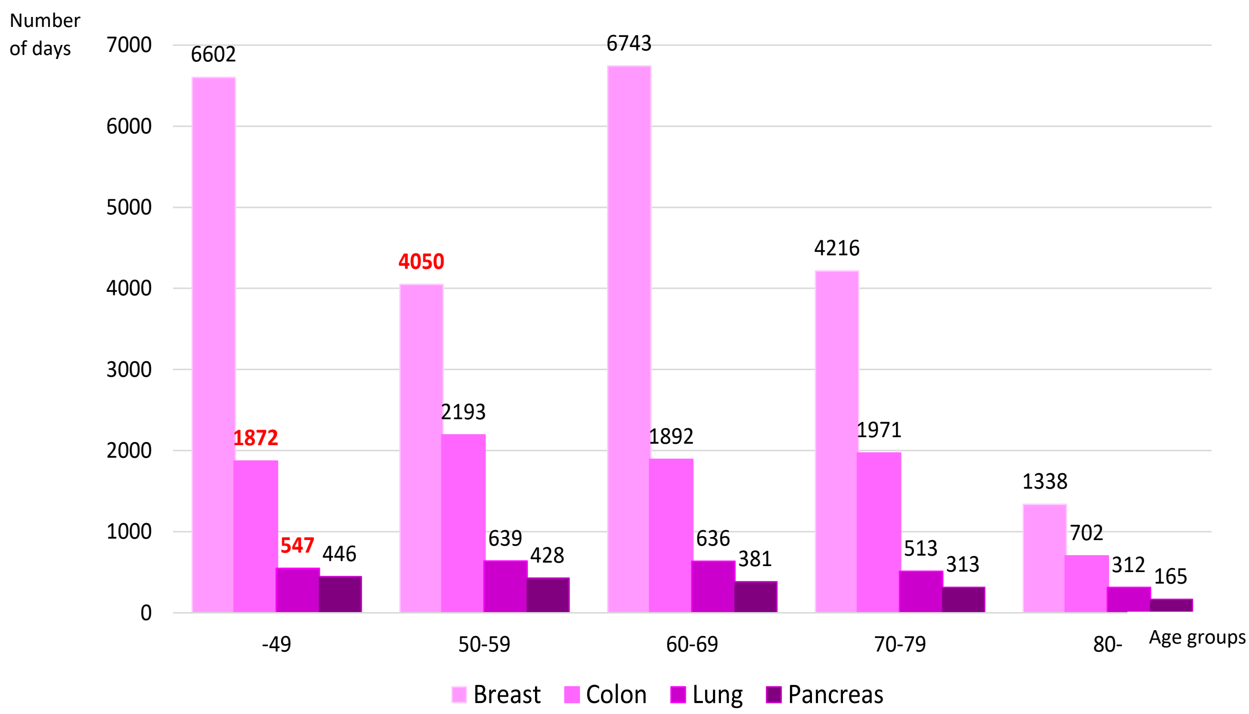
Figure 23: Kaplan-Meier curves of different cancers in Hungary by age and the estimated survivals, 2013-2015



Source: Hungarian National Cancer Registry; Madigan, 2004

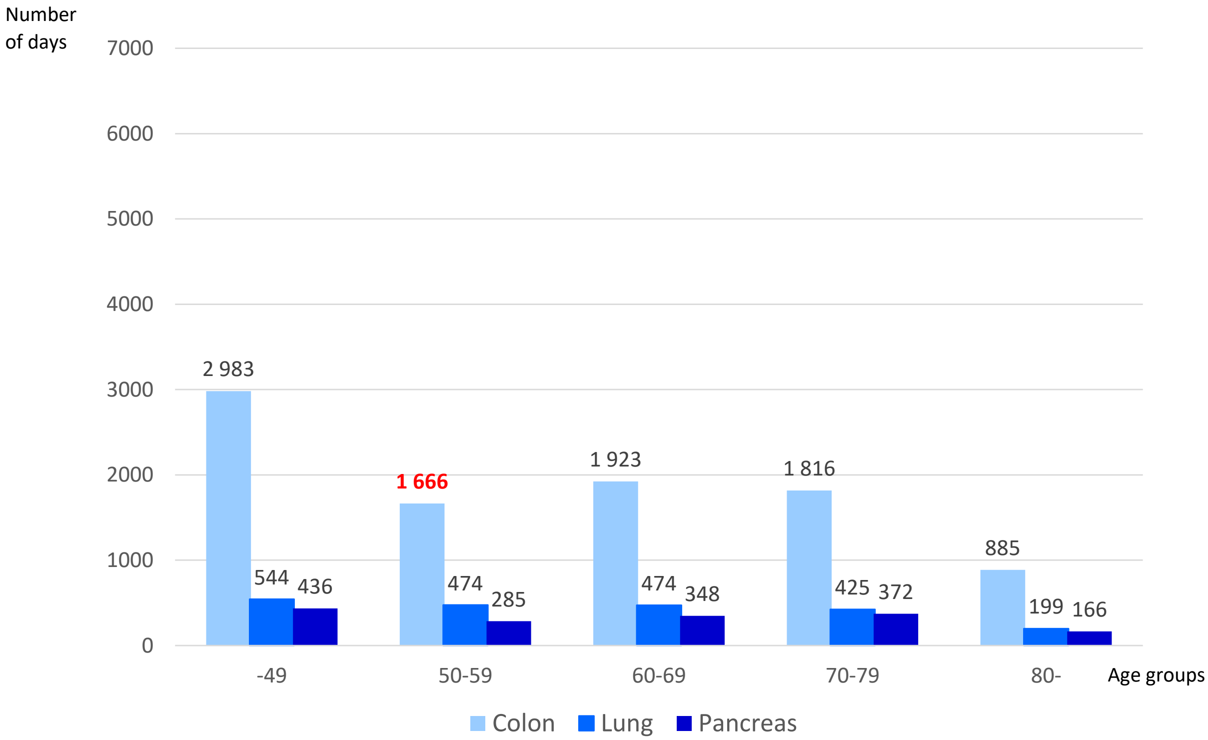
Placing all life expectancies on a bar chart separated by sex, firstly, the most apparent is that the situation of the breast cancer patients diagnosed in the age of 50s is particularly dangerous: they are living the two-third of the life of the less then 49 and 60-79 year-olds (4050 vs. 6602 and 6743 days). Secondly, the discovery of colon cancer in less than 50 year-old young females is associated with a lower life expectancy than in the older age-groups of 50-79 (1872 vs. 2193, 1892 and 1971 days). Thirdly, the less than 50 year-old female lung cancer patients generally live a shorter life than the older-age groups of 50-69 (547 vs. 639 and 636 days). Fourthly, men who are diagnosed with colon malignant neoplasms in their 50s have lower life expectancy than in the ages of 60-79. (1666 vs. 1923 and 1816 days)

Figure 24: Life expectency at diagnosis of Hungarian female cancer patients by age and by localization in days



Source: own calculations

Figure 25: Life expectancy at diagnosis of Hungarian male cancer patients by age and by localization in days



Source: own calculations

4.4. Discussion

Considering the quality of the data, the following problematic issues can be raised. Type I errors influence the examination in an unknown direction and type II errors, if they are not deleted from the follow-up, are able to falsely overestimate the survival. It must be mentioned, that in contrast with the assumption of this paper, patients live in the real world, where there are competing risks of dying and cancer patients are able to die not just in malignant neoplasms, but from other causes as well. (Lambert et al, 2011) In sum, one thing is certain: a better quality database would be better in every respect of any research.

One of the disadvantage of the Kaplan-Meier method is when the smaller number of groups increase confidence intervals, especially approaching the end of the follow-up. One solution for this is the comparison of curves by log-rank tests, but besides this, this research offers the fitting of the survival functions on the Kaplan-Meier curves, based on Madigan (2004). Nevertheless, the 5-year survival results of this analysis is in accordance with Tusnády et al. (2008) and Inotai et al. (2015). Another important question is, that in which stage of the cancer are the patients recognized by the health care system and the Cancer Registry? Of course, it would be better as early as possible, but it also depends on a plenty of factors, for instance, health awareness in the Hungarian society or accessibility and quality of the health care services.

In the case of the most prevalent, dangerous and numerous cancers the following statements can be made. In the field of breast malignant neoplasms a desired goal could be the suppress of the breast cancer mortality to such a low-level to get as far to HIV: to live with it under control and live a long livable quality of life. Regarding colorectal cancers the introduction of the colon cancer screening program is the desirable way for Hungary. The result of a working system and diagnosis in an early stage, would be hundreds of saved young lives from deaths. Problems of lung cancer raises the need of the even more effective public health campaigns and interventions against smoking, focusing more on middle-aged women. We would expect that relative survival tends to be lower as age at diagnosis increases, but this paper proves that this is not always the case, negative cohort effects can be experienced in the population, as the level of health awareness and the performance of the health care system is also uneven across different strata of the society.

In the end, the indicator “life expectancy in days at diagnosis” has many more possible extensions. The breaking down by sex, age and localization of cancer in this paper was just an introduction, showing its useful properties allowing standardized, sensitive and meaningful comparisons. Possible direction of improvement could be the record linkage between National Cancer Registry and Death Register of the Hungarian Central Statistical Office, allowing research along the variables on the death record, for instance educational attainment, marital status, social economic status etc. Another advantage could be, that with any kind of follow-up database it is suitable to measure the effect of various (experimental) therapies, medications, pharmaceuticals and any kind of medical interventions in clinical trials. It can be also used to compare the survival of groups exposed to different health risks during their lives (smoking, alcohol consumption). The method also allows small number of followed-up cases and short observing time. It is also suitable for spatial and international analysis, for more effective estimation of therapeutic costs and it is able to measure the success of the public health interventions.

5. Global smoking epidemic and the smoking-attributable mortality in Hungary

5.1. Introduction

"Death in old age is inevitable, but death before old age is not." Sir Richard Doll

Richard Doll was the British epidemiologist who – back in 1950 – was among the first scientists to confirm the association between smoking and increased risk of lung cancer (Doll and Hill, 1950). His research contributed to identifying cigarette smoking as the single most important and preventable cause of premature death in developed countries and it is also a major public health concern in many regions of the developing world (Lopez et al., 1994).

Since Doll's ground-breaking findings, more recent research has demonstrated not only that smoking is associated with lung cancer, but also that its deleterious effects are more general, extending to the whole body. Consequently, the addiction has a determining role in the development of not one, but several, chronic diseases that can lead to death, e.g., ischemic heart disease or chronic obstructive pulmonary disease (COPD) (USDHHS, 1989, 2014).

Three different approaches are used to measure smoking-attributable mortality in a population. The first takes account only of deaths due to lung cancer, and will therefore always be an underestimate (Kubík et al., 1998; Bray et al., 2004; Tyczynsky et al., 2004). But prolonged cigarette smoking causes deaths that are related to diseases other than lung cancer. For this reason, Peto et al. (1992) developed another indirect method of estimation. They assigned to tobacco a certain proportion of deaths from specific disease categories on the basis of the risk ratios found in longitudinal studies, and then calculated the number of deaths that could be attributed to smoking. The third approach is the official calculation by the American Centers for Disease Control and Prevention (CDC), which was introduced in 1989 (since when it has undergone several updates). This approach utilizes all the data used in the previously mentioned methods, plus the prevalence of smoking[4] in the population (USDHHS, 1989; 2014; Shultz et al., 1991; Józan and Radnóti, 2002; Vitrai et al., 2012; KSH, 2014; Wéber, 2017).

[4] The proportion (frequency of occurrence) of people with specific diseases, in this case smokers, in the total population.

Peto et al., in their comprehensive periodic report entitled “Mortality from Smoking in Developed Countries 1950–2010,” offer a detailed account of the effect of smoking. According to them, in 2005 some 2.7 million men and 1.4 million women in total died between the ages of 35 and 69; of these deaths, 0.7 million and 0.2 million were due to smoking, yielding a proportion of roughly 26% and 14%, respectively (Peto et al., 2011). In Hungary, the picture is even worse: in 2009, some 31,000 men and 16,000 women aged 35–69 died; of these deaths, 13,000 and 4,600 were attributable to cigarette consumption – 42% and 29%, respectively. The raw figures show that smoking places a huge burden on developed societies and economies generally. And in this context the Hungarian situation is particularly bad: beyond doubt the smoking epidemic has much deeper roots in Hungarian society.

Since it is possible to quantify smoking-attributable mortality, we can estimate the economic costs. We can split the expenditure due to tobacco consumption into two main parts: on the one hand, there are the “direct costs” – the expense of medical treatment related to smoking-attributable disease (e.g., medicine and patient care) and the extra expenses incurred by the social security system (sick pay, disability pension); on the other hand, the lost life-years and the lost productivity of active women and men due to their premature death are usually referred to as “indirect costs.” In the case of US citizens, the direct costs of smoking were nearly USD 176 billion in 2012, while the indirect cost was approximately USD 151 billion, based on annual averages for 2005–2009 (USDHHS, 2014). If the same methodology is applied to Hungary, in 2010 the direct cost was USD 1.3 billion and the indirect cost was more than USD 352 million (Balku and Varsányi, 2016). Looking at these inconceivably large sums and the overwhelmingly negative impact of smoking in Hungary (Vitrai et al., 2012), it may be said that any decision to raise the excise tax on tobacco in order to suppress consumption can be supported scientifically. This is confirmed by the International Agency for Research on Cancer (IARC) in its review of more than 100 econometric studies (quoted in Jha and Peto, 2014). This confirmed that tobacco taxes and consumption are strongly and inversely related. It concluded that a 50% increase in inflation-adjusted tobacco prices reduces consumption by about 20% in high-, low- and middle-income countries alike (Jha and Peto, 2014).

The purpose of this paper is, first, to examine the global historical trends and the expected future of the smoking epidemic, reviewing the core literature and theories on tobacco consumption and mortality. The reference country is the USA, which has made greater strides than elsewhere in the developed world. At the same time, because of its proximity and similar cultural and historical background, Austria is also used as a benchmark for Hungary. Secondly, gender-specific models are presented and gender differences are analyzed. The paper demonstrates a longer-term narrowing of the differences between the sexes; this raises a number of important sociological questions, such as the blurring of the boundaries between gender roles in the developed societies of the 21st century. Thirdly, in the beginning, the basis of the smoking-attributable mortality, smoking prevalence and its changes is showed based on the 2000 and 2014 health surveys in Hungary. Then, following the methodological clarification, giving priority to the continuity of the sex differences, the premature smoking-attributable mortality and its gender gap is calculated for Hungary in the period 2000-2015. Thereafter, the total effect of smoking on mortality in Hungary between 2000 and 2014 is analyzed in terms of sex, age group, and cause of death. Unfortunately, health survey data before the millennium were not available electronically, so the examined period could only start with 2000. If the reader looking for earlier papers in the topic, Józan and Radnóti (2002) can be recommended for the period 1970-1999, which used similar methodology. In addition, an international outlook relying on the WHO-HFA database is also presented to introduce the situation in the neighboring countries. The conclusions paint a particularly unfavorable picture for middle-aged Hungarian women; therefore, the final section of the study focuses on their situation and on the explanatory factors.

In sum, all measures that are aimed at reducing the prevalence of smoking and promoting the prevention of this addiction are therefore justified, as additional deaths caused by nicotine addiction can be prevented (Vokó, 2009). Appropriate steps in this direction were the enactment of a ban on 1 January 2012 on smoking in closed public spaces and the increase of excise duties on tobacco products. Finally, the research primarily seeks to follow the goal of earlier works: "so that we can measure the results achieved in reducing this addiction" (Józan & Radnóti, 2002, p. 9.).

5.2. Theoretical background

Descriptive model of the cigarette epidemic

Basic model

Well-dressed men sitting around a table, smoking during a meeting; Audrey Hepburn with her emblematic cigarette holder, as a representative of emancipation; passengers puffing on cigarettes on an airplane while chatting – these are all everyday images from the 1950s and 1960s.

They reveal a world that had embraced the habit of smoking and in which tobacco control strategies did not yet exist – despite the findings of Doll concerning smoking's negative impact on health (Doll and Hill, 1950). One reason why the mid-century evidence of hazard was ignored (at least initially) is the delay between the widespread adoption of smoking by young adults and the appearance of the main effects on mortality in later life. Because men started smoking before women, the effects among middle-aged men have been apparent for longer in most high-income countries (Jha and Peto, 2014). In this respect, the concept of delay is of particular importance, and is the key element in the theory developed by Lopez et al. in their 1994 article "A descriptive model of the cigarette epidemic in developed countries." Their research was based on nearly a hundred years of observations in countries with the longest histories of widespread cigarette use, and they proposed a four-stage model of cigarette consumption and subsequent mortality among men and women. From their model it is clear that current mortality is most closely related to previous – rather than current – levels of cigarette consumption. They also point out the long delay between the onset of persistent smoking and the corresponding massive increase in the death rate three or four decades later. Thus, current smoking-attributable mortality in the present is most closely related to smoking patterns 30 or more years ago, rather than to current prevalence (Lopez et al., 1994). With regard to smoking-attributable mortality, the death rate from lung cancer was used by researchers at that time, and this may have led to the earlier underestimation of deaths due to addiction.

Stage 1 is the beginning of the smoking epidemic in a population. The prevalence of smoking is relatively low among both men and women (and in the case of women, socio-cultural factors discourage smoking). Nicotine addiction then becomes socially acceptable, while strategies for tobacco control remain underdeveloped. Smoking among men rises rapidly, and some (though still relatively few) male deaths are attributable to tobacco.

In Stage 2, the prevalence of smoking among men continues to rise rapidly until it peaks. Smoking prevalence among women typically lags behind that of men by one to two decades, but it also increases rapidly. Tobacco control activities in this phase are generally not well developed.

In Stage 3, male prevalence starts declining. By the end of this stage, there may also be the beginnings of a decline in female prevalence, following a plateau (which may continue for longer than among men). Knowledge about the health hazards of tobacco is generally widespread, and the peak in female prevalence is likely to be considerably lower than that for men. There is a rapid rise in smoking-attributable mortality among both sexes. Female deaths due to smoking are still comparatively low, but a sharp rise is to be expected. A comprehensive package of tobacco control laws and regulations may be introduced. Smoking changes from being socially acceptable to socially unacceptable behavior.

In Stage 4, the smoking prevalence of both sexes continues to decline. The rise in male mortality from smoking may be expected to peak early in this period. Conversely, female deaths due to smoking are likely to rise rapidly, as the health effects of smoking earlier in life become more evident. Thereafter, smoking-attributable mortality progressively declines for both sexes. Based on scientific evidence, comprehensive controls on smoking become institutionalized.

Furthermore, researchers emphasize that other countries have the benefit of knowing the serious health consequences of smoking, and can undertake effective preventive interventions at earlier stages of the epidemic (Lopez et al., 1994).

Completion of the model

Almost two decades after Lopez et al. published their model of the cigarette epidemic, Thun et al. (2012) produced further research entitled “Stages of the cigarette epidemic on entering its second century.” In this work, they attempted to verify, revise, and update the (nearly) 20-year-old findings. The proportion of all deaths attributed to tobacco was calculated for 41 high- and medium-income countries from 1950 to the most recent year for which data were available (generally 2005–2009). The trends in tobacco-attributed mortality in later middle age were then projected to 2025, based on recent trends in tobacco-attributed mortality in early middle age (Thun et al., 2012).

Three important remarks can be made with respect to the two studies above. First, the lung cancer death rates used formerly were updated using the indirect estimations carried out by Peto et al. (1992). This was a quantitative development: the authors could now eliminate the underestimation of deaths due to addiction in earlier phases of the epidemic (an advance on the methods employed in previous studies). Secondly, the more recent study ignores the qualitative analysis of sociological and social-political factors (unlike the basic model). For instance, neither the spread of smoking across the socio-economic classes (and any variations in those trends) nor the development of tobacco control strategies (such as an increase in the tax on tobacco in order to suppress consumption) is considered (Jha and Peto, 2014). It is possible that this omission is intentional, since it would be hard to explain why, if tobacco control strategies affect the whole population, the gender differences are so pronounced, according to the stage theory. Thirdly, the researchers propose a modification of the original model to allow for the different stages to be separated into male and female epidemics in a particular country. The revised model, like the original, illustrates a delay of many decades between an upsurge in cigarette smoking by young adults and the impact on mortality. It confirms that women who smoke like men will die like men. The authors add that gender-specific differences are influenced by economic, cultural, and political determinants that differ greatly from one population to another. For example, female smoking lagged behind male smoking by only 20–30 years in the USA and the UK, because cultural prohibitions on women smoking largely collapsed during and after World War II (Thun et al., 2012).

According to their results, the prevalence of smoking in the USA has continued to decline among both sexes, although the rate of decrease has slowed and is less than predicted by the original version of the model. Over the past 20 years, the proportional contribution of smoking to all deaths has decreased among men, but has continued to increase (or has plateaued) among women. Projections up to 2025 suggest that in America, male and female smoking prevalence and smoking-attributed mortality will decrease in parallel towards lower – as yet undefined – limits. In developing countries, the model seems generally applicable to men; but it cannot predict whether (or when) women will start smoking in larger numbers. Finally, Thun et al. conclude that the four-stage model of the cigarette epidemic still provides a reasonably useful description of the processes in many developed countries. Its relevance to developing countries could be improved by describing the stages of the epidemic separately for men and women (Thun et al., 2012).

In 2004, Bray et al. examined recent trends in lung cancer mortality rates among men and women in each of the then 15 EU countries, comparing cross-sectional rates of death among the younger (30–64 years) and older populations (65 or over), and looking at the age, period of death, and birth cohort influences in the younger age group. Their results confirm the findings of the updated basic model, and the age analysis emphasizes the fundamental cohort influence characteristic of smoking. In the background, we find different degrees of health awareness in different generations, as well as the influence of tobacco control strategies. Bray et al. found that among males, a decline in lung cancer mortality is apparent in most countries – at least among younger men; rates among older men either plateaued or also fell. In younger age groups, the decreasing risk of death from lung cancer reflects changes in successive birth cohorts, due to modifications in smoking habits from generation to generation, although the stage of these developments varies greatly from country to country. Among women, recent decades have witnessed an unambiguous surge in lung cancer mortality rates in both the younger and the older female population in almost all EU countries, and there are no clear signs that the epidemic has peaked or soon will peak (Bray et al., 2004).

The situation in Hungary

Meslé and Vallin (2017) clearly demonstrate a divergence between the developed Western world and the Central Eastern European countries. In the mid-1960s, when the developed Western countries were joining the cardiovascular revolution, the Eastern European socialist systems failed to follow them; furthermore, they suffered from increasing mortality from "man-made," chronic (cardiovascular and cancer) diseases – mainly a result of high alcohol and tobacco consumption. This is called the East–West divergence by the authors (Meslé and Vallin, 2017). It is also known as the "State Socialist Mortality Syndrome," as defined by Carlson and Hoffmann (2011). In his detailed research, Józan (2008) describes the situation as it applied to Hungary. He identified the phenomenon of a "chronic, qualified epidemiological crisis" between 1966 and 1993 in Hungarian society, when the frequency of cardiovascular and cancer deaths determined the increasing level of mortality. This was mostly the case among middle-aged men, who experienced a significant decline in life expectancy at this time (the term "qualified" refers to this). As a cause, he identified (among other things) the characteristics of a dictatorial political system: "The resources needed to change lifestyle, the improvement of the physical environment and the introduction of up-to-date and costly medical technology, the Hungarian economy in crisis was unable to realize” (Józan, 2008).

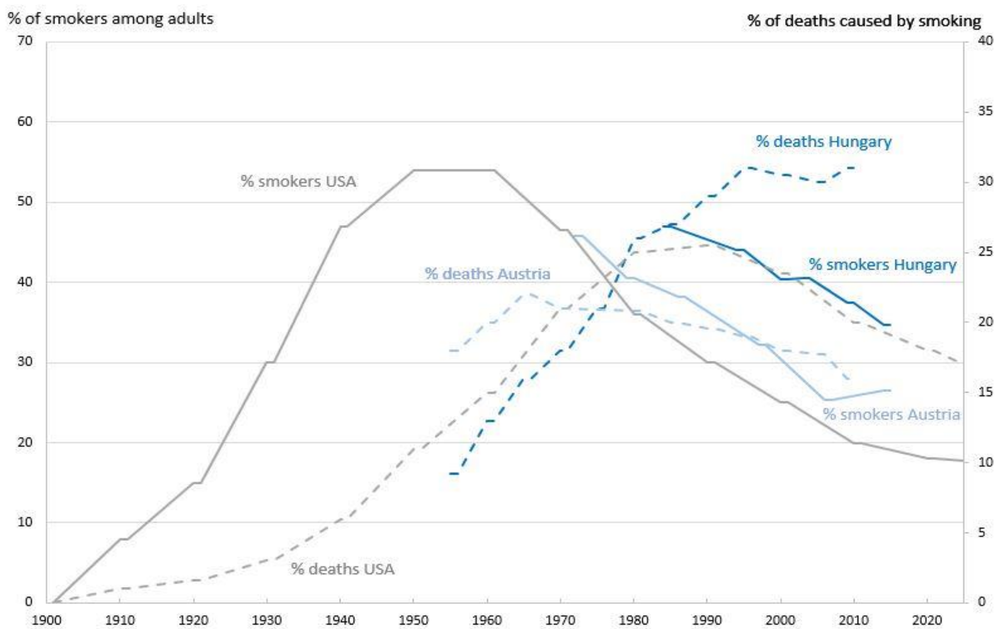
From 1994, some improvement is to be observed in Hungary; as a result, life expectancy at birth is now the highest it has ever been in Hungary (although contemporary society has inherited high mortality due to the cancer and cardiovascular diseases associated with the period of state socialism). In 2014, it was 72.1 years for men and 78.9 years for women – an increase of 7.6 years and 5.1 years, respectively, in the relatively short period since 1993. The change of regime led to the emergence of a market economy and an open society. In Hungary, this was a turning point: life expectancy increased with the emergence of a competitive, open society and – more importantly – health-conscious behavior. The cardiovascular revolution that has occurred (albeit considerably later than in Western countries) has brought a large drop in cardiovascular deaths; but in terms of cancer mortality, the improvement is much smaller (if indeed there is any). In fact, the outbreak of the “chronic, qualified epidemiological crisis” in Hungary coincided with one of the highest levels of smoking prevalence in the US; and as the promotion of health awareness was not among the priorities of the socialist system, the Hungarian population was hit by a smoking epidemic that lasted decades longer than in the United States.

Thanks to accurate and precise data collection (smoking prevalence and tobacco-related mortality) in the relevant literature, it is possible to examine the question more closely and see how the trends in Hungary fit with the trends of the global smoking epidemic.

From 1984 to 2014, a significant drop of 12% can be observed in the prevalence of smoking among Hungarian males. This decrease over three decades is in line with the trends elsewhere, but the figures at the start of the period were generally higher in Hungary than in the USA or Austria; moreover, the decline was slower. Obviously, this lag is visible in the extremely high proportion of smoking-attributable deaths in Hungary: from 1955 to the mid-1990s, there was a steep rise in the trend. In the course of those four decades, tobacco-related mortality leapt from a figure of 9% to 31%, and that proportion has stagnated since 2000. In 2009, this indicator was roughly 1.5 times greater than in the USA, and double the figure for Austria. According to the model of the cigarette epidemic, the Fourth Stage is when the proportion of smoking-attributable deaths starts to decline; but no such trend is detectable in Hungary. Thus Hungary is lagging at least two decades behind the USA – and possibly more than 40 years behind Austria!

Hopefully, the prevalence of smoking among Hungarian women plateaued between the mid-1990s and 2010, and the proportion of deaths has stabilized at around 26–28%. In Austria, the phenomenon looks similar, though the values are lower. The trajectory of female smoking shows a half-century delay compared to the USA, and also the level of the plateau is lower. Compared to Austria, the considerable lag in the decline in female smoking prevalence in Hungary means that any downward movement in the proportion of tobacco-related deaths will also take longer to show up. Thus it may be predicted that female smoking-attributable mortality will increase for some decades in both countries, but will not reach the level seen in the US in the 2000s. The Hungarian situation is particularly worrying, given that in 2009 the proportion of tobacco-related mortality was twice as high as in Austria (14% versus 6.9%).

Figure 26: Smoking prevalence and the smoking-attributable mortality of the male population in the USA, Hungary, and Austria, 1900–2025

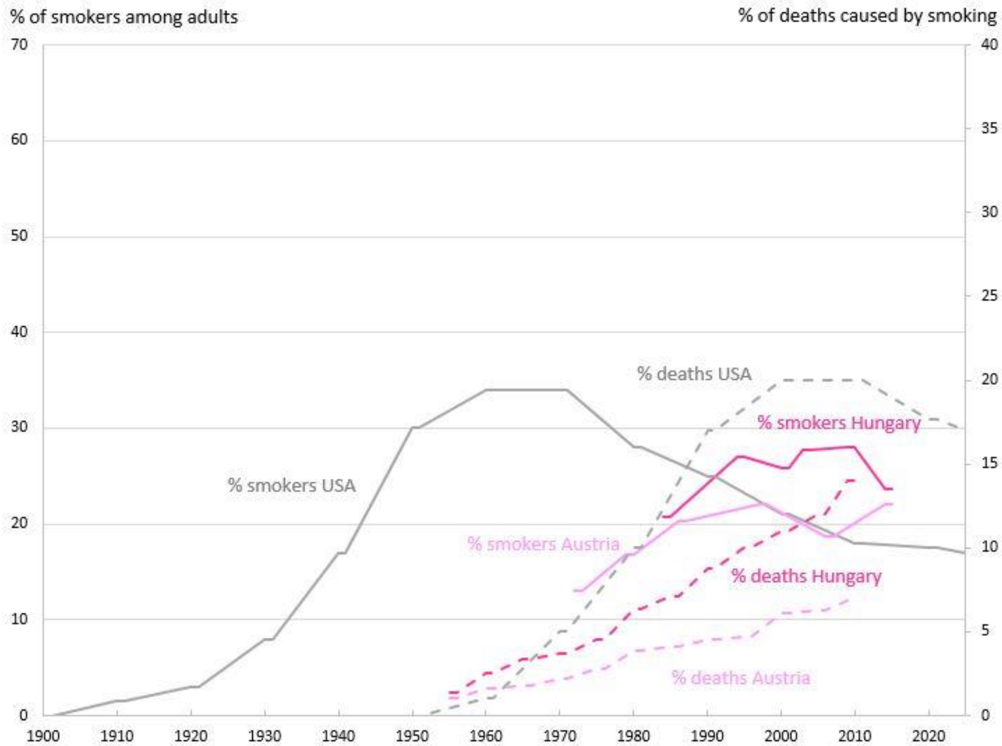


Source:

	Smoking prevalence	Smoking-attributable deaths
USA	Thun et al, 2012	Thun et al, 2012
Hungary	Tombor et al, 2010, Bőti et al, 2011, EHIS 2014	Peto, Lopez et al, 2011
Austria	Thompson et al, 2013 WHO-HFA, 2014	Peto, Lopez et al, 2011

For detailed source see Appendix D

Figure 27: Smoking prevalence and the smoking-attributable mortality of the female population in the USA, Hungary, and Austria, 1900–2025



Source:

	Smoking prevalence	Smoking-attributable deaths
USA	Thun et al, 2012	Thun et al, 2012
Hungary	Tombor et al, 2010, Bőti et al, 2011, EHIS 2014	Peto, Lopez et al, 2011
Austria	Thompson et al, 2013 WHO-HFA, 2014	Peto, Lopez et al, 2011

For detailed source see Appendix D

International comparative analyses consistently recognize the unfavorable health situation in Hungary due to tobacco consumption and confirm the above findings. Thun et al. (2012) concluded that among men aged 35–69, the proportion of all deaths attributable to smoking has decreased in Hungary; nevertheless, it still remains at a very high level. Among women, smoking prevalence has also decreased in many developed countries, but the proportion of female deaths at age 35–69 attributable to smoking has not yet fallen substantially; in some countries, it has continued to rise rapidly and is currently highest in countries like Hungary. Kubík et al. (1998) examined the development of the lung cancer epidemic in four Central European countries (Austria, the Czech Republic, Hungary, and Slovakia) for the period 1990–2009, taking into account earlier lung cancer mortality trends (1960–1989). They found that over the period from 1985–1989 to 2005–2009, the age-adjusted lung cancer mortality rates for men were predicted to increase in Hungary, and to show little change in Austria. For women, an almost exponential increase in lung cancer mortality rates was to be expected, with the highest rates in Hungary and much lower values in Austria. Lung cancer mortality among women is still much lower than among men, but it is increasing rapidly (Kubík et al., 1998). Tyczynski et al. (2004) also analyzed the longer-term trends in lung cancer (between 1960 and 2000) as a cause of death in 10 countries admitted to the EU in 2004. They found that lung cancer was the most frequent cause of cancer death among males in all the countries examined, with the highest proportions in Hungary. The most common pattern in the countries concerned showed a previous increase in mortality (in the 1970s, and in some countries in the 1980s), followed by a decline in the 1990s in this specific cancer as a cause of male deaths. The exception was Hungary, where no decrease in mortality could be observed. The situation was no better among females: the only country that saw a significant acceleration in the rate of increase was Hungary. According to the authors' categorization, it was possible to distinguish three groups of countries with different patterns of female mortality. The first comprised the three Baltic countries, where the level of mortality was relatively low, and the increase in mortality over time was negligible. Four other countries (the Czech Republic, Poland, Slovakia, and Slovenia) formed the second group, with a higher level of mortality and a rather constant increase in the rate of mortality. The third group included just one country – Hungary – the only country where the rate of increase was accelerating; the level of mortality there was approximately double that of any other country. The researchers also tried to shed light on why lung cancer ratios in the older EU Member States were much lower than in the newer EU countries (Tyczynski et al., 2004). On the one hand, this was most probably because the smoking epidemic started later in the newer EU states, and consequently the decline in smoking also came later in most of those countries. On the other hand, the difference was also rooted in the much earlier implementation of tobacco control measures in many of the older EU members.

Gender differences in the epidemiology of smoking

Basic theory

Pampel (2002) examines the details of gender differences in cigarette-smoking mortality in his study, "Cigarette Use and the Narrowing Sex Differential in Mortality." The theoretical starting point for the research was the *gender-equality theory*. Traditionally, higher levels of income, power, and prestige among men have coexisted with higher levels of mortality. The gender-equality theory suggests that the move toward social and economic equality between men and women will tend to equalize their mortality (Pampel, 2002). The basis of the thesis is the phenomenon of delay, just as in Lopez et al. (1994), described above. Pampel proposes that if one views the 1960s as the beginning of the most recent period of change in the status and role of women, and recognizes that in terms of the major causes of mortality in modern societies there is a lag of several decades between the adoption of unhealthy behaviors (or the experience of unhealthy living conditions) and death, then the gender-equality thesis accurately predicts the narrowing of the sex differential in the 1980s and 1990s.

However, such a macro descriptive theory as the gender-equality thesis has been widely criticized. On the one hand, according to Trovato and Lalu (1996), the hypothesis is too one-sided, in that it fails to consider the changes in male behaviors and roles that – alongside changes in female behaviors and roles – affect the sex differential (Trovato and Lalu, 1996). In this context, we can mention Lopez's argument that males have adapted less well than females to the more comprehensive process of modernization, and that much of the increase in male excess mortality has resulted from the widespread adoption of hazardous life styles by men and the general mismanagement of health (Lopez, 1983). On the other hand, even women with high education, in high-prestige occupations, and enjoying high income maintain a substantial longevity advantage over men, and so higher occupational status does not raise mortality among women (Waldron, 1993; 2000).

Recalling the research of Waldron (1986), that smoking represents a major source of the differences in mortality between men and women (explaining about half of the differential), Pampel (2002) asks: "if high rates of tobacco use by men relative to women largely explain the growth of the sex differential over most of 20th century, can changes in tobacco use by men and women explain the more recent reversal in the sex differential in mortality?" After examining the trends in cigarette use and lung cancer, he concludes that they can. Behind all this lies the fact that men took up smoking in large numbers earlier than women, and more recently have stopped smoking faster than women (Pampel, 2002).

Pampel's research compares changes in smoking and non-smoking deaths among women relative to men in 21 high-income countries, by examining the mean mortality rates and the logged ratio between 1975 and 1995, taking into account age in two categories: 35–69 and 70+, and using the data reported by Peto (Peto et al., 1992). Based on his analysis, the author identified three groups of countries. In the first, an increase in the advantage enjoyed by women could be observed (e.g., Japan, France, Germany, Austria, Greece, and Spain). In the second, there had been little change in the sex differential (e.g., Canada, Finland, Australia, Ireland, Belgium, Switzerland, Portugal, and Italy). Pampel explained this phenomenon as follows: the harm of smoking to women had become serious enough in those countries to counter the improvements made in female mortality among non-smokers. In the third group (e.g., the USA, New Zealand, the UK, the Netherlands, Denmark, Sweden, and Norway), a decline in the female advantage could be detected (Pampel, 2002). The author concluded that the differences in the trends in smoking-attributed mortality accounted for the differences in the overall change in female advantage. Although all three groups of countries exhibited an increase in the female advantage for non-smoking mortality, they differed in the degree of change in smoking-attributed mortality. The size of the decline in the female advantage in smoking-attributed mortality corresponded to the decline in the female advantage overall. As Pampel suggested: "These results support the claim that the narrowing sex differential in mortality found in some countries stems completely from smoking-attributable mortality at ages 35–69 and largely from smoking attributed mortality at ages 70 and older." All things considered, he believed, the narrowing differential in male and female smoking mortality was the result of the timing of the adoption of cigarette use, rather than gender equality. Advances in female longevity had fallen because large numbers of women had taken up smoking (Pampel, 2002).

Factors behind the changing trends

In order to understand and follow the Hungarian trends, we need to look at further factors behind historical examples. As has already been noted, the spread of the smoking epidemic has, perhaps naturally, not occurred at the same pace or with the same intensity in the various developed countries. Cultural and historical factors can be crucial to these processes: for instance, the engagement of a given population in global processes, the degree of openness of a society, the mentality, traditions, and level of tolerance of a given society in relation to anti-tobacco strategies. As Pampel (2002) states, differences in the price of tobacco products and the laws regulating them mean that some countries will peak at higher levels of smoking prevalence. Consequently, the same level of smoking could reflect an earlier stage in a high-smoking country but a peak stage in a low-smoking one. “The earlier cigarette diffusion begins, the later or more advanced the current stage; conversely, the later the process begins, the earlier or less advanced the current stage … Great Britain’s longer history of cigarette smoking means it has reached a more advanced stage in the diffusion process than Spain. During this late stage of diffusion, declining smoking among men and rising smoking among women should lead to small sex differences in mortality” (Pampel, 2002).

If from all the male smoking prevalence and smoking-attributable mortality values we subtract the appropriate female values, we get the gender gap. Because men are affected by smoking at an earlier phase in life, and because the pace of rising smoking prevalence differs by gender, the sex differences initially grow. Figure 3 shows that in the USA the gender gap increased steadily from the 1900s until the 1940s. As the tempo of smoking prevalence increase slowed for males, but increased steadily among women, the sex differential in smoking peaked at the time of World War II. After this, the prevalence stagnated in the 1950–1960s among men and continuously increased among women, consequently the sex differentials in smoking prevalence started to decline at that time. When the prevalence among both genders declined substantially from the 1970s, the gender gap started to narrow visibly, and, according to the estimations, the differential in smoking prevalence will have disappeared in the US by 2020. Accordingly, smoking-attributable mortality shows a similar trajectory – but with a delay of three decades: the gender gap grows from the starting point until the 1960s, peaks around the 1970s, and then decreases steeply up to recent years, when it reaches a minimum: complete gender equality in the effects of smoking in the USA. Pampel’s (2002) conclusion is similar: the more advanced the stage of the epidemic, the smaller the sex difference in mortality. Moreover, he states that in making appropriate cross-national comparisons, what emerges as crucial is the stage of cigarette diffusion, rather than the level of gender equality.

Luy and Wegner-Siegmundt (2014) decomposed gender differences in life expectancy at birth into three components: biological factors, smoking, and other non-biological factors. The analysis covered 53 populations from developed countries, and 55 years of observation from 1955 to 2009. This research categorized Hungary as belonging to the group where both the trend and the extent of the gender gap are predominantly driven by smoking. In Austria and the USA, only the trend of the gender gap is predominantly driven by smoking, while the extent of the gender gap is predominantly driven by other non-biological factors. According to the conclusion of the authors, the contribution of smoking to the gender gap declines in all populations studied, although the beginning of the decline varies in accordance with the model of the smoking epidemic (Luy and Wegner-Siegmundt, 2014).

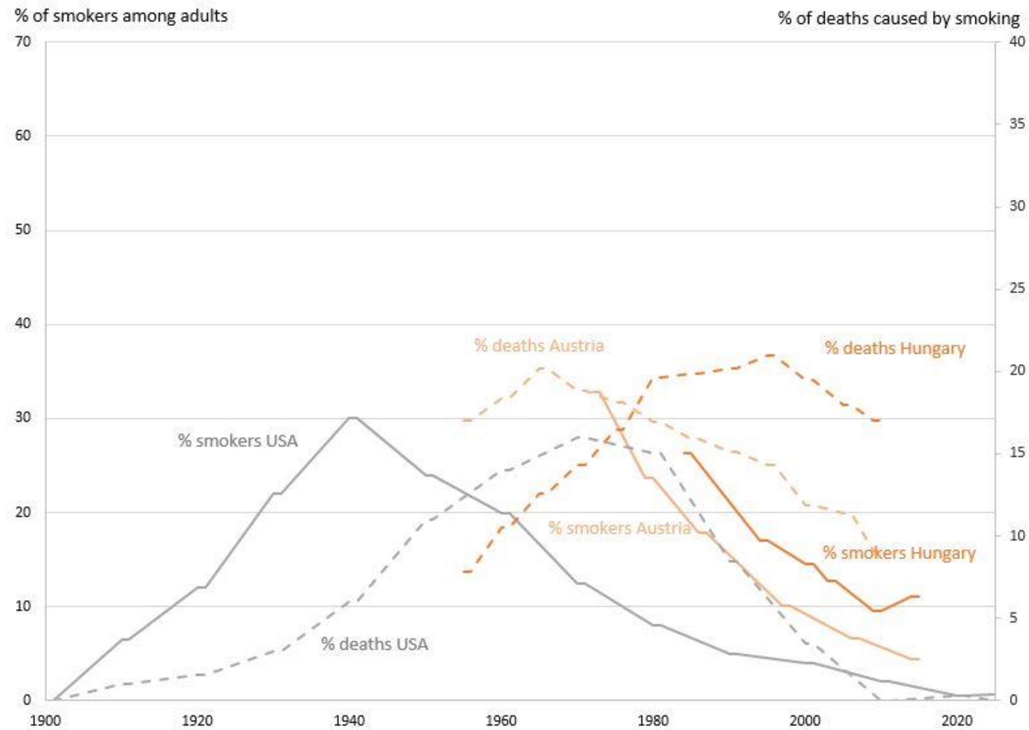
The situation in Hungary

Figure 27 shows the situation in Hungary and the two reference countries. In terms of smoking prevalence, the largest gender differences are in Hungary, followed by Austria, and then the USA. If we look at the timeline, in all three cases there is a significant drop in prevalence and a trend towards gender equality in the last decades.

In the USA, the smoking mortality gender gap peaked around the 1970s, with a difference of more than 15%. By contrast, the difference was at its greatest in Hungary three decades later, around the 2000s, and the size of the gap was larger than the USA had witnessed (over 20%). On the one hand, the changes in the Austrian gender differences paralleled those in the USA, peaking in both cases around the 1970s (in the case of Austria, a little earlier); on the other hand, the extent of the Austrian gap was more similar in size to that of Hungary.

With respect to the size of the gender differences, these observations could possibly mean that in the past, gender roles were more traditional in Austrian and Hungarian society than in the USA. Of course, both Central European countries are rather similar to each other in this respect. Furthermore, with regard to the historical change in gender differences, Austria has been better integrated and better embedded in the economy of the developed Western countries than Hungary.

Figure 28: Gender differences in smoking prevalence and smoking-attributable mortality in the USA, Hungary, and Austria, 1900–2025, in percent



Source:

	Smoking prevalence	Smoking-attributable deaths
USA	Thun et al, 2012	Thun et al, 2012
Hungary	Tombor et al, 2010, Bőti et al, 2011, EHIS 2014	Peto, Lopez et al, 2011
Austria	Thompson et al, 2013 WHO-HFA, 2014	Peto, Lopez et al, 2011

For detailed source see Appendix D

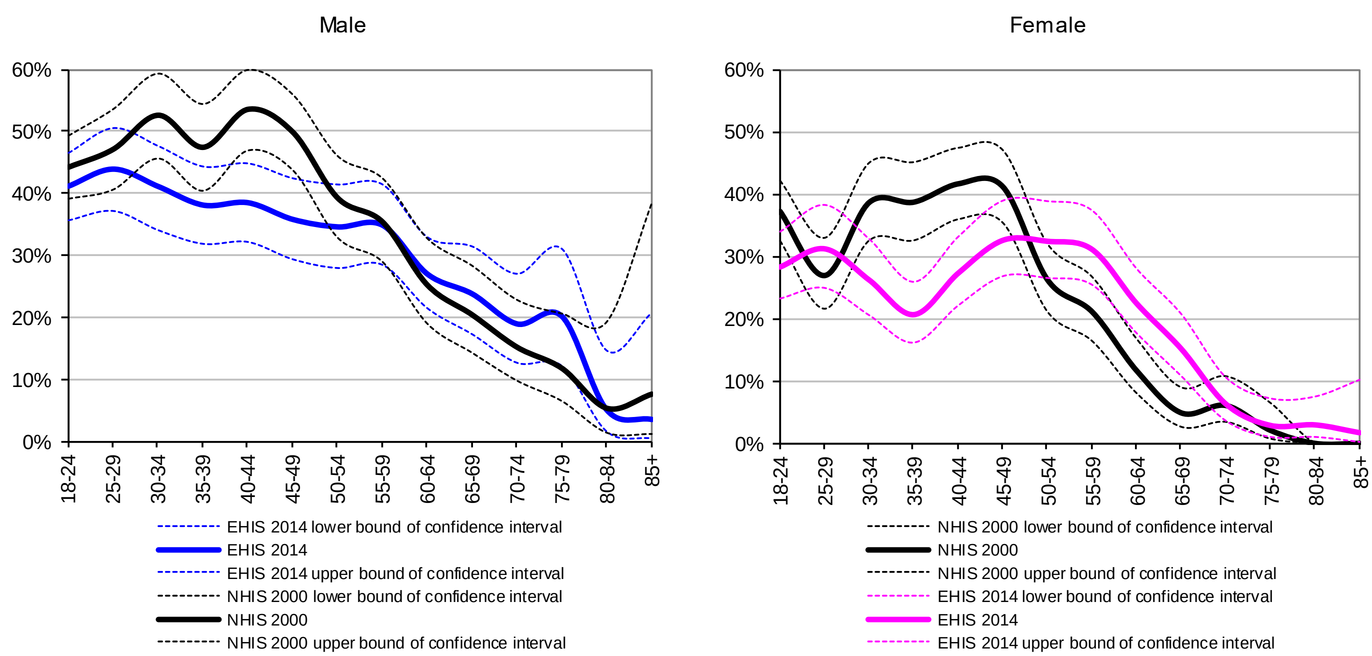
Detailed smoking prevalence in Hungary, 2000 and 2014

As indicated by the health interview surveys: NHIS 2000 and EHIS 2014, one in every two men and every third woman in Hungary is affected by nicotine dependence. According to the estimates of the questionnaire-based research, the absolute number of men who currently smoke or have quit smoking was more than 2.5 million at the turn of the millennium, but it fell to about 2.2

million by 2014. For women, the decline was lower: their corresponding figures were 1.75 million and around 1.65 million respectively. This means that over one and a half decades, the base population of smoking-attributable mortality decreased in the case of both sexes.

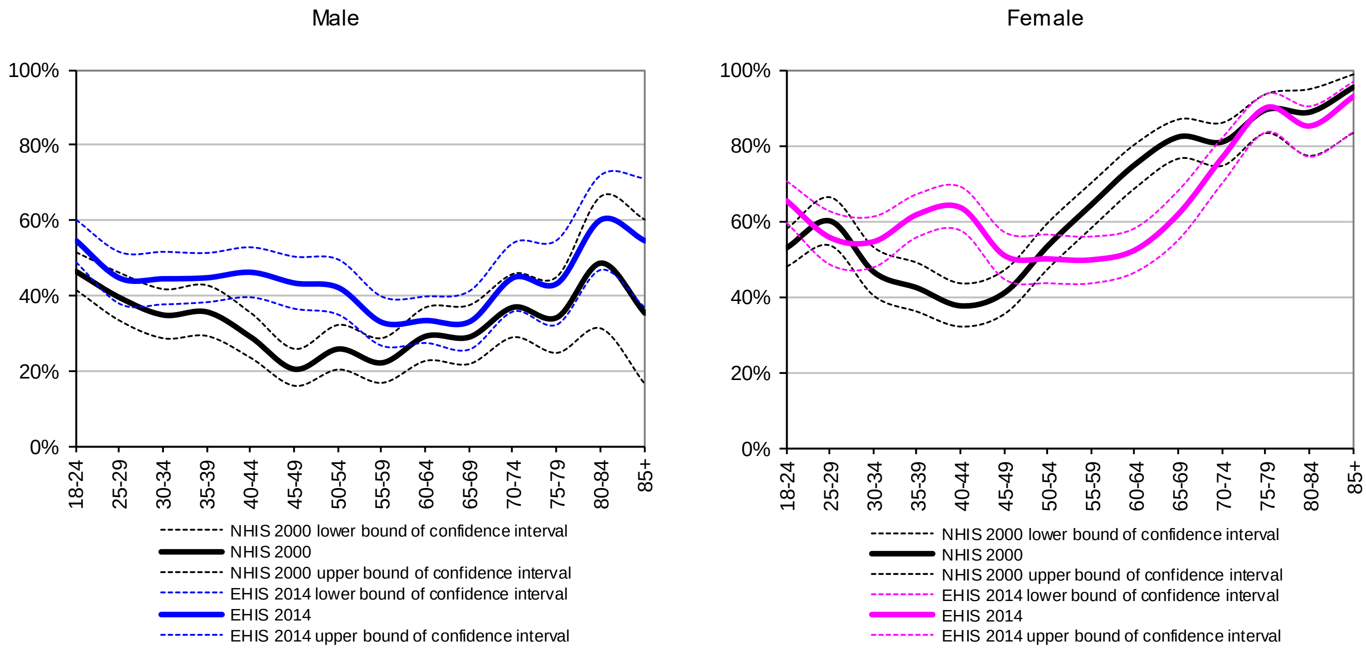
As a result, about 1.3 million men smoked according to the health interview survey in 2014, and the relevant figure for women remained steadily below 1 million. If we examine the estimates for smoking status with a 95% confidence interval by age group on Figure 29, a significant decrease can be seen among 40–44-year-old men in 2014 compared to 2000. Regarding the prevalence of smoking among women, a decline occurred in a wider age group, between 30 and 45 years of age. In contrast, the proportion of nicotine addicts among women aged 55–65 years has increased significantly since to the turn of the millennium. Another unfavorable development is that there has been no decrease in the prevalence of smoking in the 18–30-year-old population since 2000.

Figure 29: Prevalence of smoking by gender and age group, 2000 and 2014 (with a 95% confidence interval)



Source: NHIS 2000 and EHIS 2014, smoothing: spline interpolation

Figure 30: Prevalence of non-smoking by gender and age group, 2000 and 2014 (with a 95% confidence interval)

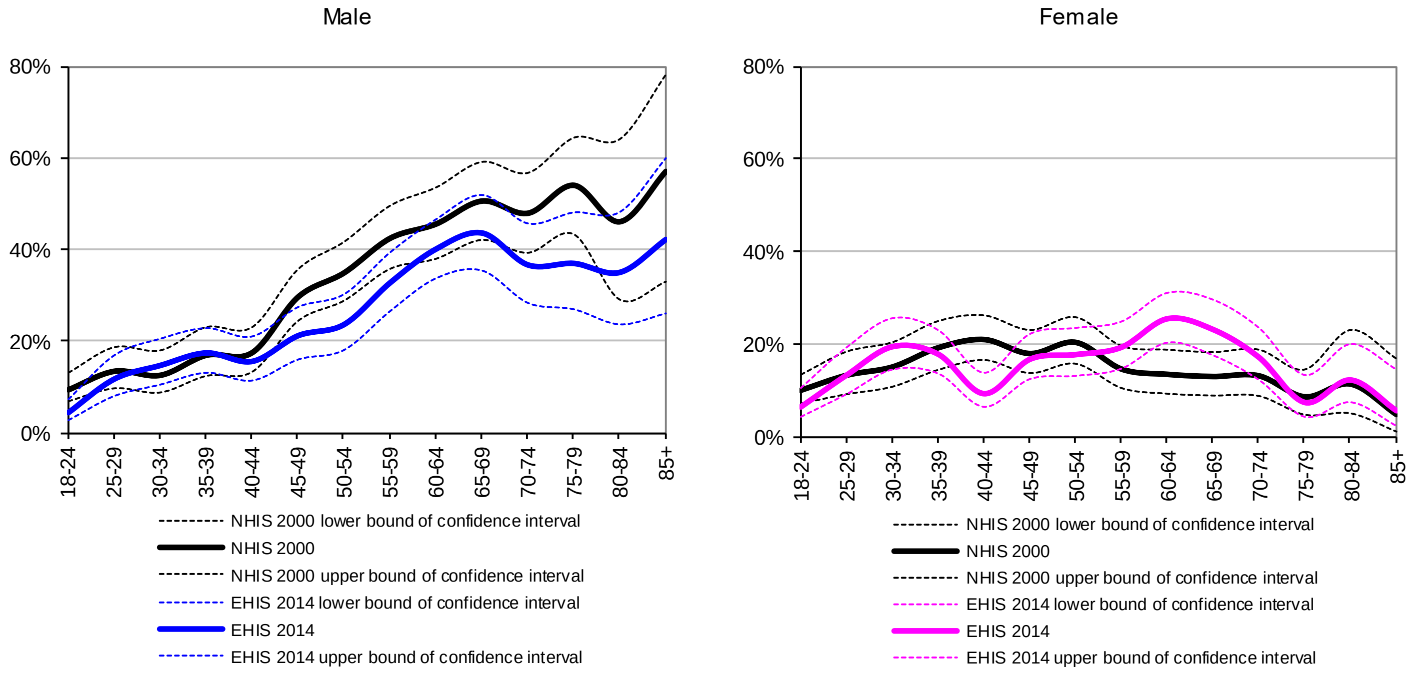


Source: NHIS 2000 and EHIS 2014, smoothing: spline interpolation

In line with the findings, non-smoking on Figure 30, became significantly more common among 40–50-year-old men between 2000 and 2014. In parallel, the ratio of non-smoking women aged 30–45 years in the female population also rose considerably, while the proportion of those who never smoked fell remarkably among older women aged 50–70 years.

In the case of those who have quit smoking on Figure 31, significant changes could only be observed in the female population during the observed period. In the prevalence of smoking among such women, there has been a slight reduction around the age of 40 and an increase in the 60–65 age group.

Figure 31: Prevalence of ex-smoking by gender and age group, 2000 and 2014 (with a 95% confidence interval)



Source: NHIS 2000 and EHIS 2014, smoothing: spline interpolation

5.3. Methods

If we know: 1. the data on smoking prevalence in a population (by sex and age), 2. the relative risks of smoking related causes of death by sex and age, and 3. the absolute number of deaths by cause of death by sex and age, then we can calculate the smoking-attributable mortality in a given year, according to the methods used for the official calculations at the American Centers for Disease Control and Prevention (USDHHS, 2014).[5]

Firstly, smoking prevalence rates for the Hungarian population are known from the health interview surveys (NHIS 2000, NHIS 2003, EHIS 2009, EHIS 2014) for the period between 2000 and 2014. The similarity of the data of four representative surveys allows the combined use of results (Vitrai et al., 2012). Based on these surveys, the population of Hungary can be divided into three parts: current smokers, those who have quit smoking and who never smoked. (confidence

[5] See detailed method in Appendix E

intervals of 95% are presented wherever possible) For intermediate and ‘outlier’ years, a statistical approximation method was applied. Secondly, the absolute number of deaths due to certain smoking-attributable causes of death by age group is available from the Death Register of the Hungarian Central Statistical Office. Thirdly, relative risks quantify the health risks of tobacco use among smokers and ex-smokers compared to non-smokers, by group of diseases as well. These values were taken over form USDHHS (2014) without any change. For example, according to the methodology updated in 2013, the chances of a 65–74-year-old smoking man to die of lung cancer is more than 28-fold compared to a non-smoking man. Consequently, the relative risk for non-smokers is always 1. In general, these multipliers are lower for women, ex-smokers and for younger age groups. The methodology of the CDC as expressed in its ICD-10 codes distinguishes 90 different causes of death related to tobacco consumption. These causes can be grouped into larger categories. This paper takes account of the most frequent – mainly chronic diseases (for instance, cancers and cardiovascular diseases) – in accordance with the general structure of causes of death in countries with an advanced health culture

“By the definition, »smoking-attributable mortality due to a certain cause of death« in a population means that how many persons would not have died out of those suffering from the given cause of death if their death rate had equalled the one of non-smokers.” (KSH, 2014 p. 30.) Due to the slow progression of smoking-associated diseases and the fact that addiction usually begins when people are in their teens, the methodology assumes that no one dies from diseases caused by nicotine addiction before the age of 35. Smoking may cause infrequently fatal accidents as well, but their number is insignificant. The few – fortunately very rare – exceptions are those cases when an infant death occurs due to the mother’s smoking during pregnancy. Consequently, in this chapter we consider smoking-attributable premature deaths, which occurs between ages 35 and 69.

Placing the total probability of dying (qx) on the vertical axis and the smoking-attributable probability of dying (qxs)[6] on the horizontal, time-path plots can be created to explore the changes in smoking-attributable mortality in Hungary by sex and age group. If the line runs up to the top-right corner, there is a clear deterioration in the age-specific mortality (both the indicators are worse); but if it runs to the bottom-left corner, it represents only positive developments (both the indicators are improving).

[6] See calculation method in Appendix F

From the point of view of public health, it is not only the age of the deceased smoker that is an important question, but also the cause of death. ICD-10 codes of causes of death groups: Lung, bronchus, trachea cancers: C33-C34, Ischemic heart disease: I20-I25, Other cancers: C00–C14, C15, C16, C25, C32, C53, C64–C65, C67, C22, C18-20, C92.0, Bronchitis, emphysema, COPD: J40–J42, J43, J44, Other smoking-attributable diseases: I05-I09, I26-I28, I11, I13, I30-I51, I60–I69, I70, I71, I72–I78, E10-E14, J09–J18, A15-A19, P07, P22, P23–P28, R95. It must be mentioned that the method of data processing in Hungary changed in 2005, when the manual method was replaced by automatic processing, where the coding of death certificates and the primary cause of death reported in the statistics are electronically selected. Because of this, in the time series there is an artificial break in the trends between 2004 and 2005.

Mortality conditions can be characterized not only by (smoking) specific death rates but also by derived indicators. Besides life expectancies, such an indicator used in statistics is the potential years of life lost, which sums up the (not lived) lifetimes of persons deceased in a certain population group until a fixed age.[7] The selection of age limits is optional, the present study analyses two of them: the 70 years of age used in international practice, and the life expectancy at the age of death. If someone dies, for example, at the age of x, then the number of years of life lost is 70 – x in case x < 70, while if he/she dies at the age of 70 or over, the indicator is 0 (KSH, 2014, p. 22.). Due to the methodology used in the research, the number of smoking-attributable excess deaths is known by age group, which allows the examination of years of life lost.

The WHO-HFA database provides an opportunity for the international comparison of smoking-related mortality.[8] Contrary to the methodology of the smoking-attributable mortality applied in this study, the indicator in the database significantly overestimates the real values due to its different calculation method. "SDR, selected smoking-related causes, per 100 000. SDR is the age-standardized death rate calculated using the direct method, i.e. represents what the crude rate would have been if the population had the same age distribution as the standard European population). The mortality from combined, selected causes of death which are known from literature to be related to smoking. It has to be pointed out that it is a relatively rough indicator and it is NOT the estimate of tobacco-attributable mortality, which is more complex and difficult to

[7] See calculation method in Appendix G
[8] See Appendix E for the links

calculate. This simple pooling of smoking-related deaths (irrespective of what is the actual proportion of deaths due to tobacco in each cause) can help to better rank countries by smoking-related mortality and can be used to better track trends in deaths associated with tobacco than would be possible by using separate causes.” This chapter provides information on countries with similar culture, historical background and geographic features in the Central European region.

5.4. Results

5.4.1. Smoking-attributable premature mortality in Hungary

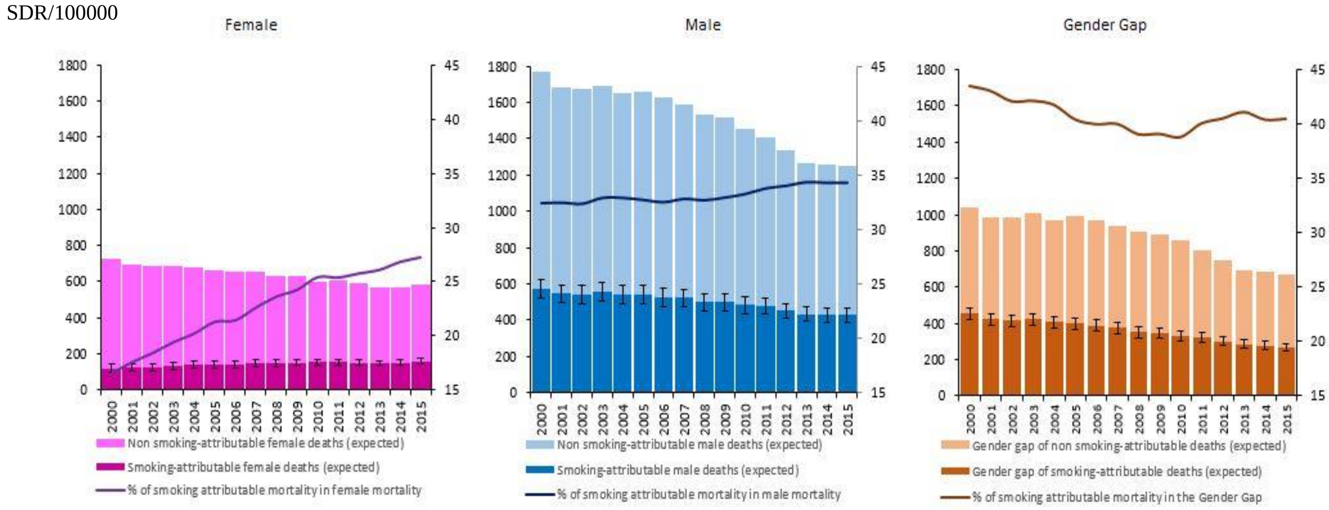
General trends by gender

In Figure 32, we can see that the trend in general premature male mortality is downwards between 2000 and 2015 (by 29%). Smoking-attributable deaths among men also decreased steadily, though to a lesser extent (only around a quarter). Consequently, tobacco-related mortality increased slowly as a percentage of all male premature deaths – from 32% to 34%.

The picture of premature death among women is quite different, as their premature mortality is generally half that of men. Nevertheless, the basic trend declines similarly, though more modestly – by only 20%. In contrast to the decline in male smoking-attributable mortality, among women there is a significant rise – of nearly a third. Because general female premature mortality has declined and tobacco-related deaths have grown, smoking-attributable mortality as a percentage of all female premature deaths has increased significantly – from 17% to 27%.

As the figures for overall premature mortality improved more rapidly for men than for women, the gender gap decreased by more than a third in the period 2000–2015. Meanwhile, the difference in tobacco-related mortality decreased by 41%. The change in the percentage of smoking-attributable mortality in the gender gap displays a more ambivalent picture: from 2000 until 2010, there was a continuous downward trend; but then the non-smoking gender gap started to decline faster than the tobacco-related one, and so the relevance of smoking-attributable mortality in the gender gap started to grow again from 2011, and by 2015 it stood at around 40%.

Figure 32: Premature (ages 35–69) smoking-attributable and non-smoking-attributable SDR/100000 by sex, and the gender gap in Hungary, 2000–2015

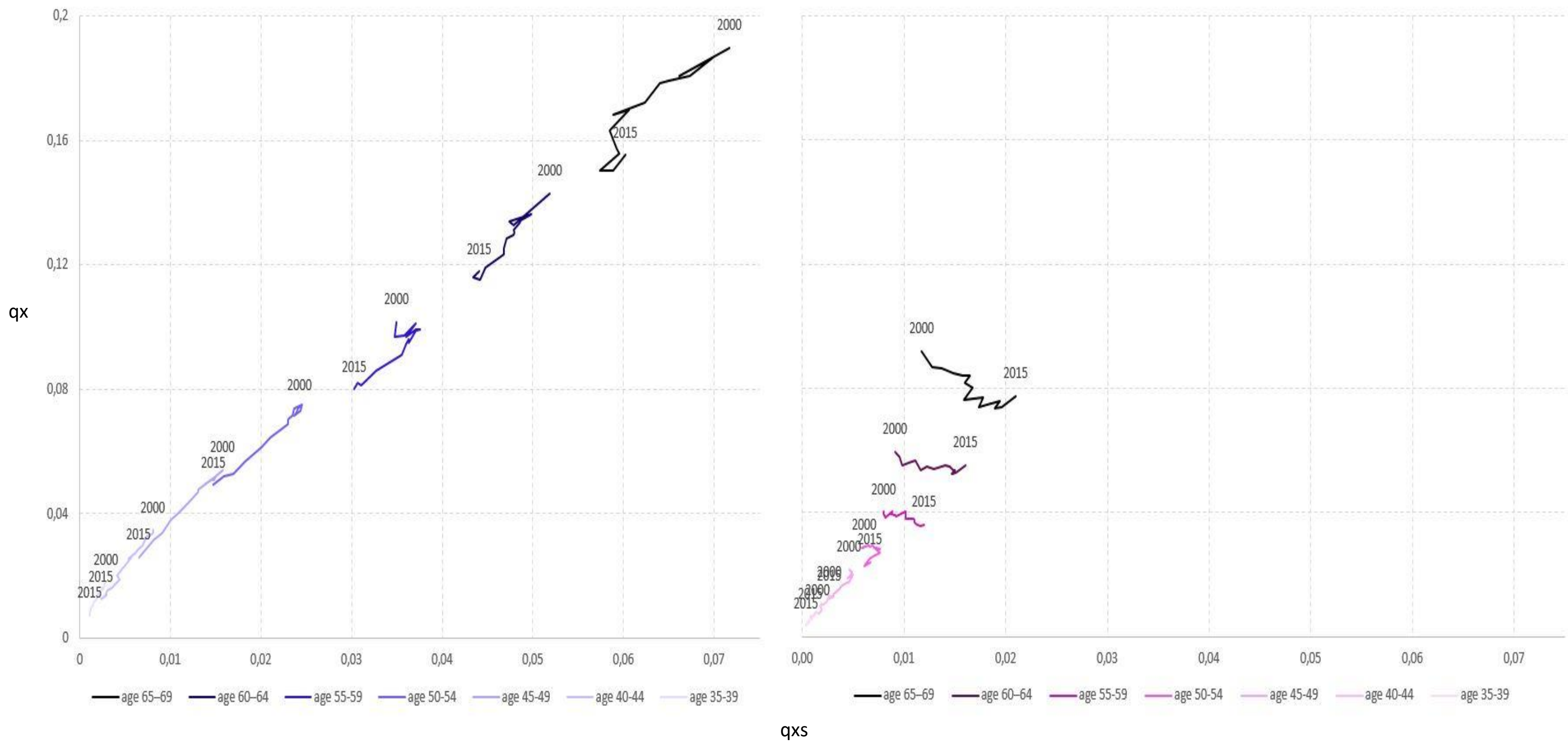


Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014. , smoothing: spline interpolation

General trends by gender and age group

Figure 33 shows that for males in all age groups we can observe a significant improvement both in total and in smoking-attributable mortality between 2000 and 2015. The opposite trend is visible among middle-aged and older women for tobacco-related deaths. An improvement can be observed in younger age groups between 35 and 45, and there is a positive reverse trend at age 45–49; but in the older age groups, there is a clear increase in smoking-attributable mortality that almost completely negates the decline in the total mortality of older (55–70) women between 2000 and 2015.

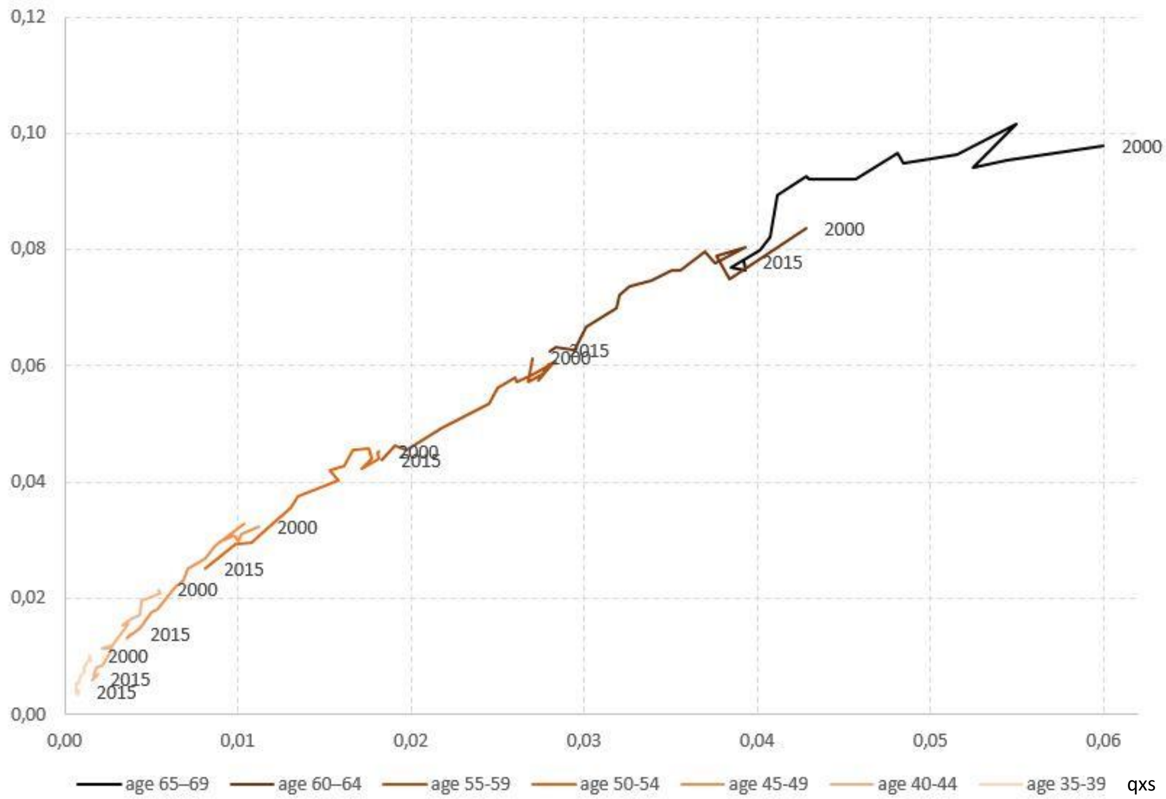
Figure 33: Probability of dying of total (qx) and smoking-attributable mortality (qxs), by sex and age group, from 2000 to 2015 in Hungary



Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014

When from the male probability of death in each age group we subtract the corresponding female value, we get the gender gap. Using the time-path plots again, it is clear that the sex difference in all age groups declined sharply between 2000 and 2015.

Figure 34: Gender differences in probability of dying of total (qx) and smoking-attributable mortality (qxs), by age group, from 2000 to 2015 in Hungary



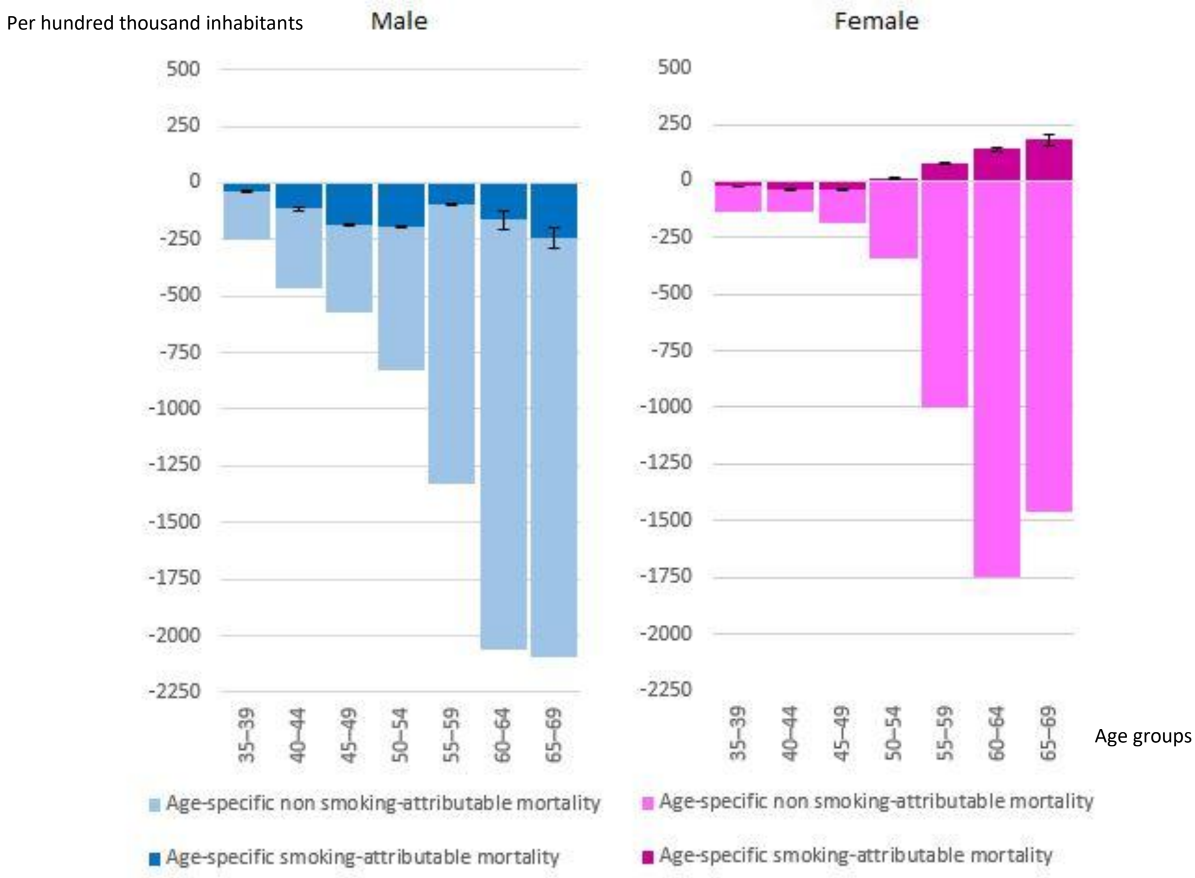
Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014.

Figure 35 illustrates how smoking-attributable mortality contributed to the change in premature mortality in Hungary by sex and age group between 2000 and 2015.

The bar chart reveals that in all male age groups, the ratio of premature death decreased substantially, helped along by the decline in tobacco-related mortality. As age increases, so the drop is more notable. The greatest fall occurred in the generation aged 60–69; however, the contribution of the smoking-attributable decrease to the drop in premature deaths is proportionately more relevant in younger age groups – 45–49 and 50–54.

In this respect, the situation of women also differs from that of men, and the development between 2000 and 2015 can be divided into two parts. On the one hand, among those under 50 years of age, the decrease in tobacco-related deaths contributed to the decline in premature female mortality; on the other hand, among those over 50, the increase in smoking-attributable mortality retards development in the field of premature female death. The results indicate that there are fundamental differences in the degree of health awareness between the younger and the older parts of the Hungarian female population.

Figure 35: Changes in the age-specific death rate/100000 between 2000 and 2015, by sex, age group, and smoking in Hungary (95% confidence intervals)



Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014.

General trends by gender, age group, and cause of death

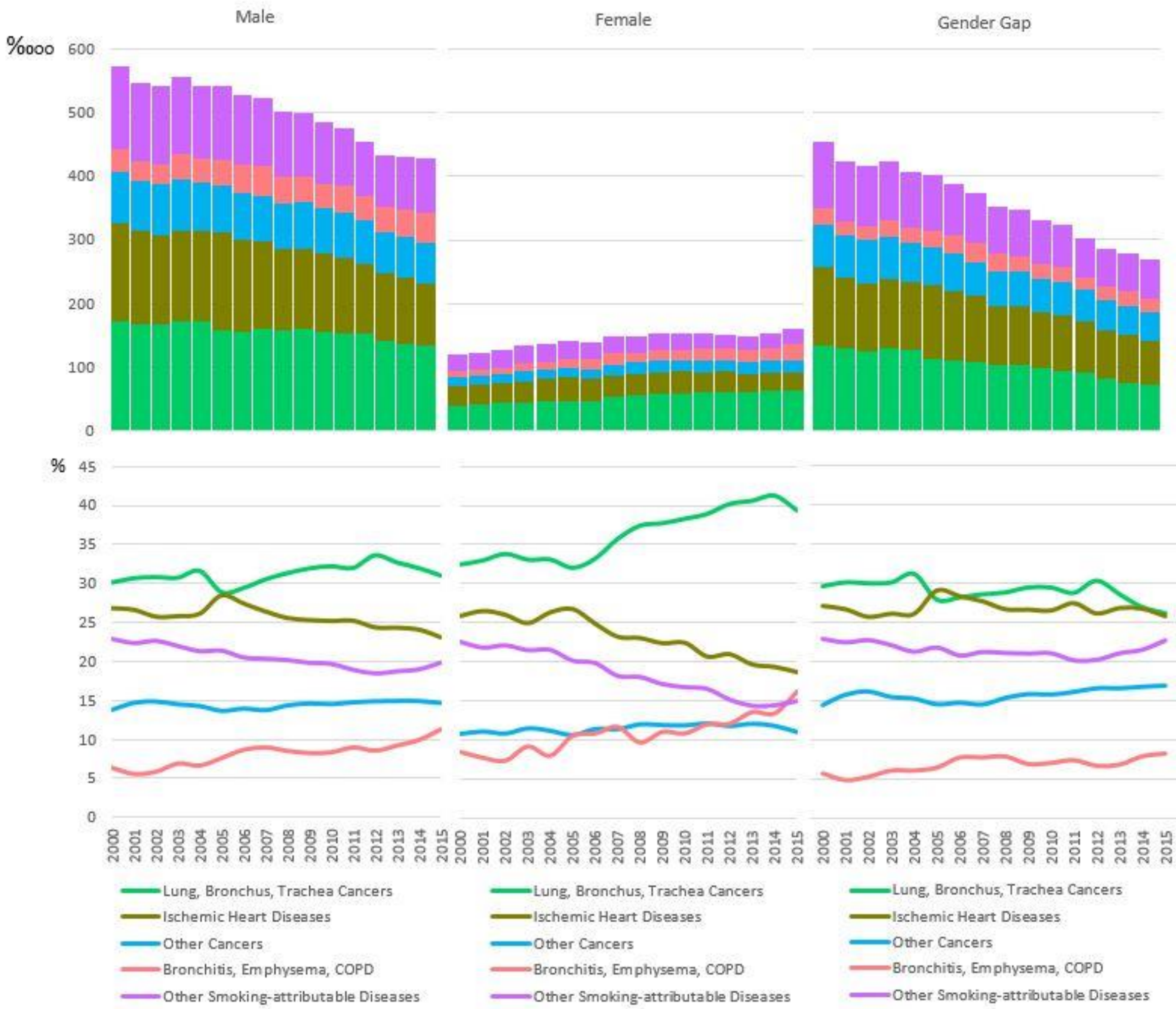
Figure 36 focuses on the smoking-attributable part of Figure 32, and breaks down the information by main cause of death. At this stage of the analysis, the 95% confidence intervals are not displayed in the diagrams, due to problems with their visual representation, only the calculated expected values.

The values of all causes of male smoking-attributable death have declined, except for the group of bronchitis, emphysema, and COPD (Figure 33: bar chart, top left). Lung, bronchus, and trachea cancers are the most relevant, at around 30%, and since 2000 the value has not changed substantially (Figure 33: line chart, bottom left). The stagnant trend for other cancers is similar, although their importance is only around half that of lung, bronchus, and trachea cancers. A significant and similar (around 3–4 percentage points) decrease can be observed in the relevance of ischemic heart diseases and other smoking-attributable deaths. Conversely, the importance of bronchitis, emphysema, and COPD causes of death almost doubled between 2000 and 2015, reaching more than 11%.

The trends in female tobacco-related mortality by cause of death differs slightly from the pattern observed among males. The most important fact is that (unlike men) the Standardized Death Ratio (SDR) values for lung, bronchus, and trachea cancer and for bronchitis, emphysema, and COPD have increased dramatically since 2000 (Figure 33: bar chart, top center). If we talk of the relative relevance of these factors in female smoking-attributable mortality, the situation appears even more critical. The proportion of lung, bronchus, and trachea cancer rose from a figure of approximately 30% to 40% between 2000 and 2015, while the incidence of bronchitis, emphysema, and COPD as the cause of death doubled among women (from 8% to 16%), similar to that among men (Figure 33: line chart, bottom center). Furthermore, gender makes no difference in the decline of other forms of cancer to stagnation, or in the ratio of ischemic heart diseases and other smoking-attributable deaths.

Taking all this into account, over the past decade and a half, the relative weight of lung, bronchus, and trachea cancers in the gender gap has decreased somewhat to reach a similar level to that of ischemic heart diseases, which have stagnated since 2000 (Figure 33: line chart, bottom right). The same stability can be observed when one considers other smoking-attributable diseases, and a slight increase can be observed in the importance of other cancers and bronchitis, emphysema, and COPD as causes of death.

Figure 36: Premature (ages 35-69 years) smoking-attributable SDR/100000 (expected value) and the relative relevance in percent by sex, cause of death and the gender gap in Hungary, 2000-2015



Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014. , smoothing: spline interpolation

Using the same time decomposition method with time-path plots as in Figure 33 by sex, age group, and cause of death, we see very interesting developments appearing in Figure 37 for men and in Figure 38 for women.

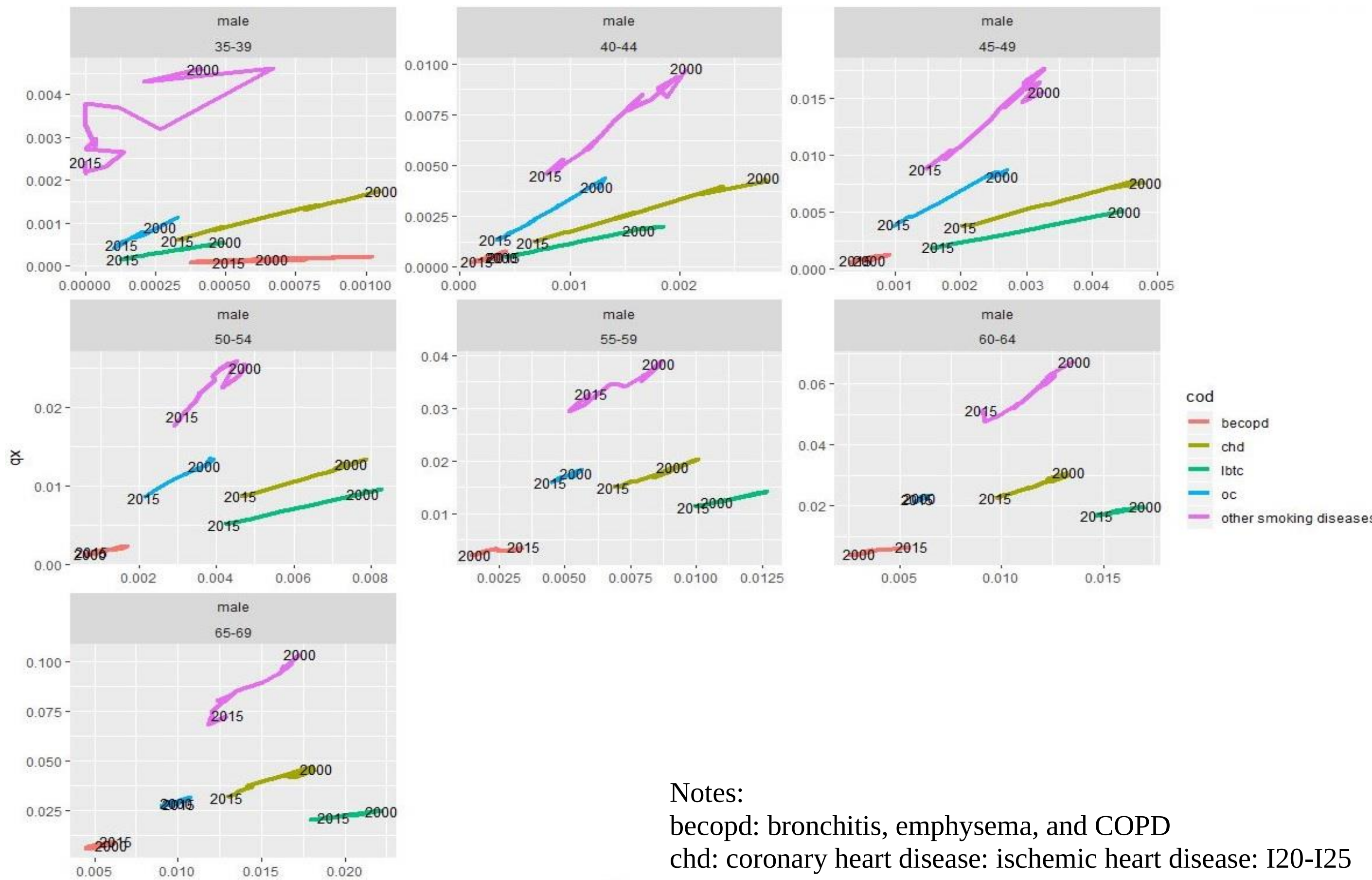
Between 2000 and 2015, almost all the male smoking-attributable causes of death declined in every age group (Figure 34), except for bronchitis, emphysema, and COPD deaths in the age groups covering 55–64, which increased between 2000 and 2015. It is important to emphasize the role of other forms of cancer, which remained more or less the same among men in their 60s.

Most of the female smoking-attributable causes of deaths show a decrease between the ages of 35 and 49 in the period observed (Figure 35). Over 50 generally, lung, bronchus, and trachea cancers and bronchitis, emphysema, and COPD smoking-attributable mortality decreased. From the age of 55, ischemic heart diseases and other localizations of cancer show negative tendencies and from 65 to 69 the other smoking-related diseases also show a rising trend.

It is worth mentioning that this decomposition method shows how much the importance of various "smoking-attributable" causes of death increased from 2014 to 2015 due to the flu epidemic at the beginning of 2015.

In Figure 36, where the changes in gender differences can be observed between 2000 and 2015, in almost all smoking-attributable causes of death there is a shrinking gender gap. Perhaps the only exception is bronchitis, emphysema, and COPD diseases, where there was no change in the gender differences in the over 40s after the turn of the millennium.

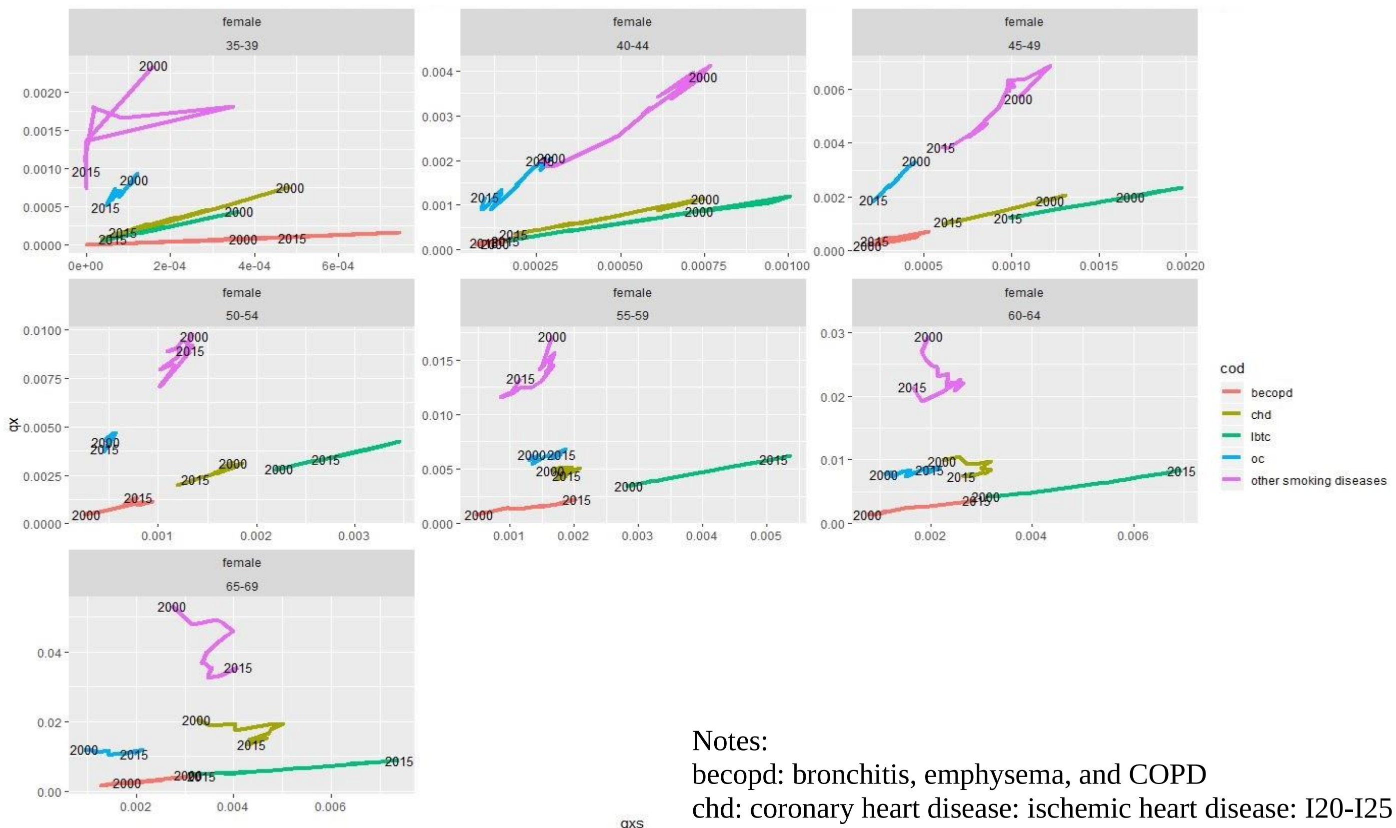
Figure 37: Probability of dying of total (qx) and the smoking-attributable male mortality (qxs) by age group and cause of death from 2000 to 2015 in Hungary



Notes:
becopd: bronchitis, emphysema, and COPD
chd: coronary heart disease: ischemic heart disease: I20-I25
lbtc: lung, bronchus and trachea cancers
oc: other cancers

Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014.

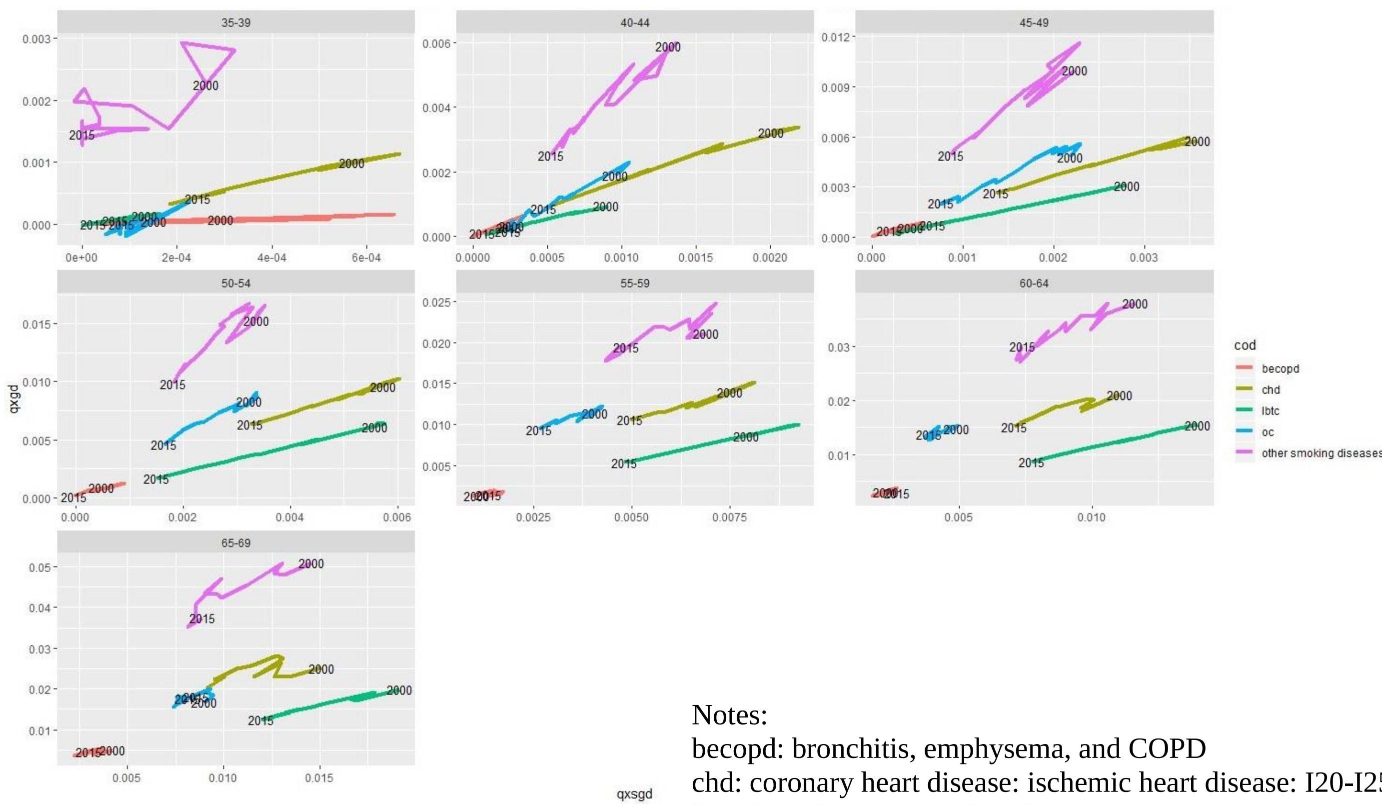
Figure 38: Probability of dying of total (qx) and the smoking-attributable female mortality (qxs) by age group and cause of death from 2000 to 2015 in Hungary



Notes:
becopd: bronchitis, emphysema, and COPD
chd: coronary heart disease: ischemic heart disease: I20-I25
lbtc: lung, bronchus and trachea cancers
oc: other cancers

Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014.

Figure 39: Gender differences in probability of dying of total (qxgd) and the smoking-attributable mortality (qxsgd)by age group and cause of death from 2000 to 2015 in Hungary



Notes:
becopd: bronchitis, emphysema, and COPD
chd: coronary heart disease: ischemic heart disease: I20-I25
lbtc: lung, bronchus and trachea cancers
oc: other cancers

Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014.

Figure 40 shows the changes in premature smoking-attributable mortality by age group and cause of death between 2000 and 2015.[9]

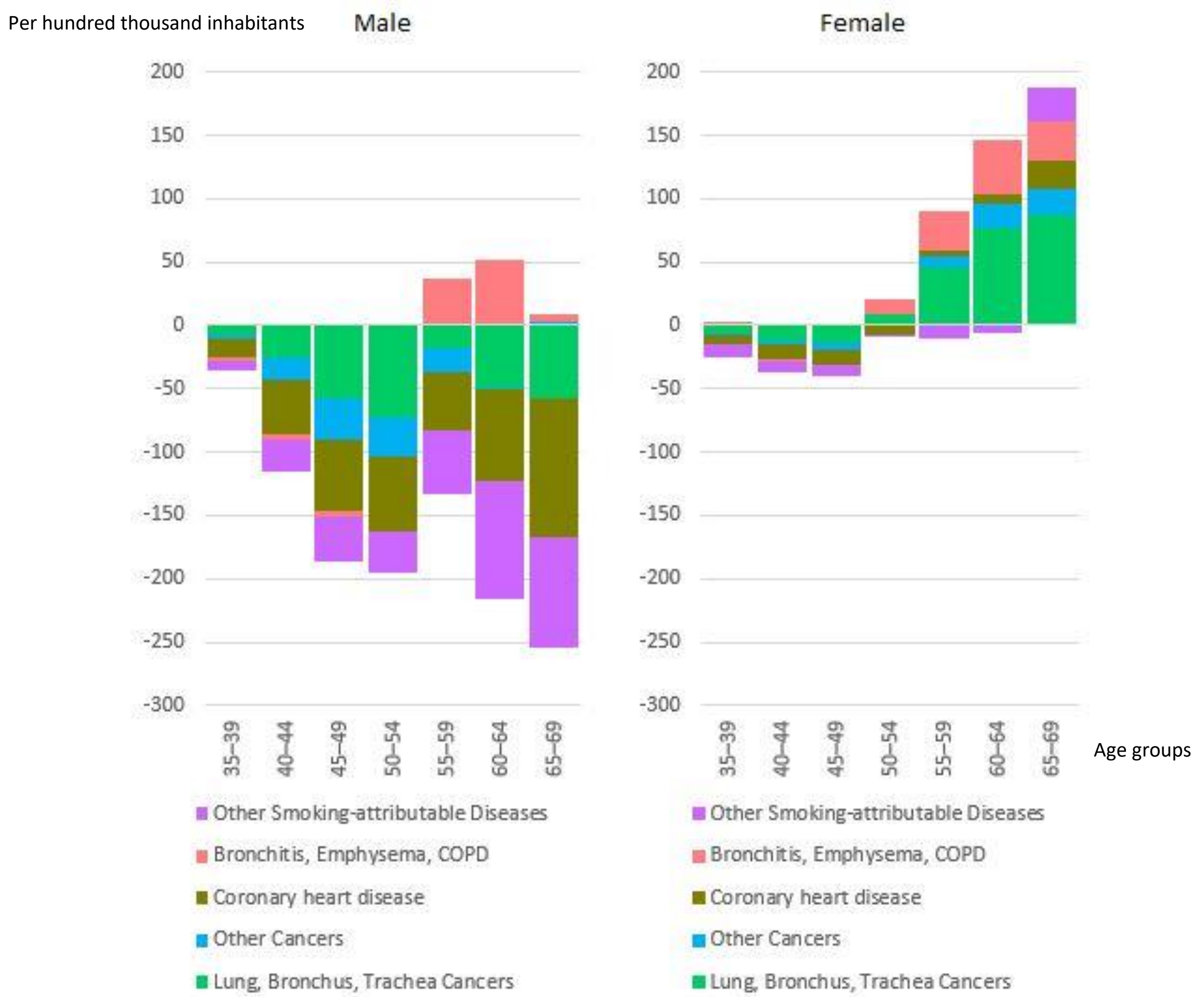
As has already been seen in the case of men, as age rises, so smoking-attributable deaths contribute more and more to the significant decrease in premature mortality; but developments in the cause of death cast something of a shadow over the picture.

On the one hand, the decrease in tobacco-related lung, bronchus, and trachea cancers, ischemic heart disease, and other smoking-attributable diseases in all age groups – and in other cancers between 35 and 59 – has contributed to a decline in premature smoking-attributable male mortality. On the other hand, an exceptional increase is to be seen in tobacco-related bronchitis, emphysema and COPD mortality between the ages of 55 and 69; this substantially slowed the improvement in premature smoking-attributable conditions in the corresponding male age groups in the period under analysis.

The mortality situation of Hungarian middle-aged female smokers appears critical. First, the rising occurrence among those aged over 50 of tobacco-related lung, bronchus, and trachea cancers, and bronchitis, emphysema, and COPD deaths has to be emphasized; this high level of occurrence rises ever more steeply with increasing age. Secondly, from the age of 55, other cancers and ischemic heart disease contribute more and more to the deteriorating picture, as the female smoker population ages.

[9] The chart is formally similar to Figure 35, the difference is just that Figure 40 particularizes the dark-colored part of the mentioned graph.

Figure 40: Changes in the smoking-attributable age-specific death ratio/100000 between 2000 and 2015, by sex, age group, cause of death in Hungary



Source: own calculations. Based on the mortality data of the Hungarian Death Register, the prevalence data are from the National Population Health Survey 2000 and 2003, European Health Interview Survey (EHIS) 2009 and 2014, the relative risks values are from USDHHS, 2014.

5.4.2. The effect of smoking on total mortality in Hungary between 2000 and 2014

Generally, approximately one in every five deceased persons dies because of smoking every year in Hungary. During the observed one and a half decades, the absolute number of deaths associated with nicotine dependence stagnated around 25 thousand. As a result of the decline in overall mortality and the stagnation of the absolute number of persons died as a result of addiction, the proportion of smoking-attributable mortality within the total number of deaths slightly increased in the examined period. However, the standardized death rate that eliminates the impact of the different age structure of the Hungarian population compared to that of the European population decreased by nearly 14% between 2000 and 2014.

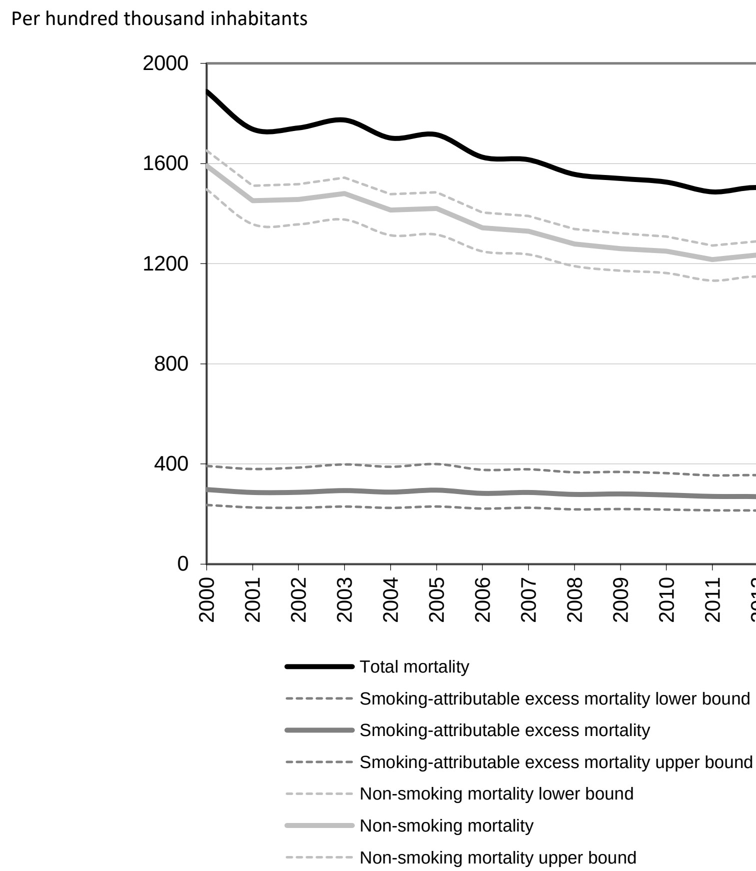
Table 7: Number of smoking-attributable excess deaths, their proportion within total mortality and smoking-attributable standardized death rate per 100 000 persons[10], 2000–2014 (with a 95% confidence interval)

Year	Number of smoking-attributable deaths	Smoking-attributable standardised death rate per 100 000 persons	Percentage of smoking-attributable deaths w ithin total mortality
2000	24 816	297,48	18,30
95% CI	20 353 - 31 168	236,22 - 391,86	15,01 - 22,99
2001	24 093	286,01	18,23
95% CI	19 675 - 30 424	226,25 - 379,77	14,88 - 23,02
2002	24 258	286,59	18,26
95% CI	19 704 - 30 855	225,09 - 385,45	14,83 - 23,23
2003	25 040	293,50	18,44
95% CI	20 307 - 31 969	229,88 - 397,96	14,95 - 23,54
2004	24 723	287,30	18,66
95% CI	20 027 - 31 510	224,63 - 388,56	15,12 - 23,78
2005	25 551	295,23	18,82
95% CI	20 611 - 32 695	230,06 - 399,37	15,19 - 24,09
2006	24 744	282,42	18,80
95% CI	20 033 - 31 451	221,8 - 376,33	15,22 - 23,9
2007	25 263	285,95	19,00
95% CI	20 448 - 32 067	225,07 - 378,37	15,38 - 24,12
2008	24 759	278,07	19,04
95% CI	19 984 - 31 452	218,6 - 366,61	15,37 - 24,19
2009	25 143	280,09	19,28
95% CI	20 233 - 31 943	219,81 - 368,03	15,51 - 24,49
2010	25 035	275,99	19,19
95% CI	20 206 - 31 901	217,79 - 363,01	15,49 - 24,45
2011	24 782	270,23	19,24
95% CI	20 082 - 31 556	214,71 - 354,09	15,59 - 24,5
2012	24 913	269,08	19,25
95% CI	20 255 - 31 735	213,82 - 354,79	15,65 - 24,52
2013	24 338	260,40	19,20
95% CI	19 829 - 31 074	207,69 - 343,73	15,64 - 24,51
2014	24 263	256,18	19,21
95% CI	19 889 - 30 907	206,1 - 336,63	15,75 - 24,47

Source: own calculations

[10] See Appendix E and B for the calculation and population standard

Figure 41: Smoking-attributable and non-smoking-attributable standardized death rate per 100 000 persons, 2000–2014 (with a 95% confidence interval)



Source: own calculations, smoothing: spline interpolation

Differences in smoking-attributable excess mortality by gender

In the observed period, the absolute number of smoking-attributable excess mortality of men decreased by 13% and amounted to 16 754 persons in 2014; the measure for women increased by more than one third, exceeding 7 500 at present. Consequently, the percentage of men who died because of nicotine dependence within total mortality stagnated during one and a half decades, while that of women increased considerably, by 3.2 percentage points. About one in every four deaths of men (27%) and one in every ten deaths of women (12%) could be attributed to smoking in 2014.

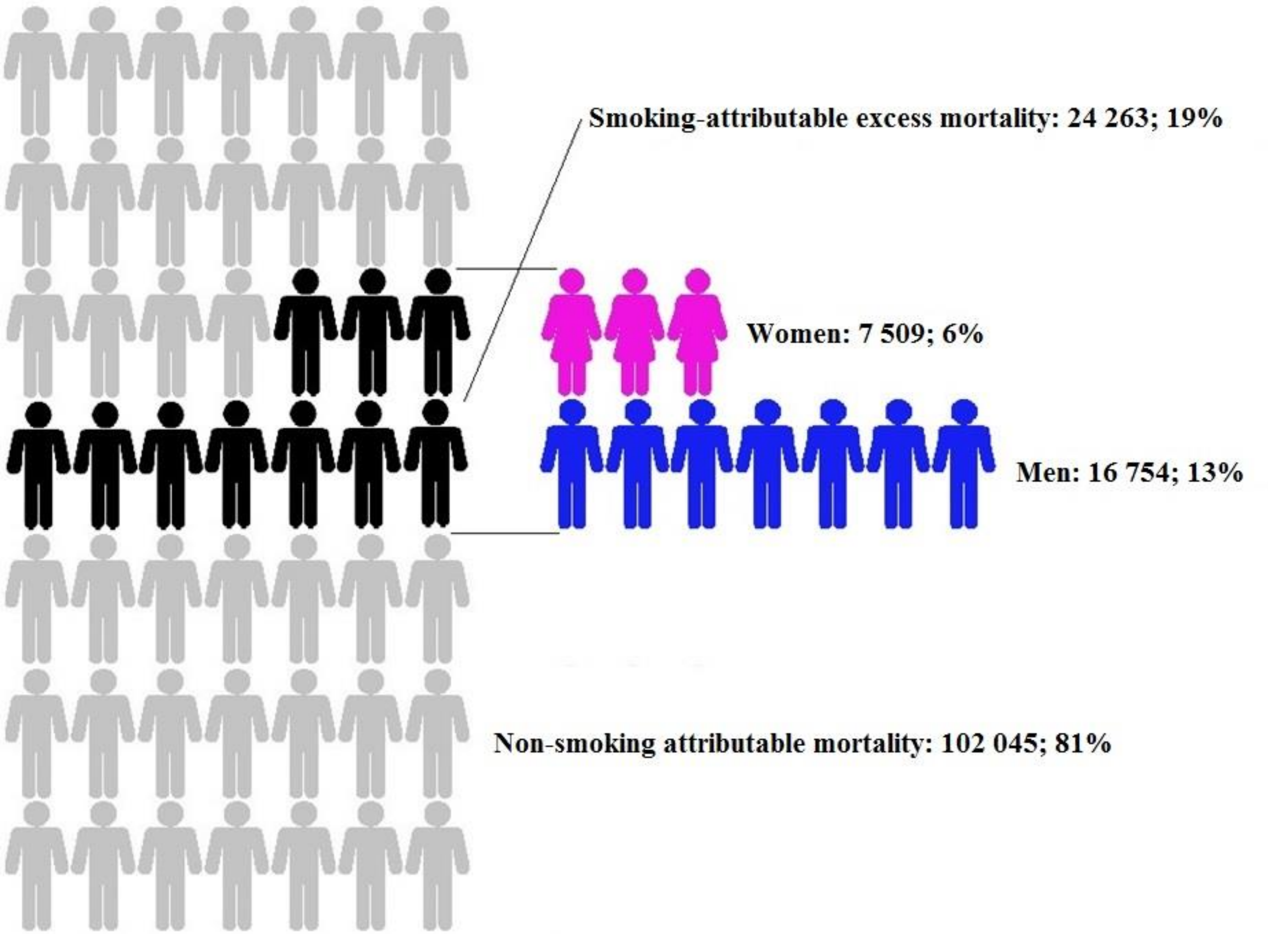
At the turn of the millennium, three and a half times more men died due to smoking than women. The nicotine-dependence-related excess mortality rate of men compared to that of women increased until 2003, then, because of a spectacular decline, the difference fell by one third by the end of the observed period, decreasing significantly the gender gap. While the relevance of smoking to men's general mortality has fallen, the addiction of women, which was less important in the past, became more substantial in the last one and a half decades.

Table 8: Number of smoking-attributable excess deaths and their proportion within total mortality by gender, 2000–2014

Year	Number of persons deceased due to smoking		Percentage of	
			men	women
	men	women	deceased due to smoking within total mortality	
2000	19 300	5 517	27,39	8,47
95% CI	16 421 - 23 030	3 932 - 8 138	23,3 - 32,68	6,04 - 12,5
2001	18 754	5 339	27,42	8,37
95% CI	15 850 - 22 438	3 825 - 7 986	23,18 - 32,81	6 - 12,52
2002	18 903	5 356	27,46	8,37
95% CI	15 851 - 22 708	3 852 - 8 148	23,03 - 32,99	6,02 - 12,73
2003	19 617	5 424	28,02	8,24
95% CI	16 376 - 23 545	3 931 - 8 424	23,39 - 33,63	5,97 - 12,8
2004	18 984	5 738	27,76	8,95
95% CI	15 877 - 22 722	4 151 - 8 789	23,22 - 33,23	6,47 - 13,71
2005	19 296	6 254	27,65	9,48
95% CI	16 111 - 23 139	4 501 - 9 556	23,09 - 33,16	6,82 - 14,49
2006	18 492	6 252	27,25	9,81
95% CI	15 502 - 22 079	4 531 - 9 372	22,85 - 32,54	7,11 - 14,7
2007	18 488	6 774	27,09	10,47
95% CI	15 505 - 22 044	4 942 - 10 023	22,72 - 32,3	7,64 - 15,49
2008	17 843	6 915	26,93	10,85
95% CI	14 952 - 21 247	5 032 - 10 205	22,56 - 32,06	7,89 - 16,01
2009	17 853	7 290	26,92	11,37
95% CI	14 941 - 21 221	5 292 - 10 723	22,53 - 32	8,26 - 16,73
2010	17 640	7 395	27,08	11,32
95% CI	14 827 - 20 929	5 378 - 10 972	22,76 - 32,13	8,23 - 16,8
2011	17 373	7 409	27,20	11,41
95% CI	14 660 - 20 580	5 422 - 10 977	22,95 - 32,21	8,35 - 16,91
2012	17 353	7 560	27,33	11,47
95% CI	14 706 - 20 519	5 549 - 11 215	23,16 - 32,31	8,42 - 17,01
2013	16 820	7 518	27,18	11,59
95% CI	14 289 - 19 899	5 539 - 11 175	23,09 - 32,15	8,54 - 17,22
2014	16 754	7 509	27,03	11,68
95% CI	14 308 - 19 771	5 582 - 11 135	23,08 - 31,89	8,68 - 17,31

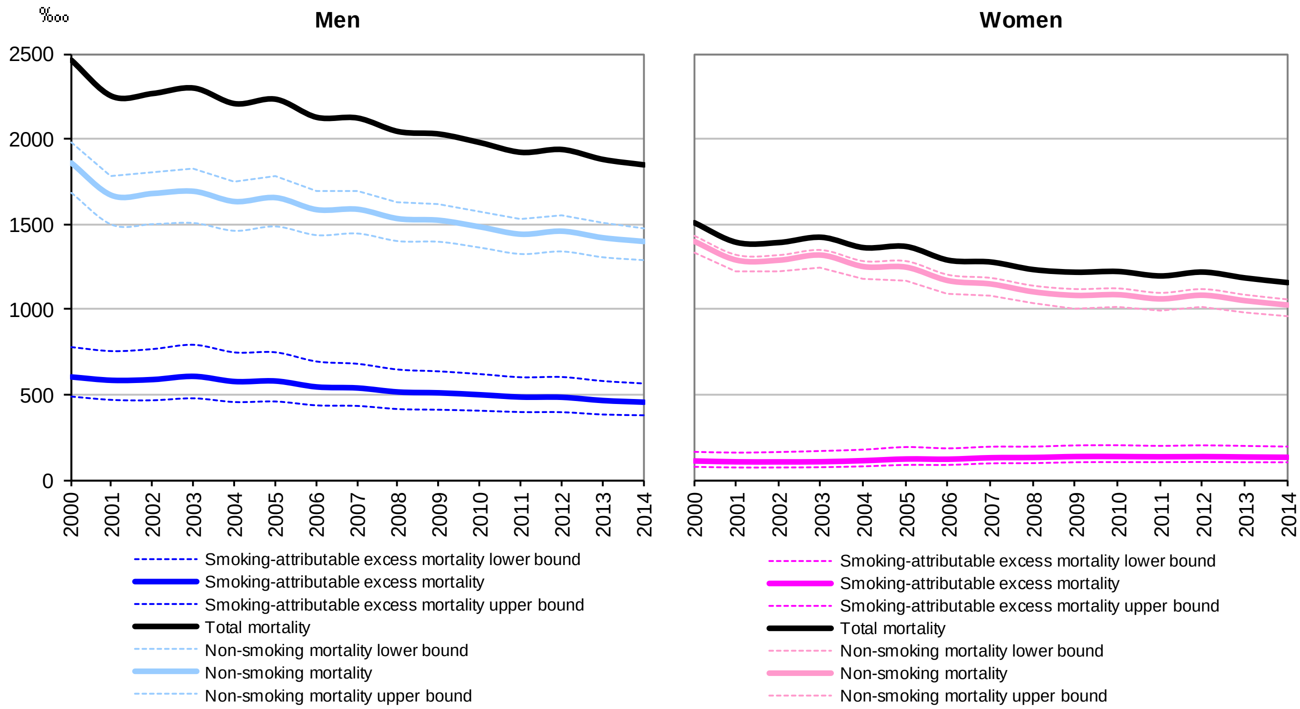
Source: own calculations

Figure 42: Estimated proportion of smoking-attributable excess mortality within total mortality by gender, 2014



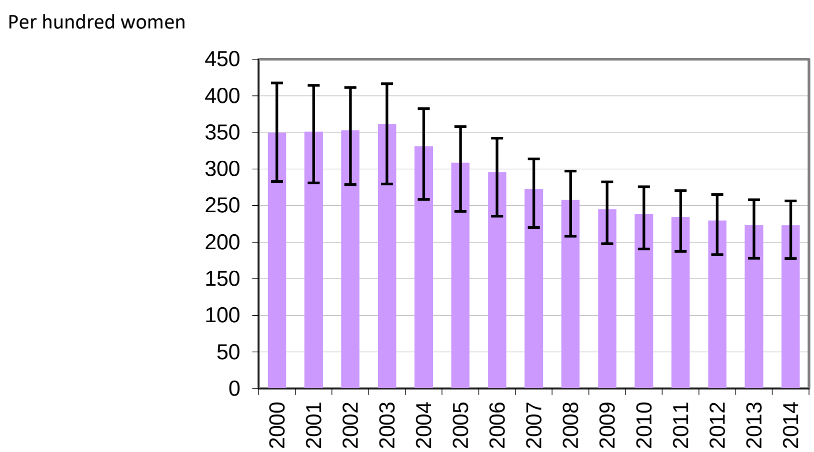
Source: own calculations

Figure 43: Smoking-attributable and non-smoking-attributable standardized death rate by gender, 2000–2014 (with a 95% confidence interval)



Source: own calculations, smoothing: spline interpolation

Figure 44: Smoking-attributable excess male mortality per 100 women, 2000–2014 (with a 95% confidence interval)

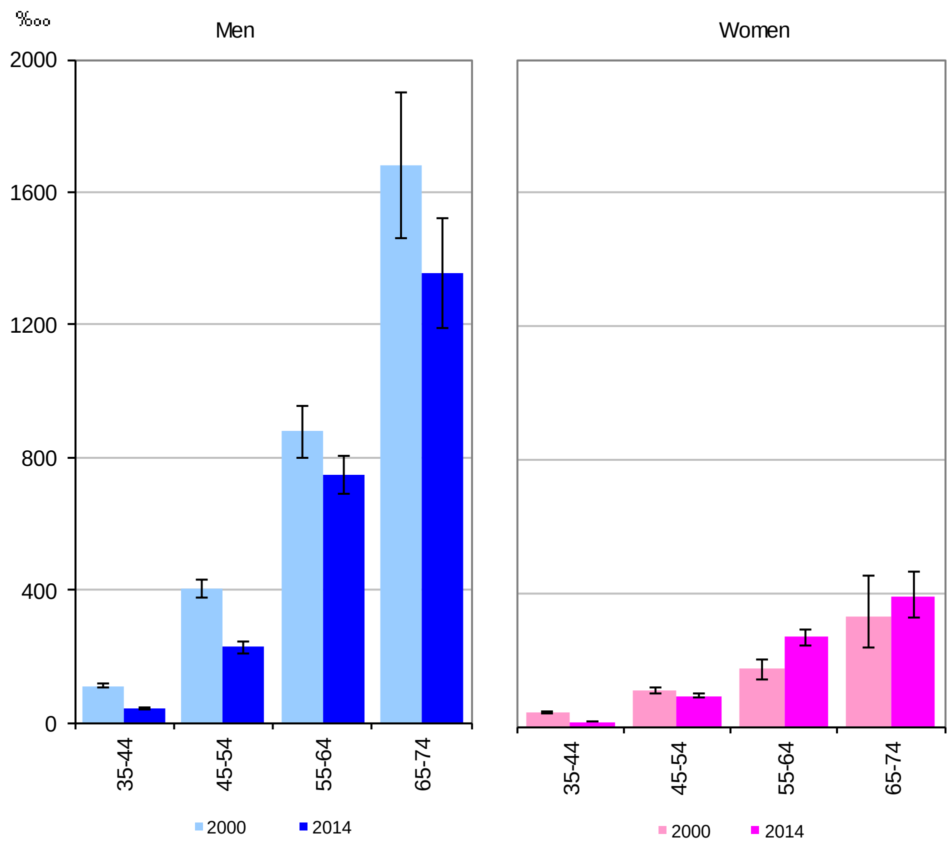


Source: own calculations

Age structure of smoking-attributable excess mortality

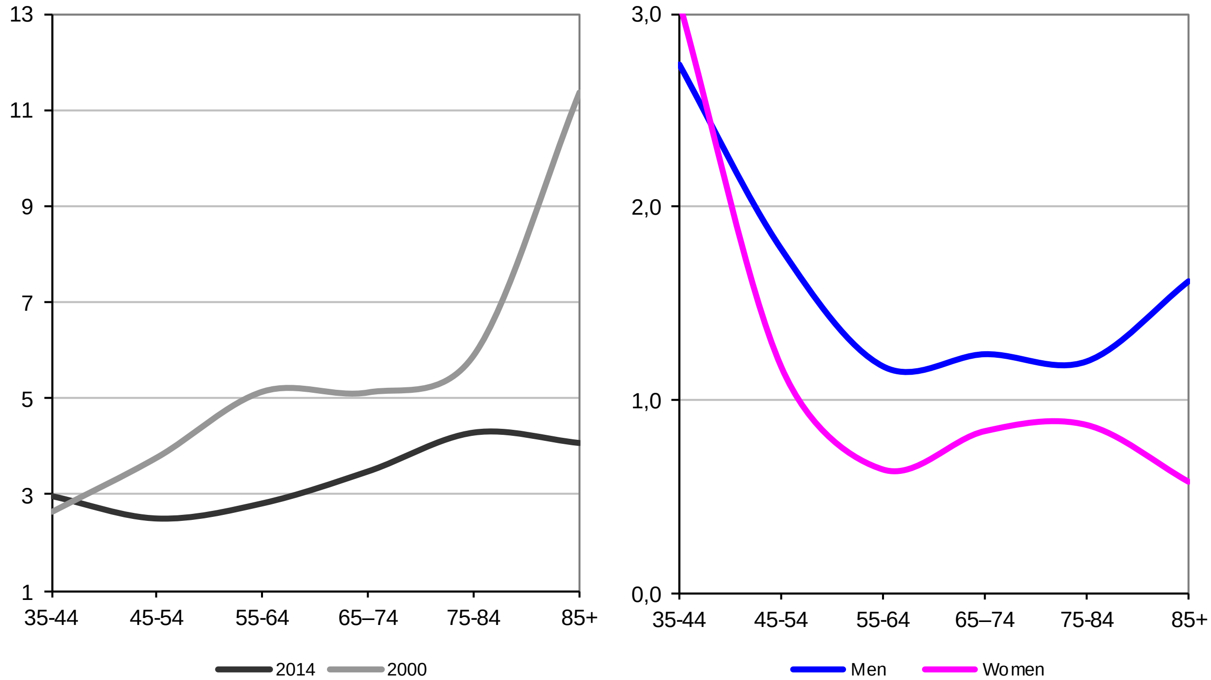
Examining the relative weight of each ten-year age group over 35 years, we can conclude that nicotine dependence requires more and more victims along with increasing age. Between 2000 and 2014, smoking-attributable standardized death rate of both sexes declined significantly in the 35–44 and 45–54 age groups: by 63% in the younger and by 44% in the older age group of men and by 67% and 15% respectively for women. By contrast, the rate grew significantly (by 56%) in the case of older, 55–64-year-old women. After one and a half decades, the gender differences, apart from the 35–44 age group, became considerably smaller in all ages, especially in the age over 85 years. (See Figure 9.) In 2014, these differences increased by the progress of age and grew from about three-fold in the age group of 35–64 to nearly four-fold over 65 years of age. In the reference period, the decline in smoking-attributable excess mortality was the largest in the 35–54 age group of both sexes. (See Figure 9.) In ages over 54, this figure was above 1 for men and below 1 for women, which means that the extent of smoking-attributable mortality of men decreased and that of women increased between 2000 and 2014.

Figure 45: Smoking-attributable standardized death rate by gender and age group, 2000 and 2014



Source: own calculations

Figure 46: Smoking-attributable excess mortality by age group (estimates): how many times it was greater for men than for women, 2000-2014 and how many times it was greater in 2000 than in 2014 by gender



Source: own calculations, smoothing: spline interpolation

Table 9: Smoking-attributable standardised death rate per 100 000 persons by gender and age group, 2000 and 2014

Year	35-44	45-54	55-64	65–74	75-84	85+	Sum
	year-old						
Men							
2000	110,1	404,2	880,9	1681,6	2096,4	4464,8	606,6
95% CI	103,2 - 116,1	377,9 - 427,9	798,7 - 957,6	1462 - 1898,8	1588,4 - 2757,1	2627,2 - 8264,9	489,6 - 781,1
2014	40,2	226,6	749,3	1357,5	1745,0	2763,2	456,1
95% CI	36,7 - 43,5	205,4 - 246,3	688,5 - 805,9	1190 - 1521,1	1350,1 - 2230,2	1785,9 - 4700,1	377,3 - 563,5
Women							
2000	41,6	106,9	171,3	328,2	355,4	393,5	109,6
95% CI	38,8 - 44,2	98,1 - 115,2	143 - 201,9	233,6 - 449,2	184,5 - 650	109,3 - 1207,7	76,3 - 167,1
2014	13,6	91,1	267,0	390,8	407,7	680,2	132,6
95% CI	12,1 - 15,1	84,0 - 97,8	244,2 - 289,0	324,6 - 465,1	231,4 - 681,6	203,2 - 2138,2	98,2 - 198,5

Source: own calculations

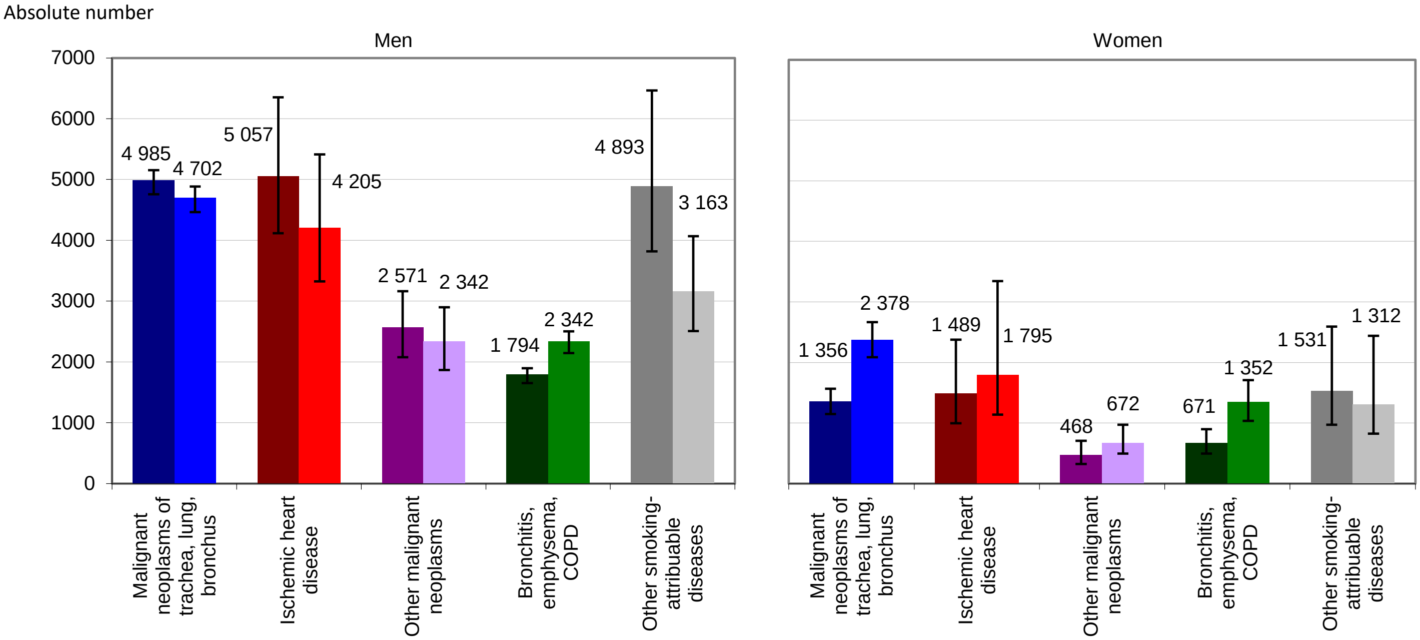
Causes of death structure of smoking-attributable excess mortality

In respect of public health, not only the age of a deceased smoker is an important issue but also the cause why the death has occurred. The latter can be analyzed by the structure of the causes of death, the change of which is basically influenced by two factors: 1. What progress has been made in medical science over the period in terms of curing and preventing a disease leading to death; 2. How the number of persons in the various age groups exposed to the possible cause of death (in other words, the age structure of the population) has changed.

In 2014, the most smoking-attributable deaths of men, a total of 4 702, were caused by malignant neoplasms of the trachea, bronchus and lung. Ischemic heart diseases are the second in the ranking with a similar value, followed by other malignant neoplasms as well as bronchitis, emphysema and COPD (chronic obstructive pulmonary disease) at a lower level. A more than 30% increase can be observed in mortality from the last four illnesses between 2000 and 2014, and by now their absolute number have reached the number of 2 342 of other malignant neoplasms.

Among women, trachea, bronchus and lung cancers were also the most dangerous, altogether 2 378 women died from these diseases due to their nicotine dependence. They were followed by ischemic heart diseases, bronchitis, emphysema, COPD and other malignant neoplasms. In 2014, 44% more women died of malignant neoplasms of the trachea, bronchus and lung and twice as many (numerically 1 352) smoking women deceased due to bronchitis, emphysema and COPD than at the turn of the millennium.

Figure 47: Absolute numbers of smoking-attributable excess mortality by gender and causes of death, 2000 and 2014



Source: own calculations

Based on the smoking-attributable standardized death rates per 100 000 persons in 2014, we can conclude that more than half of the smoking-related deaths of men was caused by malignant neoplasms of the trachea, bronchus and lung having the same weight and by ischemic heart diseases. Compared to the turn of the millennium, the relative relevance of each disease category associated with this harmful addiction has increased among men at the expense of other diseases. In the case of women, trachea, bronchus and lung cancers are responsible for one in every three smoking-attributable deaths. Note that the relative relevance of this dangerous disease group has increased by 7.7 percentage points since 2000. In contrast, ischemic heart diseases are responsible for one in every four tobacco-related deaths of women, and their relative importance has decreased by 3 percentage points since the turn of the millennium. Smoking-related mortality due to bronchitis, emphysema and COPD should be also mentioned as the relative relevance of these diseases showed a spectacular increase for both sexes in the last one and a half decades.

Table 10: Distribution of the estimated value of the standardized smoking-attributable death rate per 100 000 persons by gender and cause of death, 2000 and 2014 (percentage)

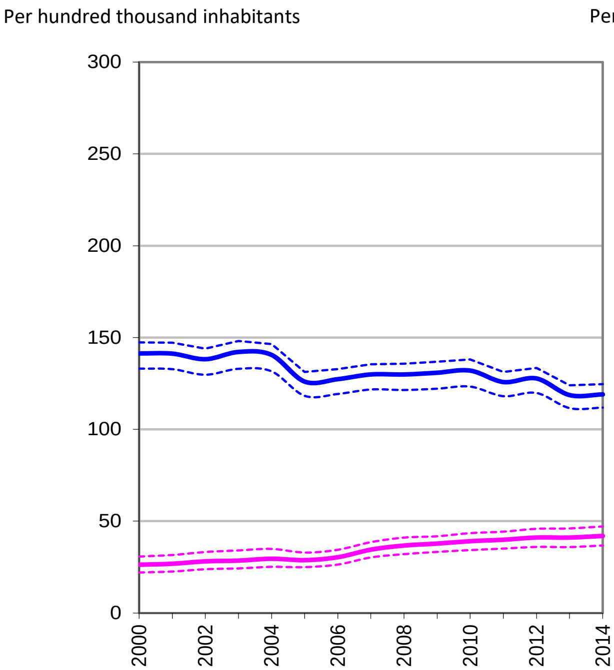
Year	Malignant neoplasms of trachea, lung, bronchus	Ischemic heart disease	Other malignant neoplasms	Bronchitis, Emphysema, COPD	Other smoking-attributable diseases	Total
Men						
2000	23,3	25,7	12,7	8,3	30,0	100,0
2014	26,1	26,0	13,5	11,5	22,9	100,0
Women						
2000	23,9	27,0	8,3	11,1	29,7	100,0
2014	31,6	24,0	8,8	15,9	19,7	100,0

Source: own calculations

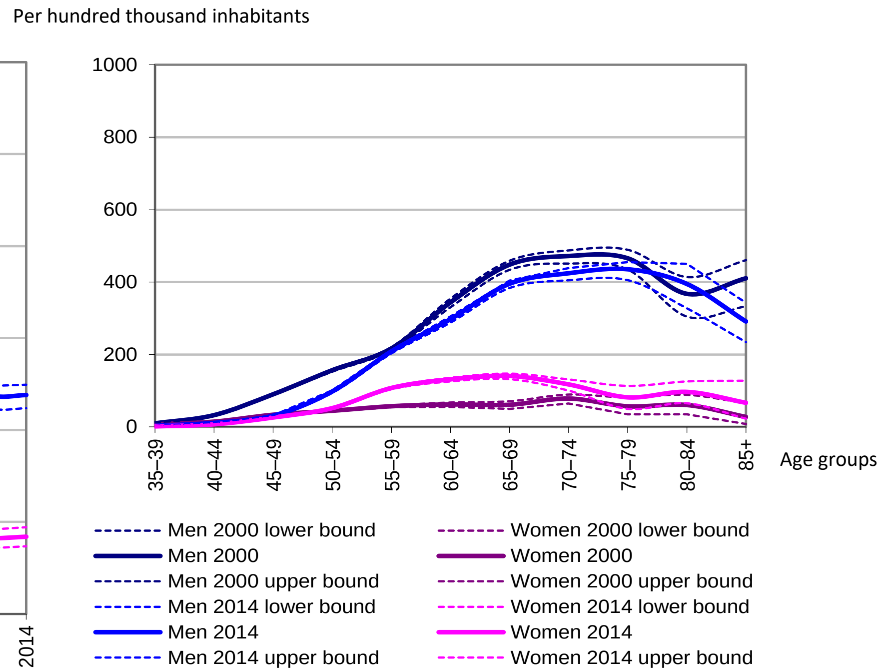
In 2014, trachea, bronchus and lung cancers as well as ischemic heart diseases were responsible for 52% of smoking-attributable excess mortality among men and for 56% among women. This justifies the detailed analysis of these two disease categories by gender, time series and age group. Another aim of this part of the research is to present the very different epidemiological nature of trachea, bronchus and lung cancers and ischemic heart diseases.

Between 2000 and 2014, the smoking-attributable standardized death rate due to malignant neoplasms of the trachea, bronchus and lung per 100 000 persons fell by 16% (with interruptions) for men and grew considerably, by 60% for women (the increase was continuous). The decrease in the age-specific rate of the 35–75 age group of men per 100 000 persons has contributed primarily to the decline, and the mortality of 50–70-year-old women caused by their alarmingly increasing nicotine addiction has been in the background of the high rise observed. About nine in every ten deaths of men due to lung cancer are related to smoking; the corresponding figure of women is less than 6-8. Between 2000 and 2014, this measure improved considerably among 35–50-year-old men and 35–45-year-old women. However, the opposite is true for 55–65-year-old, middle-aged women: the proportion of their smoking-attributable excess mortality showed a significant increase in deaths caused by malignant neoplasms of the trachea, bronchus and lung.

Figure 48: Smoking-attributable standardised death rate due to malignant neoplasms of the trachea, bronchus and lung per 100 000 persons by gender, 2000–2014

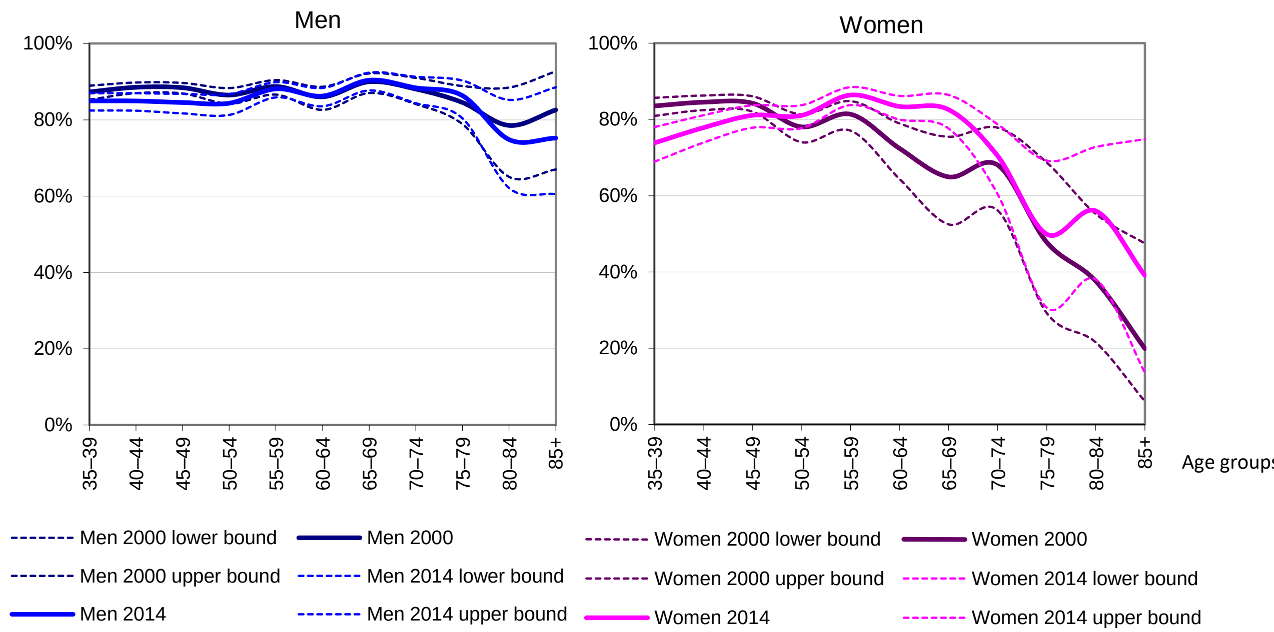


Age-specific smoking-attributable excess mortality caused by malignant neoplasms of the trachea, bronchus and lung per 100 000 persons by gender and age group, 2000 and 2014



Source: own calculations, smoothing: spline interpolation

Figure 49: Proportion of smoking-attributable excess mortality in deaths caused by malignant neoplasms of the trachea, bronchus and lung in the population aged 35 years and over by gender and age group, 2000 and 2014

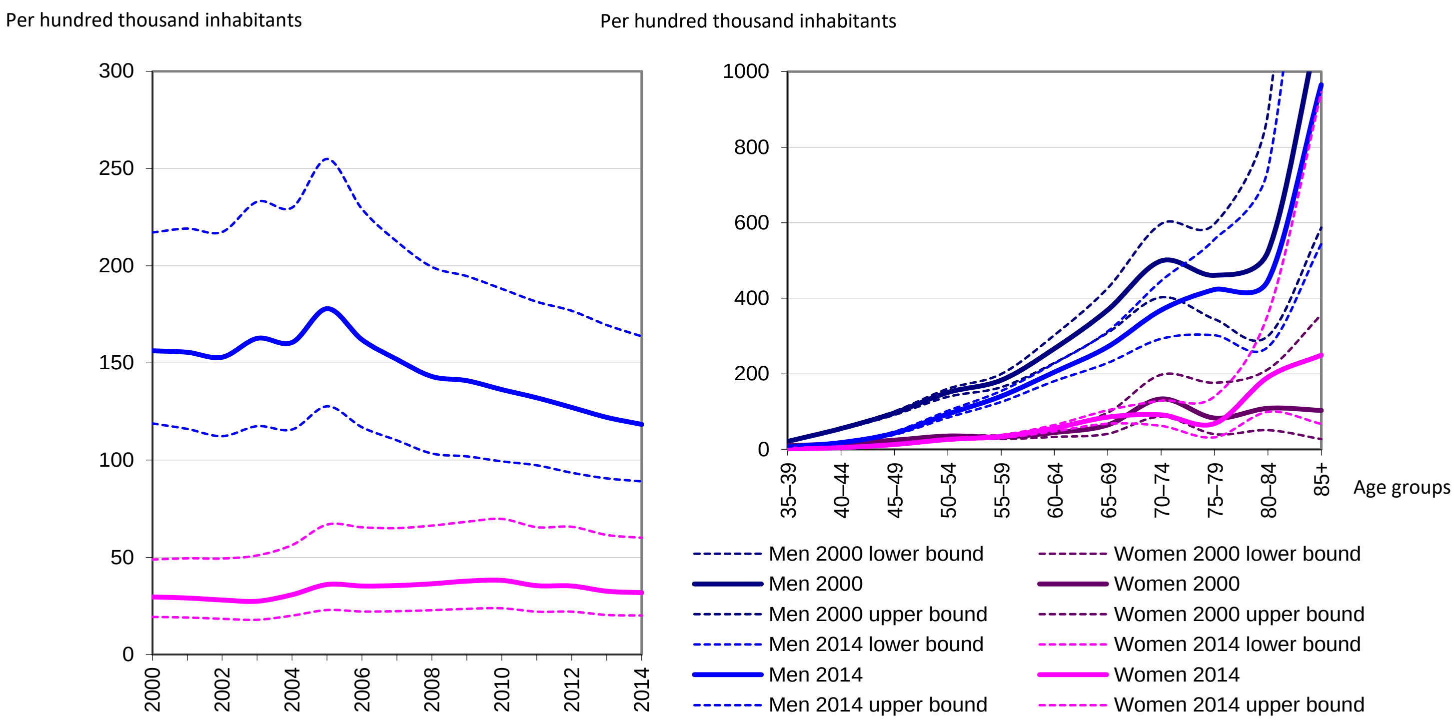


Source: own calculations, smoothing: spline interpolation

In the reference period, smoking-attributable death rate due to ischemic heart diseases per 100 000 persons, fell by 24% among men and rose by 7% among women. For the latter, the indicator peaked around 2010, and since then a slight decrease has been observed. In the case of men, the significant decline was owing to the moderate smoking of the 35–65-year-olds, while the age-specific indicator of women rose considerably only among the 60–65-year-olds. Examining the proportion of smoking-attributable excess mortality in deaths caused by ischemic heart diseases, we can conclude that generally fewer deaths can be associated with smoking than in the case of trachea, bronchus and lung cancers. As for smoking-related lung cancer, the value of the indicator improved significantly among men aged 35–50 years and women aged 35–45 years between 2000 and 2014. However, the 55–65 female age group is more affected nowadays by smoking-attributable mortality due to ischemic heart diseases than at the turn of the millennium.

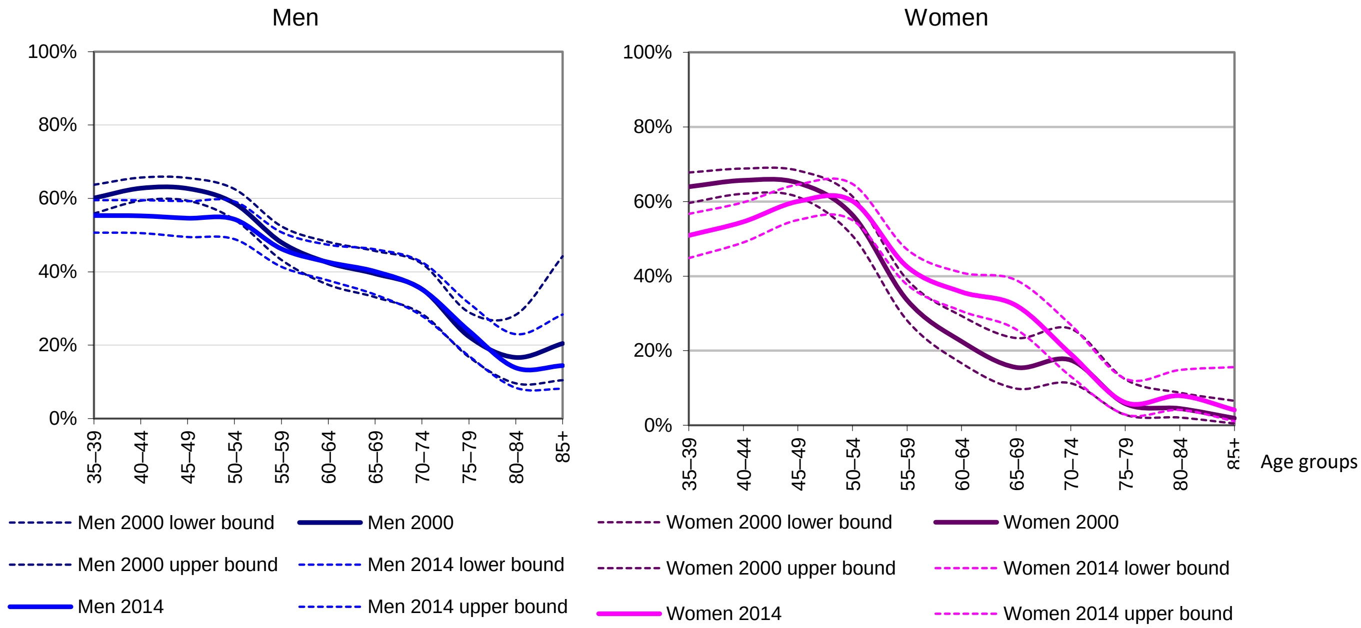
Figure 50: Smoking-attributable standardised death rate due to ischemic heart diseases per 100 000 persons by gender, 2000–2014

Age-specific smoking-attributable excess mortality caused by ischemic heart diseases per 100 000 persons by gender and age group, 2000 and 2014



Source: own calculations, smoothing: spline interpolation

Figure 51: Proportion of smoking-attributable excess mortality in deaths caused by ischemic heart diseases in the population aged 35 years and over by gender and age group, 2000 and 2014



Source: own calculations, smoothing: spline interpolation

The detailed analysis of smoking-attributable trachea, bronchus and lung cancers as well as ischemic heart diseases by gender, time series and age group reveals the very different epidemiological nature of these disease groups, too.

1. Naturally, smoking plays a role in a larger part of deaths caused by lung cancer than in deaths due to ischaemic heart diseases.
2. Nicotine-consumption-related, malignant neoplasms of the lung develop and lead to death at a younger age, therefore, they are faster in progression, spread and more aggressive than ischaemic heart diseases.
3. It is similar in both causes of death that the proportion of tobacco-related mortality within total mortality is generally higher in younger ages than among the elderly. Thus, the role of smoking in early mortality is significant, and – especially through lung cancer – results in a considerable number of years of life lost.

Years of life lost attributable to smoking

Table 11: Indicators[11] of years of life lost from the potential 70 years by gender, 2000 and 2014

Year	Absolute number of those deceased attributable to smoking under 70 years of age	Smoking attributable death rate within total mortality under 70 years of age (%)	Absolute number of years of life lost attributable to smoking from the potential 70 years	Standardised years of life lost attributable to smoking from the potential 70 years per 100 000 persons
Men				
2000	11 113	29,9	129 950	2 824
95% CI	10 124 - 12 038	27,3 - 32,4	120 321 - 138 777	2 608 - 3 023
2014	9 398	25,3	89 640	1 843
95% CI	8 554 - 10 187	23,0 - 27,4	81 872 - 96 864	1 682 - 1 992
Women				
2000	2 904	15,6	38 120	725
95% CI	2 444 - 3 425	13,1 - 18,4	34 095 - 42 263	648 - 805
2014	3 974	21,3	37 267	685
95% CI	3 584 - 4 358	19,2 - 23,4	34 023 - 40 392	626 - 742

Source: own calculations

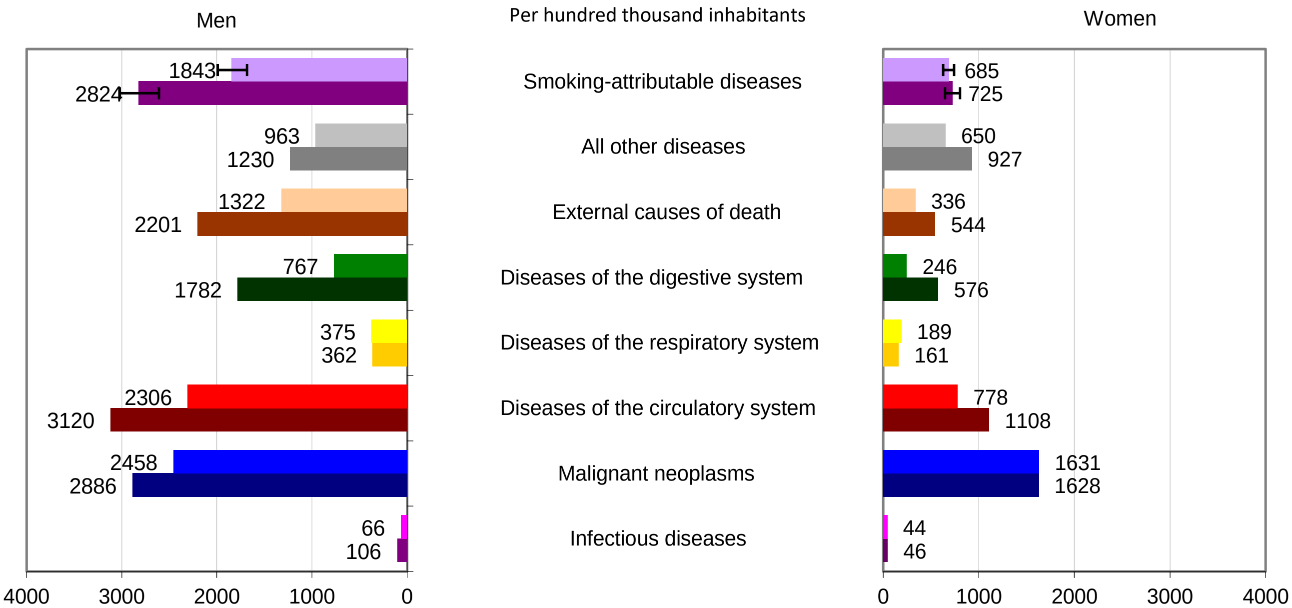
Since 2000, 1 715 fewer men and 1 070 more women younger than 70 years of age have died due to smoking, and as a result, the number of the former was 9 398 and that of the latter amounted to 3 974 in 2014. While the proportion of smoking-attributable deaths within total mortality of men under the age of 70 declined sharply in the reference period, it grew considerably among women. Nevertheless, the absolute number of years of life lost by women decreased between 2000 and 2014, which means that the age at smoking-attributable death shifted more and more to older age groups losing fewer years of life and approached 70 years.

Figure 52 shows the standard values of years of life lost from the potential 70 years per 100 000 persons by gender and cause of death for 2000 and 2014. The more than twenty causes of death attributable to smoking are combined in one category. This shares a common set with different groups, e.g. lung cancer with malignant neoplasms and ischemic heart diseases with diseases of the circulatory system. However, this duplication is not a problem if we want to draw attention to the number of years of life lost due to smoking, since it outlines the magnitude of

[11] See Appendix B and G for the calculation and population standard

smoking-attributable premature excess mortality compared to other main groups of causes of death (KSH, 2014 p. 37.).

Figure 52: Standardised years of life lost from the potential 70 years per 100 000 persons by gender and cause of death[12], 2000 (darker shade) and 2014 (lighter shade)



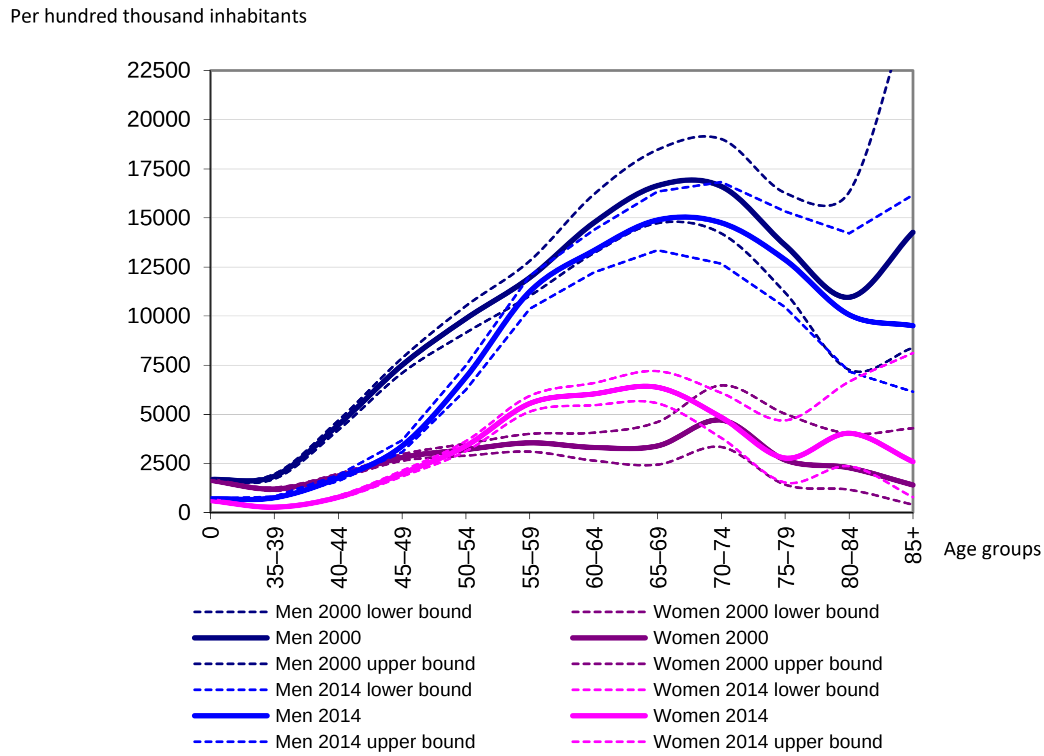
Source: own calculations

As far as years of life lost are concerned, the ranking of the main groups of causes of deaths is similar for both genders. Nowadays, most years of life are lost due to malignant neoplasms. These are followed by the diseases of the circulatory system and not much lagging behind, by the smoking-attributable excess deaths on the third place. It is noteworthy that nicotine dependence alone results in significantly more years of life lost than external causes of death (KSH [2014] p. 37.). It should be emphasized though that the extent of smoking-attributable premature mortality fell significantly among men in the past one and a half decades. Among women, however, premature mortality due to malignant neoplasms (including deaths caused by lung cancer) has increased notably.

[12] See Appendix B and E for the calculation and population standard

If we compare the years of life lost not to 70 years of age but to life expectancies in different age groups, we can examine older ages as well. In all age groups of men under the age of 55, the number of years of life lost attributable to smoking decreased considerably in the examined period. An important development was in 2014 that the 50–54 age group was a “watershed” among women compared to 2000. The indicator of years of life lost attributable to smoking compared to life expectancy per 100 000 persons by age group fell significantly under this age and increased considerably above this until 70 years of age.

Figure 53: Years of life lost attributable to smoking compared to life expectancy per 100 000 persons[13] by gender and age group, 2000 and 2014 (with a 95% confidence interval)



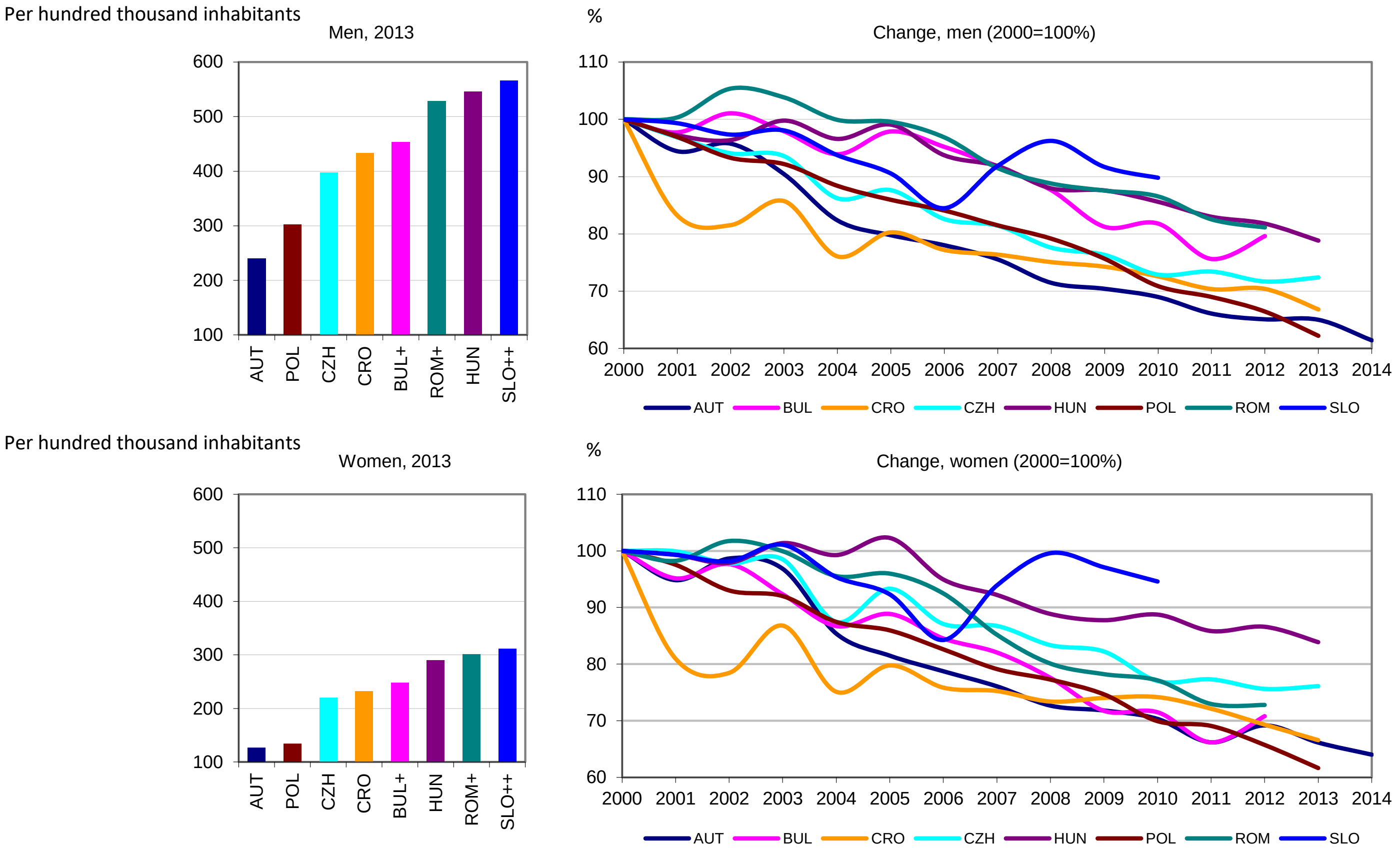
Source: own calculations, smoothing: spline interpolation

[13] See Appendix B and G for the calculation and population standard

International outlook

This chapter provides information on countries with similar culture, historical background and geographic features in the Central European region. By smoking-attributable mortality, these countries can be divided into three groups. Austria and Poland are in the first category where the value of this indicator is the lowest. The Czech Republic, Croatia and Bulgaria are in the second while Romania, Hungary and Slovenia are in the third group with the highest values. In the last one and a half decades, regardless of gender, the value of the smoking-attributable standardized death rate decreased significantly in each country, but the rate of decline was different. Among the countries of the region, except for Slovenia, the rate of mortality due to smoking fell to the smallest extent in Hungary. The lagging behind is especially high in the case of women: while the value of the indicator fell by only about 15% between 2000 and 2013 in Hungary, the decrease was approximately 40% in Poland. The situation in Austria is considered exemplary because the country has the lowest rate of smoking-attributable mortality in the Central European region and has experienced one of the strongest declines of this indicator since 2000, regardless of gender.

Figure 54: Smoking-attributable standardized death rate per 100 000 persons by gender and country, 2013, and its change by gender and country, 2000–2014[14]



+ 2012 data

++ 2010 data

Source: WHO-HFA database, smoothing: spline interpolation

[14] See Appendix H for the detailed sources

5.5. Discussion

Focusing on women

Basic theories

As we have seen, there are fundamental gender differences in the development of the smoking epidemic – including in the changes in premature smoking-attributable mortality. Put simply, bearing in mind the descriptive model of the cigarette epidemic, with its separate stages, recently we have witnessed a generally improving trend among men and a worsening trend among women. The problem is even more complex than it would appear at first sight: as Waldron (1991) suggests, historically improvements in women's rights and in gender equality have contributed to an increased acceptance of women smoking; but currently in our time, this relationship between smoking and attitudes toward women's rights and roles remains unclear. In terms of diffusion, it suggests that restrictions on women's behavior in the early 20th century contributed to the later spread of smoking among women, rather than among men.

Amos and Haglund (2000) examined this problem from a gender perspective. In their opinion, it is remarkable that within 50 years of the introduction of the mass-produced cigarette, smoking among women in North America and northern Europe had become socially acceptable – even socially desirable. This was due not only to the dramatic changes in the social and economic status of women over this period, but also to the way in which the tobacco industry capitalized on the changing social attitudes toward women by promoting smoking as a symbol of emancipation – a "torch of freedom". Moreover, in their paper they point out Hungary's particular exposure to this serious problem: "Some of the most blatant commercial targeting of women has occurred in the former socialist countries of Central and Eastern Europe, which are now exposed to the forces of 'free' markets, and which have the highest rates of female smoking in the world. Here cigarettes are promoted to women as a potent symbol of Western freedom, as in 'Test the West.' In Hungary, the slogan is 'Lady's first' (sic), while in the Czech Republic young women are encouraged to join men in their Western male leisure pursuits. Smoking rates among young women in these countries are increasing much more rapidly than in countries where smoking took off earlier this century" (Amos and Haglund, 2000).

Pirie et al. (2013) made a quantitative analysis of the increasing prevalence of female smoking. In their study, a huge number of UK women – 1.3 million – were recruited in 1996–2001 and resurveyed postally about three and eight years later. All were followed up until 2011 through national mortality records. Participants were asked, when they first joined the survey group, whether they were current or ex-smokers, and how many cigarettes they currently smoked.

The researchers came up with three main conclusions, following analysis of the data. First, during the 12-year mortality follow-up, those who had been current smokers at baseline had an overall mortality rate that was almost three times the rate of those who had never smoked. Secondly, the age at which women first started smoking regularly affected overall mortality decades later: those who had started at about age 15 were at greater risk than those who started only four years later. Thirdly, smokers who stop at about the age of 40 avoid about 90% of the excess hazard among continuing smokers, whereas those who stop at about the age of 30 avoid about 97% of it (Pirie et al., 2013).

In their study, Gregoraci et al. (2017) measured socioeconomic inequalities in smoking-attributable mortality and their contribution to inequalities in total mortality in 1990–1994 and 2000–2004 in 14 European countries. They found that since 1990–1994, absolute inequalities in smoking-attributable mortality and the contribution of smoking to inequalities in total mortality had both decreased in most countries among men, but had increased among women. According to their conclusions, in many European countries, smoking has become less important as a determinant of socioeconomic inequalities in mortality among men, but not among women (Gregoraci et al., 2017).

Hungarian women

The age-specific smoking-attributable mortality analysis revealed that the situation of Hungarian women aged 50–70 worsened significantly between 2000 and 2015; meanwhile, in the younger age groups, a slight improvement can be observed. This shows the presence of a strong cohort effect in the Hungarian population, meaning that the female cohorts born between 1945 and 1965 are more affected by the habit of smoking and are generally more likely to persist with unhealthy lifestyles and other risk factors, carrying them over from the past. But, of course, the overall picture is more complex. For instance, with the collapse of state socialism, this generation quite suddenly found itself part of a new world order in the early 1990s. Faced with increasingly individualized and competitive conditions, Hungarian women had to rebuild their own individual strategies. At the same time, these goals could contradict family and gender relationships, and the division of labor within the family.

Utasi (2011) examined the factor of subjective tension and work stress in the life of married women in 24 European countries, based on the 2005 European Social Survey. The key concept of her analysis was the "double workload" (a notion that originated with the early suffragettes; and indeed Marx and Engels used the expression "the double burden", as it is usually translated, in their works on female emancipation as long ago as the 1870s and 1880s). This refers to family tension arising from the reconciliation of housework and paid labor, and to the fact that women are more exposed to this effect. According to multi-dimensional research, the overwhelming majority of countries with high levels of work-related stress are in the former socialist bloc. According to Utasi, the responses of people living in Central and Eastern Europe are colored by fear of losing their jobs – a fear that is much more prevalent in the post-transition period than previously. However, it should also be noted that while Central and Eastern European women and men both experience the highest reported level of work-related stress, wives in this region still report significantly higher levels of negative stress than husbands, since female emancipation is less advanced. Traditional expectations in terms of the division of labor at home are higher, while the technical-civilization level is lower than in other regions (Utasi, 2011).

Lurking behind the worsening smoking-attributable situation of middle-aged and older women could be the accelerated emancipation and the blurring of the borders between gender roles. At the same time, the higher rate of premature death among men, alongside the phenomenon of divorce, may fundamentally alter the family ties and situation of middle-aged women. Coping with the new situation could lead to greater stress, which could encourage women smokers to increase their tobacco consumption. (KSH, 2014)

5.6. Conclusions

We used Hungarian, Austrian, and American data to gain a comparative picture of the Hungarian situation. In the case of Hungarian men, the greater destruction compared to the benchmark countries, initial advance and subsequent retreat of the smoking epidemic is evident; this is largely due to the epidemiological crisis characteristics of Hungarian society before the regime change in 1989. In the case of women, more traditional gender roles previously dominated society in Austria and Hungary in a way that was different from the USA; these social norms to some extent protected Central and Eastern European women from even greater harm arising from the cigarette epidemic. But at the same time, the picture is complex: in the over-50 age groups, the increased smoking-attributable mortality is holding back improvement in women's early mortality. Furthermore, the critical tobacco-related causes of death have been identified in Hungary from 2000 until 2015 in some detail. The results demonstrate that there are fundamental differences in the degree of health awareness between the younger and the older cohorts of the Hungarian female population. If we examine this problem more closely, we find that middle-aged and older Hungarian women smokers were the unprotected population targeted by the tobacco industry in the critical and challenging times around the regime change. Analysis shows that a strong cohort effect can be observed in the Hungarian population, meaning that female cohorts born between 1945 and 1965 are more affected by the habit of smoking and its consequent harm, and this is probably also related to the phenomenon of the "double workload." The research shows that – due to the progress and nature of the smoking epidemic – sex differences in Hungary are going to decrease substantially in the future. This is also supported by the results of the smoking-attributable mortality figures, where in every age group, and for almost all causes of death, the sex differences have declined sharply in Hungary since the turn of the millennium.

The detailed examination of the causes of death structure revealed that chronic diseases, i.e. malignant neoplasms (especially lung cancer) and the diseases of the circulatory system, are the most dangerous for smokers and ex-smokers of both genders. At the same time, the very different epidemiological nature of smoking-attributable trachea, bronchus and lung cancers and ischemic heart diseases is revealed, too: malignant neoplasms develop and lead to death at a younger age, therefore, they are faster in progression and are more aggressive than ischemic heart diseases. In this respect, the situation of smoking women is especially alarming: the smoking-attributable standardized death rate due to trachea, bronchus and lung cancers grew drastically between 2000 and 2014. In addition, the examination of years of life lost revealed that the relevance of smoking-related diseases has overtaken that of external causes of death for both genders. Due to the magnitude of excess mortality caused by this addiction, smoking has had a significant impact on Hungary's mortality from the turn of the millennium until now. Nicotine dependence has considerably slowed down the downward trend in mortality between 2000 and 2014; its contribution to the natural decrease was determinant (KSH, 2014). In the past one and a half decades, this addiction claimed more than 370 thousand lives in Hungary. The country struggling with the negative inheritance of the socialist era. Nevertheless, it has been able to make some efforts in the recent past to protect its population against the spread of the smoking epidemic – for instance, the steady increase in the extra tax on tobacco and the smoking ban in all enclosed spaces since 2012; but there should be no let-up in the battle against the smoking epidemic. As Vokó (2009) states, effective means of combating smoking are well known. Hungary has taken some important steps in the past two decades, but these have been too little and not effective enough. Stopping this entirely preventable epidemic must now rank as a top priority in public health policies (Vokó, 2009). This research has demonstrated that the female population should be a key target for policy intervention. It should be stressed that there is still a lot to be done in the field of improving smoking-attributable mortality conditions in Hungary, which is also proven by the fact that, according to the international outlook, the lagging behind of Hungary is significant compared to the other countries of the region.

6. Discussion and conclusion

This research aimed to explore in depth the phenomenon of early cancers through the epidemiological transitions in Hungary, Austria and Denmark. For the non-secret purpose that to draw (and borrow) conclusions from the western societies, in order to suppress the huge cancer burden of Hungary. The epidemiological crisis characteristic of socialist systems is the key factor, in that the life expectancies of the Eastern bloc are far below those of the West. At the same time, the epidemiological renewal lasts for a quarter of a century, but the question still remains open: can life prospects of the east ever catch up with the west? On one hand, Jasilionis recommends that, "in all new EU member states, further progress requires much more systematic efforts in combatting cardiovascular diseases and persisting burden of excess male mortality at adult ages" (Jasilionis et al., 2018) On the other, somewhat contradictory Meslé and Vallin states, that "For countries like Poland or Czech Republic (including Hungary, Romania and Bulgaria as well), the main uncertainty no longer concerns cardiovascular and/or man-made diseases at working ages but rather their capacity to follow Western countries like France or Japan which are starting to reduce mortality at old and very old ages. This will call for further adaptation of their health systems to address the needs of the elderly population, in terms of both living arrangements and health care provision." (Meslé and Vallin, 2017).

However this research complements these statements by cancer mortality for both sexes must be in the center of attention as well. Moreover, it proved the fact that, the wave of the epidemiological crisis in the period of renewal manifested in high-level cancer mortality and increasing relative relevance of neoplasm deaths in Hungary. One of the main reasons for this may be that medical sciences has allowed a much more effective therapy for cardiovascular diseases, as opposed to malignant tumors and the realized curability of cardiovascular diseases push the fragile-health crowds towards to cancer illness as a competing risk, in the post-socialist societies. This analysis proved, that in the background of the premature cancer mortality a so-called 'triangle' can be identified in all countries with advanced health culture. This means that the mortality of lung, breast and colon cancers, are responsible for around the half of the early cancer deaths in total and within this, smoking-attributable cancers plays the most important role. At the same time, this research revealed the main challenges in the era of Epidemiological Renewal in Hungary. Firstly, prevention of colon cancers, for the reason, that there is no such reasonable development in their mortality concerning all age groups for both sexes in the period 1994-2015, contrary to Austria and Denmark. Secondly, the suppression of gynaecological cancers, because there is no significant improvement in all female age groups in the observed period, besides this, these neoplasms are widely avoidable at the current level of health care**.** Thirdly, to continue the fight against breast cancer, for the reason that, the situation of the breast cancer patients diagnosed in the age of 50s is particularly dangerous: they are living the two-third of the life of the 50 and 60-79 year-olds.

Returning to the important issue of smoking, the single most important preventable main risk factor for the healthy life is still tobacco consumption. As we have seen above, this addiction has greatly contributed to the initiation of divergence cycles in the development of life expectancies, triggering negative cohort effects in certain populations. This phenomenon was verified in all three societies by this research. Firstly in Austria, however there seemed to be no stoppages in the rise in life expectancy, a latent third cycle held back the lengthening life expectancies by the 50-75 year-old women, between 1994 and 2015. Secondly in Denmark, a clear third cycle affected the Danish female mid-war generations, as a result the life expectancy at birth for women stagnated in the period 1977-1995. Thirdly in Hungary, a second and a third divergence cycle both hit the population. Earlier, mostly the Hungarian middle-aged men during the epidemiological crisis, then recently from 1994 to 2015, the 50-75 year-old female cohorts were affected, similarly to the Austrian situation. At the same time, the above discussed stage theory of the descriptive model of the smoking epidemic predicts, that smoking-attributable mortality will be lost its relevance in overall mortality in the near future, along with a significant narrowing of gender differences. Nevertheless, this research draws attention to the vulnerable cohorts in term of health of the middle-aged and older Austrian and mostly Hungarian women. They - alongside with the younger generations - should be really in the focus of the primary and secondary prevention strategies, public health campaigns, healthy lifestyle promotions and the fight against smoking should never stop. Furthermore in the Hungarian healthcare system there are still a lot of things to do, for instance improve the accessibility and the quality of health care, e.g. directing patients to medical centers where there is greater therapeutic and healing experience. This summary also emphasizes that in the near future Hungarian social system will face a huge challenge: large number of "Ratkó grandchildren" will enter into old-age and they are going to place a heavy burden on the health care system among others. Social and medical sciences and advanced countries has already revealed the solutions and the good practices long ago to suppress the burden of early deaths. For this reason the rest of the noble task falls on the Hungarian national health decision makers to implement these already known tools and actions. To solve this problem, this research can offer the particularly advantageous statistical tool of life expectancy at diagnosis. All in all, according to the best of our knowledge, the solution to this huge task is impossible without significant investment in health of the human resources, because only this can guarantee the market competitiveness in today's world.

6.1. Theses

a-b. Fundamental theories and explorative and descriptive data analysis

- The epidemiological crisis characteristic of socialist systems is the key factor, in that the life expectancies of the Eastern European bloc are far below those of the West. The cardiovascular revolution appeared more than three decades later in Hungary, than in Austria and Denmark.

- Will the east ever be able to catch up with the west? Critical middle-aged mortality significantly dropped in Hungary in the period of the epidemiological renewal, however it would be important to reduce old-age mortality. (Meslé and Vallin, 2017)

- The wave of the epidemiological crisis and the cardiovascular revolution in the period of renewal manifested in high-level cancer mortality and increasing relative relevance of neoplasm deaths in other words, a cancer crisis in Hungary. Medical sciences has allowed a much more effective therapy for cardiovascular diseases, as opposed to malignant tumors and their realized curability push the fragile-health crowds towards to cancer illness as a competing risk, in the post-socialist societies.

- In all three examined countries, the relative relevance of cancer mortality (the percentage of cancer deaths in the premature mortality) significantly increased, particularly among Hungarian women. Consequently, this is one of the biggest challenge for contemporary Hungarian and international epidemiology. (Józan, 2005)

- A favourable development, that both sexes make a significant contribution to increasing life expectancy at birth at younger ages in Hungary. This means, that if there is no determinative change in the future, the Hungarian population has good chance to prolong its life prospects.

- In the background of the premature cancer mortality a so-called 'triangle' can be identified in all countries with advanced health culture. This means that the mortality of lung, breast and colon cancers, are responsible for around the half of the early cancer deaths in total and within this, smoking related cancers plays the most important role.

- Contribution of cancer localizations and population groups to the increasing life expectancy in the epidemiological renewal in Hungary, which means improvement, can be observed in case of men under age 50 neoplasms related to smoking, above age 50 stomach cancers. Considering women, under age 55 breast tumors and under age 45 neoplasms related to smoking.

- Cancer localizations and population groups, which have no contribution or braking the increasing life expectancy in the epidemiological renewal in Hungary, which means deterioration, in colon cancer in all age groups for both sexes (unlike Austria and Denmark), 50-75 year old women smoking related cancers (also in Austria), in gynecological neoplasms in all age groups (unlike Austria and Denmark) and above age 55 breast cancers.

- Identified strong health cohort effects: in Denmark the third divergence cycle (cohorts born between 1915 and 1945), in Austria the same in a 'latent' form (50-75-year old women), in Hungary second and also third: middle-aged men in the epidemiological crisis and 50-75-year old women in the renewal. (Meslé and Vallin, 2017) This is the greatest identified obstacle to the Hungarian women's life prospects catching up with Western populations.

- Recovery of Denmark from the negative cohort effect: as a selection effect the extinction of the whole mid-war female generations. Healthier lifestyle: limitation of smoking and alcohol consumption, promoting physical activity and the implementation of the so-called Heart Plan health intervention. (Lindhal-Jacobsen et al., 2016)

c. Survival analysis of Hungarian cancer patients and the life expectancy at diagnosis

- The women in their in 50s who were diagnosed with breast cancer in 2013, lived only the two-third of the life of the 60-79 year old patients. The females who are under age 50 and diagnosed with colon cancer live a shorter life, than the older ones, between age 50-79. The youngest age group of women with a lung cancer can expect a shorter life than those who are 50-69 years old. Men in their 50s with colon tumor, live less than the 60-79 aged patients.

- Life expectancy at diagnosis: How many days a patient diagnosed with a particular disease can expect based on their particular demographic characteristics? It can identify groups at risk of certain diseases in society. It is suitable for measuring the effects of various (experimental) therapies, medications and physical interventions in clinical trials. It can be used to compare populations which were exposed to various health risks during their lifetime (smoking, alcohol consumption). With the application of record linkage unique researches could be conducted broken down by i.e. educational attainment, marital status or economic activity. The methodology can be applied to cases with a small number of items and to short-term follow-up.

d. Global smoking epidemic and the smoking-attributable mortality in Hungary

- The global smoking epidemic was the most destructive among Hungarian men compared to Americans and Austrians. In all three cases, prevalence and smoking-related mortality also decline.

- Hungarian and Austrian women are half century behind the peak of the epidemic in the United States and the harmful effects are also less. Hopefully, in case of the European countries the prevalence peaked, however the smoking-related mortality will surely increase in the near future.

- The gender gap in smoking-related mortality will be significantly reduce in the future.

- Compared to the USA, Austrian and Hungarian societies may be characterized by more traditional gender roles and associated cultural norms, all of this may have reduced the harmful effects of the cigarette epidemic to Central European women.

- There is a strong negative cohort effect in the Hungarian female population born between 1945 and 1965, largely due to smoking.

- Different epidemiological nature of smoking-attributable trachea, bronchus and lung cancers and ischemic heart diseases is revealed, too: malignant neoplasms develop and lead to death at a younger age, therefore, they are faster in progression and are more aggressive than ischemic heart diseases.

- The situation of smoking women is especially alarming: the smoking-attributable standardized death rate due to trachea, bronchus and lung cancers grew drastically between

2000 and 2014. In addition, the examination of years of life lost revealed that the relevance of smoking-related diseases has overtaken that of external causes of death for both genders.

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Data sources

1. Human Mortality Database (HMD), mortality.org
2. WHO-HFA database, http://data.euro.who.int/hfadb/
3. Eurostat Database, https://ec.europa.eu/eurostat/data/database
4. The World Bank Databank, https://databank.worldbank.org/data/home.aspx
5. For the calculation of the smoking-attributable mortality in Hungary: see detailed method in Wéber (2017)
6. Hungarian Central Statistical Office – Death Register
7. Number of deaths by sex, age group, causes of death
8. National Population Health Survey 2000 and 2003 (Országos lakossági egészségfelmérés) and European Health Interview Survey (EHIS) 2009, HCSO
9. EHIS, 2014 - for the year 2014 smoking prevalence in Hungary. Source: and European Health Interview Survey (EHIS) 2014, HCSO
10. Prevalences and their 95% confidence intervals, by sex, age group, smoking status

Appendix

Appendix A

Calculation of the coefficient of variation for life table:

$$CV = \frac{\sqrt{\sum_{x=0}^{\omega} d_x (x + a_x - e_0)^2}}{e_0}$$

where x refers to the age-groups, d_x is the number of deaths in each age-groups, a_x is the parameter to estimate mid-term mortality, e_0 is the life expectancy at birth.

Appendix B

Data sources

Data for the Hungarian population and mortality from 2000 to 2014 are from the Population and Death Database of the Hungarian Central Statistical Office. The basis of the annual population numbers are the censuses 1 February 2001 and 1 October 2011 and the back-, and further calculations from them. The complete mortality data broken down by sex, age and causes of death are recorded on the Certification of death (CD) and the Death Record.

Categories of data used and examined

Sex: male, female

Age-groups (reached age): 0, 1-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 70-74, 75-79, 80-84, 85+

Cause of death: the recorded disease in the column of underlying cause of death. In the research period the classification was carried out according to the 10th revision of the International

Classification of Diseases (ICD-10). The method of processing causes of death has changed since 2005. Manual coding has been replaced by automated processing in which the coding of diagnose texts and the selection among underlying causes are carried out by a software. Therefore, there are breaks in the time series of causes of deaths data between 2004 and 2005.

Calculation of mortality rates (Józan-Radnóti, 2002, 40)

The rate of the absolute number of deaths and the mid-year number of population at risk of passing away in the same observed period.

$$m = \frac{D}{P}$$

D: number of deaths

P: mid-year population

m: mortality rate

Potential Years of Life Lost (PYLL) (Radnóti, 2003)

This indicator, which is widely used in statistics, summarizes the remaining non-lived lifetime of the dead members of the population, with a reference of a specific age. The age limit is chosen arbitrarily, in this research we use 70 years similarly to the international practice. Thus, if someone dies younger than the reference age (70 in this case) at age x, the number of lost years of life is in case of $x < 70$ is $70 - x$. If the individual dies older, than the age of 70, the value of the indicator is logically 0 (KSH, 2014, 22). We calculate the indicator for every 5-year age group per hundred thousand inhabitants and then standardize the results based on the Eurostat population standard according to the official recommendations. As a result we get a standardized indicator, which is sensitively quantify the premature mortality in a given population.

Total number of life-years lost out of the potential 70:

$$PYLL_{70} = \sum (70 - x_i) * D_i$$

Di: number of deaths per age-group

xi: average age of the deceased of the specific age groups

Age-specific ratio of life-years lost compared to age by age groups:

$$\sigma_i = \frac{\sum(70 - x_i) * D_i}{P_i}$$

Pi: mid-year population

Standardization (Józan-Radnóti, 2002, 40)

Applying the method of direct standardization: the indicator was calculated as standardized for the age composition of the European population in 2012, calculated per hundred thousand inhabitants and as recommended by Eurostat.

$$m^s = \frac{\sum P_i^s m_i}{\sum P_i^s}$$

ms: standardized mortality rate

Pis: standard population

mi: age-specific mortality rate

European Population Standard

Age-group	Standard population
0	1000

1-4	4000
5-9	5500
10-14	5500
15-19	5500
20-24	6000
25-29	6000
30-34	6500
35-39	7000
40-44	7000
45-49	7000
50-54	7000
55-59	6500
60-64	6000
65-69	5500
70-74	5000
75-79	4000
80-84	2500
85-89	1500
90-94	800
95+	200
Total	100000

Source: Revision of the European Standard Population (2013) - Report of Eurostat's task force. Eurostat, European Commission

Appendix C (Madigan, 2004)

We are assuming that the time-to-event follows a Weibull distribution,

Hazard function:

$$h(t) = \alpha\gamma t^{\gamma-1}$$

Survival function:

$$S(t) = \exp\left(-\alpha t^{\gamma}\right)$$

Example for breast cancer patients less, than 49 years-old:

```
> s.49br <- survreg(Surv(life, status) ~ 1, data = agegroup1, dist = "weibull", scale = 0)
> summary(s.49br)

Call:
survreg(formula = Surv(life, status) ~ 1, data = agegroup1, dist = "weibull", scale = 0)
             Value Std. Error     z         p
(Intercept)  8.860      0.381 23.24 1.72e-119
Log(scale)  -0.197      0.141 -1.39  1.63e-01

Scale= 0.821

Weibull distribution
Loglik(model)= -447.1   Loglik(intercept only)= -447.1
Number of Newton-Raphson Iterations: 12
n= 1100
```

The formula of the fitted survival curve:

$$S(t) = \exp\left(-\exp\left(-\frac{8.860}{0.821}\right)\right) t^{1/0.821})$$

Appendix D (for Figures 26, 27, 28)

Smoking prevalences are measured by:

Thun et al, 2012 – *“Data on adult smoking prevalence from 1965 to 2010 represent measurements from the USA National Health Interview Survey. Projections through 2025 estimated based on current trends in early middle-age”*

Tombor et al, 2010 - for the year 1984 and 1994 smoking prevalence in Hungary. Sources: Microcensus 1984, „Data collection on health status”, 1994, HCSO

Bőti et al, 2011 - for the year 2000, 2003 and 2009 smoking prevalence in Hungary. Sources: National Population Health Survey 2000 and 2003 (Országos lakossági egészségfelmérés) and European Health Interview Survey (EHIS) 2009, HCSO

EHIS 2014 - for the year 2014 smoking prevalence in Hungary. Source: and European Health Interview Survey (EHIS) 2014, HCSO

Thompson et al, 2013 - for the year 1972, 1979, 1986, 1997 and 2006 smoking prevalence in Austria. Source: Table 1 - Prevalence of smoking (in percent) by sex and age group for selected survey years, age-specific prevalence values averaged

WHO-HFA, 2014 - for the year 2014 smoking prevalence in Austria. Source: WHO – Health for All Database: https://gateway.euro.who.int/en/indicators/hfa_421-3010-of-regular-daily-smokers-in-the-population-age-15plus/

Smoking-attributable deaths are measured by:

Thun et al, 2012 – *"Smoking-attributed deaths estimated indirectly from lung cancer rates and expressed as a percentage of all deaths"*[15]

Appendix E

Smoking-attributable excess mortality by causes of death

The concept of the method was elaborated by Levin [1953], was used later by Shultz [1991], and in the 1990s, it was built into the internationally recommended methodology of the project of CDC (Centers for Disease Control and Prevention) titled SAMMEC (smoking-attributable mortality, morbidity and economic costs). This was applied to domestic conditions by Józan and Radnóti in 2002, its updated version was used by Vitrai and his co-authors in 2012 and by Wéber and Faragó in 2014 and by Weber in 2016. This research uses the latest available version of the method, which was developed in 2013 and its description was published in 2014 in the summary volume titled 'The Health Consequences of Smoking – 50 Years of Progress: A Report of the Surgeon General'. The renewed methodology includes, among others, the quantification of deaths caused by passive smoking as well.

[15] Peto, Lopez et al., 1992 and Peto et al, 2011

The methodology of calculating smoking-attributable excess mortality relies on three different data sources: on the relative risks, on the smoking prevalence and on the number of deaths due to certain causes of death. Among these, the relative risks are the bottleneck as these values originate from a follow-up survey conducted in the United States. In 2013, Thun and his co-authors re-evaluated the data of the CPS-II (cancer prevention study) survey. Based on this, the results included in the Excel-annex were obtained by gender, smoking status (smokers, ex-smokers), age and causes of death.

Disease		ICD-10	Relative risks								
				Smokers				Ex-smokers			
			0	35–54	55–64	65–74	75–	35–54	55–64	65–74	75–
			year-olds								
		Men									
Malignant neoplasms of trachea, bronchus and lung		C33–C34		14,33	19,03	28,29	22,51	4,40	4,57	7,79	6,46
Other malignant neoplasms	Malignant neoplasms of lip, oral cavity and pharynx, oesophagus, stomach, pancreas, larynx, cervix uteri, kidney, renal pelvis, bladder, liver, colon, rectum, acute myeloblastic leukaemia	C00–C14, C15, C16, C25, C32, C53, C64–C65, C67, C22, C18–20, C92.0		1,74	1,86	2,35	2,18	1,36	1,31	1,49	1,46
Ischaemic heart diseases		I20–I25		3,88	2,99	2,76	1,98	1,83	1,52	1,58	1,32
Other heart diseases	Chronic rheumatic heart diseases, pulmonary heart diseases, other heart diseases	I05–I09, I26–I28, I11, I13 ,I30–I51				2,22	1,66			1,32	1,15
Cerebrovascular diseases		I60–I69				2,17	1,48			1,23	1,12
Other vascular diseases	Atherosclerosis, aortic aneurysm, other arterial diseases	I70, I71, I72–I78				7,25	4,93			2,2	1,72
Diabetes mellitus		E10–E14				1,50	1,00			1,53	1,06
Other cardiovascular diseases	Other heart diseases, cerebrovascular diseases, other vascular diseases, diabetes mellitus	I05–I09, I26–I28, I11, I13, I30–I51, I60–I69, I70, I71, I72–I78, E10–E14		2,40	2,51			1,07	1,51		
Influenza and pneumonia, tuberculosis		J09–J18, A15-A19				2,58	1,62			1,62	1,42
Chronic obstructive pulmonary disease	Bronchitis, emphysema, chronic obstructive pulmonary disease	J40–J42, J43, J44				29,69	23,01			8,13	6,55
Influenza and pneumonia, tuberculosis, chronic obstructive pulmonary disease		J09–J18, A15–A19, J40–J44		4,47	15,17			2,22	3,98		
Perinatal conditions	Short gestation/low birth weight, respiratory distress of newborn, other respiratory diseases in the perinatal period	P07, P22, P23–P28	1,5								
	Sudden infant death syndrome	R95	2,7								
		Women									
Malignant neoplasms of trachea, bronchus and lung		C33–C34		13,30	18,95	23,65	23,08	2,64	5,00	6,80	6,38
Other malignant neoplasms	Malignant neoplasms of lip, oral cavity and pharynx, oesophagus, stomach, pancreas, larynx, cervix uteri, kidney, renal pelvis, bladder, liver, colon, rectum, acute myeloblastic leukaemia	C00–C14, C15, C16, C25, C32, C53, C64–C65, C67, C22, C18–20, C92.0		1,28	2,08	2,06	1,93	1,24	1,28	1,26	1,27
Ischaemic heart diseases		I20–I25		4,98	3,25	3,29	2,25	2,23	1,21	1,56	1,42
Other heart diseases	Chronic rheumatic heart diseases, pulmonary heart diseases, other heart diseases	I05–I09, I26–I28, I11, I13 ,I30–I51				1,85	1,75			1,29	1,32
Cerebrovascular diseases		I60–I69				2,27	1,70			1,24	1,10
Other vascular diseases	Atherosclerosis, aortic aneurysm, other arterial diseases	I70, I71, I72–I78				6,81	5,77			2,26	2,02
Diabetes mellitus		E10-E14				1,54	1,10			1,29	1,06
Other cardiovascular diseases	Other heart diseases, cerebrovascular diseases, other vascular diseases, diabetes mellitus	I05–I09, I26–I28, I11, I13, I30–I51, I60–I69, I70, I71, I72–I78, E10–E14		2,44	1,98			1,00	1,10		
Influenza and pneumonia, tuberculosis		J09–J18, A15–A19				1,75	2,06			1,28	1,21
Chronic obstructive pulmonary disease	Bronchitis, emphysema, chronic obstructive pulmonary disease	J40–J42, J43, J44				38,89	20,96			15,72	7,06
Influenza and pneumonia, tuberculosis, chronic obstructive pulmonary disease		J09–J18, A15–A19, J40–J44		6,43	9,00			1,85	4,84		
Perinatal conditions	Short gestation/low birth weight, respiratory distress of newborn, other respiratory diseases in the perinatal period	P07, P22, P23–P28	1,5								
	Sudden infant death syndrome	R95	2,7								

Relative risks quantify how higher the exposure of smokers (RR1) and ex-smokers (RR2) is than that of non-smokers, and the relative risk for non-smokers is always 1. These values are known by different groups of diseases. Due to the slow progression of smoking-attributable chronic diseases and the fact that the addiction generally begins in teenage age, the methodology assumes that no one dies of diseases caused by nicotine addiction before the age of 35. (Smoking may cause rarely fatal accidents as well, but their number is insignificant.) The few exceptions are those – fortunately very rare – cases when an infant death occurs due to the mother's smoking during pregnancy.

The basis of smoking-attributable excess mortality is people who currently smoke (p1) and those who have quit smoking (p2). Its prevalence broken down by smoking status (smokers, ex-smokers, non-smokers) and age groups (35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85–) is known from the National Health Interview Surveys (NHIS 2000, 2003) and European Health Interview Surveys (EHIS 2009, 2014). For intermediate years, an interpolation statistical approximation procedure was used. The percentage of non-smokers in the total population is p0. Furthermore, as it was a survey-type data collection, the 95 per cent confidence interval was always indicated.

Knowing the relative risks and the prevalence, the rate of smoking-attributable excess mortality, i.e. the so-called smoking-attributable fraction (SAF) can be defined within a given disease group.

$$SAF = \frac{(p_0 + p_1(RR1) + p_2(RR2)) - 1}{p_0 + p_1(RR1) + p_2(RR2)}$$

If this rate is multiplied by the number of deaths due a certain cause of death, we will get the absolute number of smoking-attributable mortality (SAM) of those who died in the given cause of death.

$$SAM = SAF * D$$

Appendix F (For figures 33, 34, 37, 38, 39)

To obtain the smoking-attributable age-specific probability of dying:

$$q_{xs} = (5 * m_{xs})/(1 + (5 - a_x) * m_{xs})$$

where x refers to the specific age-groups, m_{xs} is the smoking-attributable central death rate and a_x is the parameter (from the Human Mortality Database: http://mortality.org) to estimate mid-term mortality. The formula is the same for the smoking-attributable causes of deaths, just calculated for every cause each.

Appendix G

Potential years of life lost (PYLL) attributable to smoking

The indicator sums up the (not lived) lifetimes of the deceased people in a certain population group until a fixed age. The selection of the age limit is optional, the present study analyses two age limits: the 70 years of age applied in international practice and the life expectancy at the age of death. If someone dies younger than that, at the age of x, the number of years of life lost is for example 70 – x in case x < 70, while if he/she dies at the age of 70 or over, the indicator is 0 (Wéber–Faragó [2014] page 22).

Total number of years of life lost from the potential 70 years:

$$PYLL_{70} = \sum (70 - x_i) * D_i \text{ .}$$

Number of years of life lost compared to the life expectancies by age groups:

$$PYLL_{Life\exp} = \sum (Life_{\exp_i} - x_i) * D_i \text{ ,}$$

where

Di –the number of deceased people by age groups,

xi – the average age of deceased people in the age groups,

Lifeexpi – life expectancy of the given age group.

Age-specific rate of years of life lost compared to life expectancies by age groups:

$$\sigma_i = \frac{\sum (Life_{\exp_i} - x_i) * D_i}{P_i},$$

where

Pi – mid-year population.

Appendix H

International data and explanation are included in the WHO-HFA database:

SDR (selected smoking-related causes), calculated for hundred thousand population.

http://data.euro.who.int/hfadb/

https://gateway.euro.who.int/en/indicators/hfa_296-1980-sdr-selected-smoking-related-causes-per-100-000/

Plágiumnyilatkozat

Doktori értekezés benyújtása és nyilatkozat a dolgozat eredetiségéről

Alulírott

név: **Wéber András**

anyja neve: **Csányi Ildikó**

születési hely, idő: **Budapest, 1985.02.01**

Premature cancer morbidity and mortality conditions through the epidemiological transitions and the global smoking epidemic

című doktori értekezésemet a mai napon benyújtom a Pécsi Tudományegyetem

Bölcsészettudományi Kar, Demográfia és Szociológia Doktori Iskola, Demográfia Programjához

Témavezetők neve: **Prof. Józan Péter, Prof. Sándorné Kriszt Éva**

Egyúttal nyilatkozom, hogy jelen eljárás során benyújtott doktori értekezésemet

- korábban más doktori iskolába (sem hazai, sem külföldi egyetemen) nem nyújtottam be,
- fokozatszerzési eljárásra jelentkezésemet két éven belül nem utasították el,
- az elmúlt két esztendőben nem volt sikertelen doktori eljárásom,
- öt éven belül doktori fokozatom visszavonására nem került sor,
- értekezésem önálló munka, más szellemi alkotását sajátomként nem mutattam be, az irodalmi hivatkozások egyértelműek és teljesek, az értekezés elkészítésénél hamis vagy hamisított adatokat nem használtam.

Dátum: Pécs, 2020.03.04.

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doktorjelölt aláírása