The effects of 2004 European Union enlargement on mortality development for joining countries.

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Abstract

The life expectancy development during the past 150 years has been remarkable in many parts of the world. These developments, however, have been very different across countries. In Europe, the diverse historical and political changes lead to clusters of regions that followed different mortality developments. The aim of this study was to examine how countries that entered the European Union in 2004 and 2007 differ in terms of mortality from continuous members of the EU and from Eastern European countries that have never joined the EU. Moreover, I studied a possible convergence in mortality indicators between these groups of countries. The data used to explore mortality conditions in those groups of countries was derived from two sources: The Human Mortality Database and European Health for All Database. Descriptive statistics and calculations of average yearly pace of change for groups of countries have been applied for each mortality indicator. Furthermore, regression models have been conducted to estimate the impact of belonging to a country group on mortality indicators, adjusted for some macro-level indicators of economic progress and health expenditure. The results verified previous research implying the importance of period factors which can affect mortality in the short term. For all mortality indicators, accelerated improvements between 1995 and 1999 have been found in countries who became EU members in 2004. Moreover, life expectancy convergence was observed for life expectancy at birth but not for the older ages which could imply that the positive progress affected older ages to smaller degree. My findings confirm the importance of social environment and imply that the process of joining the EU possibly could reduce social stress and affect mortality conditions positively.

Keywords: life expectancy, convergence, infant mortality, European Union, enlargement, Eastern and Central Europe, social environment
Introduction

At the beginning of the 21st century people living in developed countries can happily enjoy the prospects of a long life. The improvements in life expectancy during the last 150 years have been quite astounding, which is reflected in the data for highest life expectancy reached all over the world. Since the middle of the 19th century the pace of increase in life expectancy has been very stable. Although record life expectancy has increased linear by nearly three months per year during that period, predictions about the maximum life-span have been difficult as almost all predictions were overtaken by reality (Christensen, Doblhammer, Rau, & Vaupel, 2009; Oeppen & Vaupel, 2002).

Those positive changes in human survival during the last one and a half centuries were however not the same over time. According to Christensen et al. (2009) until the 1920s it was infant and childhood mortality decline which contributed most to the increase in record life expectancies, while for the most recent period it was the mortality decline at ages 80 and older which contributed most to increase in life expectancy (p. 1196). This confirms earlier findings testing the limits to human life expectancy, where it was found that increased survival for ages above 75 contributed most to the life expectancy increase (Manton, Stallard, & Tolley, 1991, p.628). Those changes indicate a substantial shift in the age pattern in mortality – from changes in infant and child mortality to changes in the oldest ones mortality being most important for life expectancy increases.

Furthermore, over the time, different causes of deaths have contributed differently to progress in life expectancy. Due to the Epidemiological Transition formulated by Omran (1971) there are three stages of epidemiological transition which have different mortality patterns. In the first phase, mortality is very high and very often due to infectious diseases, famines and wars. In the second stage, mortality decreases gradually as a result of fewer epidemics and better living conditions which contribute to increases in life expectancy (particularly for the youngest ages). In the last phase mortality levels decreases and eventually levels-off and is mainly due to man-made diseases, cancers, cardiovascular diseases and diabetes.

Although those diseases became prime causes of death in contemporary time, the mean age for dying from those diseases has increased as well (Manton et al., 1991, p.608). The trends
for the past fifty years reveal that in well developed countries death rates for cardiovascular diseases have decreased substantially (Vallin, Meslé, & Valkonen 2001, p.99) which could imply that the transition as formulated by Omran have moved forward to the next phase he could not foresee.

Although increases in life expectancy were observed in all advanced countries, improvements in mortality conditions have not been similar in all countries. According to Meslé and Vallin (2002), in 1950, the northern and western parts of Europe had much higher levels of life expectancy compared to Mediterranean and Eastern Europe. In the following fifteen years considerable improvements in life expectancy in Southern and Eastern Europe contributed to reduction of that difference. The direction of development in life expectancy changed however again in the middle of the 1960s when the pace of increases slowed down in the eastern part of Europe while it continued to rise quickly in the southern parts of Europe. A comparison of change in life expectancy between 1965 and 1995 for European countries shows that the different pace and direction of the mortality development during that time split Europe in two clearly divergent groups. The different development in mortality conditions in northern, western and southern Europe compared with the development in former Soviet Union (Belarus, Estonia, Latvia, Lithuania, Moldova, Russia and Ukraine) divide the European region in two distinct groups. The mortality course in countries of Central Europe locates those in between those two (Meslé & Vallin, 2002).

In the search for explanation for the mortality divergence between East and West Europe Bobak and Marmot (1996) discuss several possible explanations. Their main postulation is that socioeconomic variation between East and West can operate in similar way as it does within countries, leading to higher mortality in countries where the socioeconomic situation is worse. Additionally, life style behaviours such as the propensity to smoke or to consume alcohol can be affected by the social and economic situation in the country they live in. Furthermore, the differences in mortality development in central and Eastern Europe are confirmed by recent research. Billingsley (2011) identified three clusters of countries which have been grouped by similar mortality developments between 1980 and 2005. The first group of countries (Transition Type 1) consist of Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia and is characterized by initial short-termed mortality
increase, followed by gradual decrease of death rates for both males and females. The second group (Transition Type 2) share the experience of initial increase in females and males death rates in the first half of 1990s followed by gradual decrease though that increase was more powerful and prolonged than for countries in Transition Type 1. This cluster of countries includes Armenia, Azerbaijan, Estonia, Georgia, Latvia, Lithuania, Tajikistan and Uzbekistan. Finally, the last group of Transition Type 3 includes countries (Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia and Ukraine) that have undergone bigger fluctuations in deaths rates levels, initially experiencing a levelling off of mortality rates in the mid-1990s followed by second increase since 1998.

The development of mortality in Russia has been mainly related to alcohol, smoking, week health-care system and social stress (Shkolnikov et al., 2004). The combination of harmful life-style behaviours, week health care (also prevention) and strongly varying political and economic conditions have not been to the advantage of Russian life expectancy since 1965. The changeable time in Russia with both positive and negative events: anti-alcohol campaign 1985, political and economic collapse of Soviet Union in 1990 and the economic crises 1998 have been reflected very well in the mortality changes. The influence of unstable economic and political conditions on mortality during the past few decades are not easily to prove, nevertheless some evidence suggested that it can affect mortality indirectly in many ways (higher alcohol-consumption, poorer nutrition or worse health-care). The evidence presented by Billingsley (2011) confirms the role of economic context. Real Gross Domestic Product (GDP) per capita, which is a measure for economic development and relative position of countries, along with inflation change had greatest impact on mortality rates. Her analysis contributes also with evidence for the relation between poor economic conditions and damaging alcohol intake.

The mortality development in central and Eastern Europe and the possible explanations described above indicate that the contextual situation in countries can affect mortality in the short-term; however, it is generally difficult to empirically test such associations. In Europe a possibility of testing the influence of economic and political conditions on plasticity of mortality has been possible in the case of German reunification. After a few decades of being divided in two separate states with divergent political and economic systems, East and West Germany became one state again in 1990, making it possible to study how changes in
economic, political and social conditions have affected levels of mortality. The case of East and West German reunification indicates that much can be done to improve survival even for the oldest ones (Gjonça, Brockmann, & Maier, 2000; Scholz & Maier, 2003; Vaupel, Carey, & Christensen, 2003).

Gjonça et al., (2000) compare trends in old age mortality between East and West Germany for the period covering time before, during and after reunification. The aim of their study was to examine mortality patterns for older ages hypothesizing about whether increases in survival at older ages have contributed to increases in life expectancy and whether that trend was affected by the German reunification. The starting point for their analysis was 1970 when the mortality trends between East and West Germany started to diverge from each other. Although the life expectancy at birth continued to increase in both states, the pace of increase was greater in West Germany which contributed to growing differences in life expectancy between East and West. Immediately after the German reunification in 1990 the trends of lower pace of development in East Germany reversed and life expectancy in both states started to converge again. However immediately before and after reunification life expectancy for males decreased somewhat what the authors explains with increases in mortality for the age group 16-65. A decomposition in three time periods showed that for both females and males in West Germany the period before reunification was most important for the mortality decline, while in the East Germany the period after reunification was most important. The authors discover that observed convergence in life expectancy of East and West Germany was due to a rapidly improved survival in the East after reunification. Furthermore their analysis demonstrated that most of the increases in life expectancy was due to a decline in mortality at older ages, which confirmed the hypothesis of the authors. Among the determinants which have potentially affected survival of East Germans, improvements in health care system have been found being of large importance, implying that period effects can became visible relatively fast (Gjonça et al., 2000).

The above mentioned results give a picture of how changes in political and economic context of a country can affect mortality conditions and the development of life expectancy in the short term.
Since the fall of the communism, eastern and central Europe have not experienced any new regime change but on the other hand one other very important event – joining the Europe’s biggest economic and political partnership – the European Union (EU). In 2004, ten new countries became members of EU: Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia and Slovenia. Only three years later, in 2007 additional two countries from Eastern Europe – Bulgaria and Romania joined EU. The process preceding receiving of membership is usually time-consuming as the applicant country must fulfil the conditions EU require, which among others include, stable institutions guaranteeing democracy and rule of law and a functioning market economy along with implementation of all current EU rules (http://ec.europa.eu/enlargement/policy/conditions-membership/index_en.htm).

Countries who joined the European Union in 2004 and 2007, applied for membership in different years. Malta and Cyprus were applying in 1990 and 1992, respectively, the other countries between 1994 and 1996 (Christoffersen, 2007c, pp.24-28). The accession negotiations started at first with a limited number of countries. In 1998 six countries that made most progress, namely Cyprus, Czech Republic, Estonia, Hungary, Poland and Slovenia were invited to open enlargement negotiations with the EU. The reason of opening the negotiations for only few countries originated in the view that enlargement with up to five new countries would not involve a need for some major institutional change of EU (EU decided however to open negotiations with six countries as most of the Member States did not expected Cyprus to fulfil the implicit accession condition –reunification - in the near future). However, the separation of applicant countries in groups was not considered unproblematic by some member countries. Therefore a decision about treatment based on the same criteria and participation in the accession process on equal basis of all applicant countries of Central and Eastern Europe and Cyprus was agreed at the same time (Christoffersen, 2007c, pp.31-33). In 1999 the enlargement negotiations opened also for the remaining countries: Bulgaria, Malta, Latvia, Lithuania, Romania and Slovakia (Christoffersen, 2007a, p.53).

The period of accession negotiations is aimed for defining the terms and conditions under which each of candidate countries will be allowed to join the European Union. The most essential part for accession is applying by candidate countries “the acquis of the Union, that is
the combined set of rules, regulations, and practices (including those established as case law by the EC Court of Justice) applied by the Union at the time of entry” (Christoffersen, 2007b, p.43). The candidate countries expects to fully accept the rights and obligations which follow the accession to the Union system and its institutional framework (the acquis) but some transition periods, if necessary, can be negotiated (Christoffersen, 2007b).

A summary of EU legalisation which presents the main aspects of European Union legalisation is available online on http://europa.eu/legislation_summaries/index_en.htm#. Nevertheless the differences between countries in compatibility with the existing at the time of enlargement EU legalisation, and the adjustment needed for each country is beyond the scope of this paper. All the candidate countries have nevertheless gone through a “screening”, which is “a first step in negotiation process where the Commission together with the candidate countries examines in detail how each country’s laws, regulations and administrative practices relate to those applicable in the European Union” (Christoffersen, 2007c, p.33).

Applying for membership in EU can therefore motivate countries and push their social and economic development toward the levels of wealthier countries. Especially the requirement of implementation of existing EU rules might contribute to improvements in medical care systems or economic status. The adjustments to existing EU rules required from candidate countries, can affect the health outcome in those countries in either long or short term. For instance, in Latvia, Kesteris and Plamse (2007) mention the challenging implementations of EU’s law regarding tough hygiene standards in the food processing plants or adopting the higher standards for drinking water (however, negotiations resulted in relatively long transitional period), sewage systems or waste management. Another big contributor to health outcome – cigarettes, or to be more exact the taxes on cigarettes, was also a subject for negotiations. As a result, the EU offered a horizontal solution for all the negotiating countries which allowed for a transition period and gradual tax increases during that period (Kesteris & Plamse, 2007). Those examples are only a fraction of the, sometimes challenging, process of changes in each country which started with the willingness and determination to become an equal member of the European Union.
The aim of this paper is therefore to explore whether membership in the EU can have any beneficial effects on life expectancy for the new member countries, implying that membership in the EU can operate in similar way as regime changes described earlier, especially in the case of German reunification. In the next section I give a brief description of the theoretical base relevant for this paper.

Theory

Models which intend to explain mortality differences can vary a lot, depending on the research question and the chosen study populations. In a review of analytic methods used to exam differentials in adult mortality Hummer, Rogers and Eberstein (1998) described development of methods and data used in sociodemographic mortality research in the US. According to the authors, the methods have developed from being of describing nature, showing patterns and trends but not be able to give much of an explanation, toward a broader approach where some socioeconomic variables as education, income, occupation, wealth, marital status, social support nativity etc., have been included (ibid., pp.559-561). On the individual level, mortality is a process influenced by different groups of independent variables, where those sociodemographic factors should be seen as mortality determinants working through behavioural, psychosocial, health care and biological factors (ibid., p.563).

The changing view on mortality reflects furthermore in the shift in the ageing studies which transformed in the recent decades from being mainly focused on single causes (for instance - genetic), toward understanding ageing as a complex process which can be affected by a range of different factors simultaneously, pointing toward the plasticity of that process (Weinert & Timiras, 2003). Results found in Kannisto, Lauritsen, Thatcher and Vaupel, (1994) where mortality at advanced ages for 27 countries compares, exemplify the plasticity of the ageing process. Their findings show that even at the highest ages considerable reductions in death rates have been taking place in developed countries resulting in acceleration of mortality improvements at advanced ages. In this section I will describe some of the factors usually used when explaining mortality differences between developed countries, which are of importance when mortality patterns between well developed countries of Western Europe are
compared with the trends in Eastern Europe. This section includes both behavioural and structural factors.

Social environment
Social environment as referred here include mainly the political and economic surroundings individuals living in. Those surroundings include ideological systems of governments which in turn influence wealth of nations.

An influence which social environment can have on mortality is not easily to prove. The reason for that is that the economic and political conditions can rather operate indirectly affecting mortality through many different factors. There are some determinants which affects health regardless of social position why improvements in health behaviour and environment will benefit everybody regardless of their social status, but the differences in health can not only be attributed to differences in lifestyle behaviour such as diet or smoking (Marmot, 2004, p.249).

Characteristics of the social environment and it changes over time, for example health care quality and political system have been found to be partly accountable for the fluctuations and high levels of mortality in Russia during the past few decades.

The socio-economic transition from communism to market economy system during the communist and post-communist period have created high level of psychosocial stress with increased levels of premature deaths as a result but also affecting the lifestyle behaviours of individuals negatively (e.g. harmful alcohol consumption, increased smoking rates) which in turn affecting mortality levels negatively (Shkolnikov et al., 2004).

Socioeconomic status
The socioeconomic status, measured by income, occupation, education, or wealth, is one of the factors which can be used to describe mortality differences between individuals.

A study of economic conditions early in life and individual mortality (Van den Berg, Lindeboom, & Portrait, 2006) uses occupation of the father as indicator of social class with the conclusion of lower mortality in higher social classes. Similarly, educational level has been used to examine mortality differences at older ages in Western Europe, showing relationship between socioeconomic position and mortality levels. Individuals with lower socioeconomic position had higher mortality, and cardiovascular diseases were contributing
most to those differences (Huisman et al., 2005). Mackenbach et al., (2003) uses both educational level and occupation when comparing mortality and causes of deaths for six Western European countries for two periods of time, 1981-1985 and 1991-1995. Their result shows that during that period mortality from cardiovascular diseases generally declined faster in the upper socioeconomic groups. Furthermore, they found increasing mortality rates in lower socioeconomic groups for some diseases (e.g. lung cancer, breast cancer, respiratory diseases and injuries) which contributed to the widening of socioeconomic inequalities in mortality.

On the national level, an indicator of economic conditions in the population is Gross Domestic Product (GDP), which has been shown to be important for mortality development (Billingsley, 2011). Bobak and Marmot (1996) searched for an explanation for the mortality divergence between Eastern and Western Europe and concluded that socioeconomic variation between East and West can operate in a similar way as it does within countries, leading to higher mortality in countries where the socioeconomic situation is worse. Nevertheless, it is important to emphasize that socioeconomic status can operate as an extraneous variable which affects mortality through variables which will be described in following sections: health-care and life-style factors (e.g. see Osler, 1993 who examined how health behaviours are influenced by social class).

Health care
Understanding differences in mortality outcome, especially between countries cannot be done without understanding factors operating on the structural level, such as health care. In his epidemiologic transition theory Omran, (1971) indicated the relevance of medical care for the development of mortality patterns. The gradual decrease in mortality during the second stage of the transition was mainly due to improvements in the living conditions and fewer epidemics, but also medical innovations such as vaccines and antibiotics have contributed to the development. Those factors contributed to substantial improvements in infants and child mortality, which in turn contributed to increases in life expectancy. Nevertheless, since the middle of 20th century, it has been mortality decline at older ages which contributed most to positive development of life expectancy (Christensen et al., 2009). Although diseases as cancers and cardiovascular diseases have now became prime causes of death, the increases in
mean age for dying from those diseases has increased as well (Manton et al., 1991, p.608) and the role of medical development cannot be overlooked here. The importance of health care operates through growing knowledge about differential risk factors along with emerging of new technologies to treat and prevent acute symptoms. Moreover, advances in health care are important on both national and individual level since individual health and mortality can be affected by medical advances in their country of living along with individual access or use of those services, which can also vary due to stratification through gender or socioeconomic status. The role of health care system can thus affect mortality outcome at least in two different ways. One is through advances of the health care system because of the access to better information or technology (positive effect on life expectancy) or through the absence of adequate health care advancements (negative effect on life expectancy).

The importance of the health care system for mortality at older ages has been supported by findings following the German reunification. Gjonça et al., (2000) argued that the oldest age groups are highly dependent on welfare transfers. Thus the authors argue that the fast improvement of the health care system after the reunification in East Germany was probably the main reason for the convergence in mortality at older ages observed there.

Similarly, the negative development of mortality in Russia has been partly explained by inadequate health care advancements. Before the collapse of the Soviet Union the health-care system was not prioritized. However after the collapse the economic crisis made it difficult to keep up with medical advances of other high-income countries, which have affected possibilities to better health for Russian people (Shkolnikov et al., 2004, pp.61-65).

**Life-style factors**

Among the determinants which affect health there are a number of behavioural determinants usually labelled as life-style factors. Even though many behavioural factors may influence health outcome, there are two main risk factors which are often associated with chronic diseases – smoking and hazardous alcohol consumption.

Smoking is one of the hazardous habits of people which can lead to many diseases. A prospective study from England followed a group of males for over fifty years, to examine how cigarette smoking affects mortality. The results indicate very clear link continuous
smoking with higher mortality rates compared to non-smokers, but also the positive effects of smoking cessation on life expectancy (Doll, Peto, Boreham, & Sutherland, 2004).

Smoking-related mortality has been shown to be higher in Eastern European countries than in Western Europe. Although there are many differences within those two regions, generally, both males and females in Eastern Europe have higher mortality rates related to smoking (McCartney, Mahmood, Leyland, Batty, & Hunt, 2011), furthermore smoking has also been held responsible for the recent narrowing of the sex differential in mortality (Pampel, 2002). Over time high cigarette consumption has shifted from high-income countries to middle- and low-income countries. Between 1990 and 2009 cigarette consumption in Western Europe has decreased by 26%, while it continues to increase in middle- and low-income countries (Eriksen, Mackay, & Ross, 2012, p.28). For 2009, the estimated per capita consumption numbers was generally higher in Central and Eastern Europe than in Western Europe and the Nordic countries. Russia and Bulgaria are among the countries with the highest cigarette per capita consumption, but also the rest of the former communist countries are near behind (ibid., p.29).

Furthermore, due to the cigarette epidemic model proposed by Lopez, Collishaw and Piha (1994) smoking-related mortality is expected to rise with a time-lag of three to four decades after rise in smoking prevalence, why current smoking-related mortality is associated with smoking patterns at least thirty years ago. In the former Soviet Union smoking has increased during the 1990s (Shkolnikov et al., 2004, p.55) which could imply that smoking-related mortality in the former communist countries have not reached its peak yet. Nevertheless other study have pointed out that the time lag of the proposed cigarette epidemic model differs for males and females. Moreover, the unpredictable development of cigarette cessation can reduce mortality rates, making the time-lag predictions more uncertain (Thun, Peto, Boreham, & Lopez, 2012).

Alcohol consumption is another well-recognized factor in mortality research often related to health outcome and premature mortality of people. In a review of Rehm, et al., (2003) many negative outcomes such as chronic or acute diseases were confirm to be associated with excessive alcohol consumption. When comparing countries, however, it is important to
remember that it is amount of drinking in combination with pattern of drinking which are important for the severity of the health outcomes associated with alcohol consumption. Alcohol consumption which is more typical for countries as France, where wine drinking is more regular and in connection to meals (also beer consumption in Czech Republic) can even have heath positive outcomes (Marmot, 2004, pp.218-219). In contrast, Russia is an example of a country where both the amount and the way of drinking, classifies as binge drinking – meaning irregular but heavier alcohol consumption, which have been found being jointly responsible for both the fluctuations since 1980s as well as for mortality levels as a whole, operating through both direct and indirect death causes as poisoning, tuberculosis, violence, liver or cardiovascular diseases (Shkolnikov et al., 2004, p.59). Alcohol consumption in Central and Eastern Europe vary among countries, but the high level of binge drinking is a common characteristic for the region (Popova, Rehm, Patra, & Zatonski, 2007). Furthermore, similar to smoking-related excess of mortality rates for males, alcohol-related mortality has been found being partly responsible for the gender differences in mortality. How much of the observed differences in females and males mortality is attributable to alcohol vary between countries, from 20 to 30 per cent in Eastern Europe, to 10-20 per cent in other parts of Europe (McCartney, Mahmood, Leyland, Batty, & Hunt, 2011).

In the two first parts of this paper, the most important changes in mortality development in advanced countries have been highlighted. People are now living not only longer, but also the contemporary mortality is concentrated to older ages. Nevertheless the focus on situation in Europe reveals that the development in Europe has not been the same for all regions. The course of the history operating through political and social changes separated Europe in clusters of regions with different mortality development. Among others, have differences in health care advances, social environment and life style behaviours been held responsible for the diversity in the mortality progress. The influence of German reunification or Russian socio-political collapse on mortality development indicates that changes in the economic and political context can be of importance for the development in life expectancy in the short-term. This presented research leads to the question whether EU can affect mortality conditions in similar way. To examine that, I will focus on the following questions.
Research questions

1. **Does group belonging of the countries (EU membership status) affect mortality development, expressed as changes in life expectancies and/or infant mortality, around the time of EU enlargement in 2004?**

I assume that the observed differences in life expectancy will be different for groups of countries who have different EU membership status. Furthermore, the change over time is assumed to be affected by group-belonging meaning that different groups experience differing development in life expectancy and/or infant mortality around the time of enlargement of European Union in 2004. The pace of change in life expectancy progress presumes to be faster for the countries who became EU members in 2004.

2. **Does the life expectancy showing any trend toward a convergence in life expectancy between earlier (prior to 2004) and newest (since 2004) EU members?**

I assume that the effect of joining European Union will appear in form of some convergence of life expectancy between the group that have been EU member for a longer time and the group that became member of EU in 2004.

Data

In order to explore how the mortality conditions in selected regions of Europe have changed over the past few decades and whether those changes differ for countries with different membership status in European Union, I will be using data from two distinct sources.

**Human Mortality Database (HMD)**

The data used to compare life expectancies between countries have been downloaded from Human Mortality Database (HMD), an open-access database that contains both period- and cohort data for mortality conditions in 37 countries as for today (Human Mortality Database...
The uniform set of procedures used to create the database reduces the risk for bias when countries with different data sources are compared, which makes this database very suitable for use in this paper. For the complete description of the methodology please see the methods protocol available on HMD home page.

The first, descriptive part of the analysis rests on the data collected from HMD for selected years (1980, 1995, 1999, 2004 and 2009), which includes all available EU-member countries and additional three countries of Eastern Europe (former Soviet Union) who are not members of the EU as for today. Countries who are currently (May 2013) members of EU are: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom (http://europa.eu/about-eu/countries/index_en.htm). There is no data for Cyprus, Greece Malta and Romania available in HMD. To avoid any bias caused by including data from different sources, those countries have been excluded from calculations of average life expectancies. Countries have been clustered in four separate groups depending on their EU membership status.

**EU core members:** Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom. Labelling those countries as “core members” denotes only the divergent period of entering EU. All the mentioned countries have joined EU before 2004 although in different points in time. For the descriptive statistics in this paper those countries were grouped together as the reference group.

**EU 2004:** Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. Countries of Central and Eastern Europe who joined the European Union in 2004.

**EU 2007:** Bulgaria.

**Non EU members:** Belarus, Russia and Ukraine. A group of Eastern European countries that did not become members of the European Union.
The average for 1980 for the *EU core members* do not include data for Germany, as it still was divide in West and East Germany at that point. Corresponding calculations for average life expectancies in 1980 for *EU 2004* do not include data for Slovenia, as data for this country is only available from 1993.

Furthermore, the Human Mortality Database is also used in the regression analysis section where life expectancy at birth and life expectancy at age 80 have been included in the models. Data were downloaded for the following countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Sweden, Italy, France, Austria, Germany, Russia, Ukraine and Belarus. Again, Malta, Cyprus and Romania have not been included in the analysis because the data was not available in the HMD. The data derived for use for the regression analysis covers years 1980-2011 (or latest available). Again, Slovenian and German data are only available from a later year. For some countries there is the possibility the trend mortality data are biased. Such risk exist for Estonia, which has lower data quality for the years 2001-2009 (Human Mortality Database, 2013b) and Slovenia, where collection systems and definitions changed in 1987 (Human Mortality Database, 2013c). Furthermore, population estimates for Russian individuals above age 80 are more unsecure compared to other countries (Human Mortality Database, 2013d).

**European Health for All Database**

The second database used here is the European Health for All Database, which was downloaded from the World Health Organisation Regional Office for Europe web page (European Health for All Database, 2013). The offline version of the downloaded database (latest updated in January 2013) has been saved for future needs as the data in following versions can be different depending on most recent updates. The European Health for All Database provides a range of health related indicators for 53 countries of the WHO European Region. In the following I provide the list of variables that have been used from this database and their definition:

- Real Gross Domestic Product, PPP $ per capita
GDP expressed in purchasing power parity (PPP) is adjusted to the relative domestic purchasing power of the national currency as compared to the US dollar, rather than using the official exchange rate. Multipliers (PPPs) are estimated periodically, using the cost of the standard basket of goods. (WHO/EURO uses World Bank World Development indicators, indicator NY.GDP.PCAP.PP.CD as the common source.)

GDP expressed in purchasing power parity gives the possibility to better compare countries economic development and the relative position to other countries. Countries economic situation, or an output produced by an economy compared to other economies is in that way not affected by exchange rates or price inflation.

- Public sector expenditure on health as % of total government expenditure, WHO estimates

Public sector (or general government) expenditure on health is the sum of outlays for health maintenance, restoration or enhancement paid for in cash or in kind by government entities, such as the Ministry of Health, other ministries, parastatal organizations, social security agencies, (without double-counting the government transfers to social security and to extra-budgetary funds). Includes transfer payments to households to offset medical care costs and extra-budgetary funds to finance health. The revenue base of these entities may comprise multiple sources, including external funds. Estimates for this indicator were produced by WHO. The estimates are, to the greatest extent possible, based on the National Health Accounts classification (see the World Health Report 2006 for details). The sources include both nationally reported data and estimates from international organisations like IMF, WB, UN and OECD. Therefore they may somewhat differ from official national statistics reported by countries.

- Infant deaths per 1000 live births, separately for males and females

A measure of the yearly rate of deaths in children less than one year old. The denominator is the number of live births in the same year. Infant mortality rate = [(Number of deaths in a year of children less than 1 year of age) / (Number of live births in the same year)] *1000 (ICD-10).
The data for infant deaths have been used in a similar way as for life expectancy, both for calculations for the average infant deaths for different region and selected years and in the regression models. Countries have been clustered in the corresponding groups as for life expectancy calculations. The only exception is Greece, which was added as a member of the group EU core members because data on infant mortality was available. However, some data is missing for certain years:

**EU core members:** Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom. The data is not available for Germany 1980, Italy 2004 and Belgium 2009.

**EU 2004:** Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. The calculations for 1980 are based on the data available which is only for three countries: Hungary, Latvia and Poland.

**EU 2007:** Bulgaria.

**Non EU members:** Belarus, Russia and Ukraine. The calculations for 1980 are only based on data for Russia.

**Methods**

With the aim to explore mortality conditions between regions I have chosen to use three measures: life expectancy at birth, life expectancy at age 80 and infant mortality per 1000 live births. Each of those measures will give a different aspect of mortality in the examined regions. Life expectancy at birth is a one most often used measure when health of countries compares and gives a god overview for mortality for the whole age range. This measure represents an average number of additional years people at birth expect to live. Life expectancy at birth provides an idea of the overall mortality and health conditions in the observed countries. However, comparing the life expectancy at birth between countries does not reveal which age groups are responsible for mortality differences. Therefore, I decided to
also study two additional mortality measures: life expectancy at age 80 and infant mortality. Life expectancy at age 80 is an average number of years people expect to live above age 80. Life expectancy at age 80 is important for old age mortality overview which has been shown to be of importance in the convergence process in Germany and why it is used here. Finally, also infant mortality is studied because infant mortality is very vulnerable to improvements in the medical care system (Omran, 1971). Those two additional measures will give a description of mortality conditions of infants and the older people – the two groups whose mortality changes have been shown being most important for life expectancy increases in the last one and a half centuries. All three measures together give a better picture of mortality conditions and mortality changes in the examined regions.

The methods used to explore whether the membership in the EU can have an effect on life expectancy and infant mortality progress consist of two parts. First, I will give a descriptive picture of the situation for groups of European countries belonging to EU along with a group of countries that was a part of former communist state, but are not members of EU as of today. Through the comparison of average yearly increase in life expectancy for different groups of countries I will examine the pace of change in life expectancy for selected groups of countries. In a next step, I will use regression models to estimate the impact of being in a certain group on life expectancy, adjusting for some macro-level indicators of economic progress and health expenditure in the studied countries. A similar analysis will be made for infant mortality variable as dependent variable.

**Descriptive analysis**

In the first, descriptive part of the analysis I have calculated the mean life expectancy and infant mortality for countries included in the four different groups: EU core members, EU 2004, EU 2007 and Non EU members. For the reason that the time periods between selected years differ in length, I also calculated the average annual change in life expectancy/infant mortality for the different groups. Annual average change for life expectancy at birth ($e_0$), and life expectancy at age 80 ($e_{80}$) in corresponding way, is calculated as:

\[
e_0\text{annual change} = \frac{(e_0\text{year } x + 1) - (e_0\text{year } x)}{\text{year } x + 1 - \text{year } x}
\]
Infant mortality annual change is calculated as relative percentage annual change, where the absolute change in infant deaths per 1000 live births is related to previous examined year for percentage change for each country and divided by numbers of years between.

**Regression analysis**

In the second part of the analysis I have constructed a number of multiple regression models using programme IBM SPSS Statistics Version 21. I used three dependent variables which measure mortality conditions: life expectancy (at birth and at age 80) and infant deaths per 1000 live births, separately for males and females. For the reason that the period effect is essential for the analysis I divided the data in three time segments: 1980-1994, 1995-2003 and 2004-2011. Even though the main aim of this study is to examine the effect of enlargement of EU in 2004, which mainly include period before and after 2004, the analysis is furthermore extended to beginning of the 1980s because it is assumed that the dramatic changes that have been observed in the 1980s and especially in the 1990s may have a long lasting impact on the mortality conditions later. The missing values are excluded from the analysis pairwise (e.g. see Field, 2009, p.177) which means that the number of cases (n) differs between the models.

In the first model (Model 1) I tested whether life expectancy/infant deaths differ significantly between groups with different EU membership status. To do that I constructed a group of core EU countries which have joined EU before 2004 as a reference category and three dummy variables:

- Reference category: Austria, Germany, France, Italy and Sweden
- EU members since 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia
- EU members since 2007: Bulgaria
- Non- EU members: Belarus, Russia and Ukraine

I the next step of the analysis (Model 2), I assume that the development of life expectancy/infant mortality can depend on differential economic development of the countries and therefore I additionally control for the annual change in economic progress in these countries. I use Real Gross Domestic Product (GDP), PPP $ per capita, expressed in US dollars, to calculate the difference in progress from one year to another. Using GDP expressed
in purchasing power make it possible to better compare between countries because the core of this measure is the relative position of countries. The calculations are expressed as percentage annual change.

Finally, in the last model (Model 3) I also control for the effect of governmental expenditure on health. Controlling for public sector expenditure on health (as estimated by WHO), expressed in percentages, provides the opportunity to control for differences in each country’s progress in the health care sector. However, for the great majority of countries no information on public sector expenditure on health was available for the very earliest years. Therefore I decided to exclude the earliest time-period (1980-1994) in this last model. The results of all analysis presents in subsequent sections.

**Results**

This section contains the results of the analysis for the two main variables: life expectancy (at birth and at age 80) and infant mortality. First, I will present the descriptive evidence followed by a regression analysis that examines the impact of EU membership status on mortality.

**Life expectancy at birth**

**Descriptive statistics**

The first descriptive illustration of the differences in life expectancy between groups is given in Table 1.

**Table 1. The average life expectancy at birth for different groups of countries. Selected years.**

<table>
<thead>
<tr>
<th></th>
<th>FEMALES</th>
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<th></th>
<th></th>
<th>MALES</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EU core members</td>
<td>77,11</td>
<td>80,09</td>
<td>80,78</td>
<td>82,08</td>
<td>82,94</td>
<td>70,46</td>
<td>73,62</td>
<td>74,70</td>
<td>76,40</td>
</tr>
<tr>
<td>EU 2004</td>
<td>74,21</td>
<td>75,60</td>
<td>76,97</td>
<td>78,31</td>
<td>79,55</td>
<td>65,52</td>
<td>65,79</td>
<td>67,86</td>
<td>69,34</td>
</tr>
<tr>
<td>EU 2007</td>
<td>73,90</td>
<td>74,88</td>
<td>75,09</td>
<td>76,23</td>
<td>77,26</td>
<td>68,44</td>
<td>67,63</td>
<td>68,19</td>
<td>69,06</td>
</tr>
<tr>
<td>Non EU members</td>
<td>74,21</td>
<td>72,77</td>
<td>73,32</td>
<td>73,63</td>
<td>75,30</td>
<td>63,98</td>
<td>60,71</td>
<td>61,55</td>
<td>61,32</td>
</tr>
</tbody>
</table>

*Note: EU members: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom; EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine*
In 1980, women and men living in the core EU countries could enjoy prospects of the longest average life expectancy compared to the other groups of countries. For females those differences were relatively equal – all other groups could on average expect about three fewer years of life. The difference in average life expectancy between the other groups and the core EU members varied more for males, between two and almost six and a half years. In 1980 the greatest difference was between males living in the core EU countries and those who are not members of EU. The development which follows during the next thirty years appears to be relatively similar for both males and females. The annual change in females’ life expectancy for different periods is presented in Figure 1 and for males in Figure 2.

**Figure 1. Average annual change in years for females’ life expectancy at birth between selected years.**
In the first period the difference between groups of countries grows somewhat for women and to larger extent for men. Two aspects contributed to growing divergence between presented groups of countries. The first aspect is that not every group experienced the positive development of life expectancy at birth. For males and females who are not EU members, but also for males in Bulgaria (EU 2007) the development moved in opposite direction. A comparison of average life expectancy at birth for 1980 and 1995 (Table 1) reveals the magnitude of this change. Between 1980 and 1995, the average life expectancy at birth for non EU members dropped by 1.44 years for females and 3.27 years for males. In Bulgaria (EU 2007) the negative change in life expectancy affected only males resulting in 0.81 lower life expectancy in 1995 compared to 1980. The second aspect contributing to the growing divergence between country groups was the fact that for those groups who actually experienced an increase in life expectancy between 1980 and 1995 the pace of increase was slower as for the core EU members (Figure 1 & Figure 2). Between 1980 and 1995 life expectancy for the core EU members have been increasing with 0.2 years every year for females and slightly more for males. For women living in the EU 2004 countries the pace of
increase in life expectancy at birth have been about a half of that of women in core EU countries, while for Bulgarian women (EU 2007) about one third.

Those two aspects together contributed to the growing divergence in life expectancy at birth. In 1995, compared to women living in the core EU countries, the average life expectancy at birth was 4.49 years lower for females in EU 2004 countries and 5.21 years lower for Bulgarian females (EU 2007). The observed decline in average life expectancy at birth observed in non EU countries has contributed to that the distance between women in core EU countries and in non EU countries increased to more than seven years. The differences in prospects of life expectancy at birth between European regions are even more apparent for males. Compared to the males living in core EU countries, the average life expectancy at birth in 1995 was 7.83 years lower for countries of EU 2004 and 5.99 years for Bulgarian males (EU 2007). The distance between core EU countries and non EU members have increased to as much as 12.91 years (Table 1).

In the following period, between 1995 and 1999, the pattern of life expectancy development changed for all groups of countries. During that time females and males in countries of EU 2004 were experiencing the fastest increases in life expectancy at birth, while development in core EU countries have not accelerated as much for males and actually slowed down for females compare to period before. Between 1995 and 1999 life expectancy at birth was increasing twice as fast in EU 2004 countries than in core EU countries. Especially favourable development has been found for males living in EU 2004 countries, who gained on average half a year each year between 1995 and 1999. The increase in Bulgaria slowed down somewhat for females and reversed for males toward increasing trend in life expectancy. Moreover, the non EU member countries experienced comparable with core EU countries pace of increase in life expectancy. The fast annual increase in life expectancy at birth for EU 2004 members in combination with reduced increases for the core EU members, contributed to reduction in the life expectancy gap between those two groups. The difference between core EU countries and the other two groups continued to grow.

The pattern of improvement in life expectancy which occurred in following period (1999-2004) changed somewhat compared to the period before. Life expectancy at birth have
increased with a similar pace for women in core EU countries, EU 2004 countries and Bulgaria during that period, nearly 0.3 years for each year. Compared to the previous period, life expectancy development continued to accelerate for both males and females in core EU countries while it slowed down in EU 2004 countries. Nevertheless, women in EU 2004 countries continued to increase the life expectancy somewhat faster than women in the other groups. The very weak gains in life expectancy for females in non EU countries and once again reversed development for males made the life expectancy gap grow larger again. In 2004, the distance to core EU countries have increased for males in all other groups of countries compared to year 1999. Males living in Bulgaria and the countries of EU 2004 have on average about seven years lower life expectancy in 2004, while non EU males about 15 years lower life expectancy compared to core EU countries. For females those differences were much smaller, between 3.77 years (EU 2004) to 8.45 (non EU countries). Furthermore, women living in EU 2004 countries were the only group who continued to reduce the life expectancy gap to core EU countries.

In the latest compared period between 2004 and 2009, the pattern of development continue for the group of EU 2004 countries who continue to improve life expectancy at birth with a faster pace of development compared to core EU countries. However, the region which experienced the largest improvements between in the latest period was countries who are not EU members. But despite this positive development in the latest period, in 2009 a female in the non-member countries was expected to live on average 7.64 fewer years than a woman from a core EU country. The corresponding difference for women from EU 2004 country was only 3.39 years (5.68 fewer years for Bulgarian women). A similar pattern emerges for males, but the differences between those groups are even greater. In 2009, a male from non-member country could expect to live on average 13.84 fewer years that a man living in a core EU country. The corresponding difference for a man from EU 2004 country was on average 6.68 fewer years and for a Bulgarian man 7.63 fewer years. Between 2004 and 2009 females and males in almost all groups (except Bulgarian males) was able to reduce the life expectancy gap to core EU member countries to some extent.

Regression analysis
In the following I will conduct a regression analysis to estimate the impact of being a member of different groups on life expectancy. I furthermore examine whether controlling for economic progress and also for governmental health expenditure of countries will change the outcome.

In the results of models using life expectancy at birth as dependent variable (Table 2 & Table 3) belonging to group with different EU membership status proved to be statistically significant and have an effect which remains through all three periods. Belonging to any other group of countries and not the group of core EU members (Table 2, Model 1) have a negative impact on females’ life expectancy at birth. The differences in the relation to the reference group are quite similar for all other groups in the beginning of examined period, between 4.02 and 4.60 fewer years on average. Those differences continued to increase in the following period (1995-2003) however with diverse intensity for different groups. In that period the negative impact of belonging to some other group and not the group of core EU members was smallest for the group of countries who became EU members in 2004, who could expect 4.64 years shorter life expectancy on average, while corresponding difference for EU member since 2007 was 6.64 - and for non EU-members 8.33 fewer years. In the last period, the negative effect of not being a member of the core EU countries, have continued to increase somewhat for all groups beside the countries who became EU members in 2004. This group has in fact reduced the difference towards core EU countries.

In the second model, in which an indicator for economic change were introduced (Table 2, Model 2), the general pattern of the effect belonging to certain groups have, remains mostly the same. Controlling for the economic change in countries gives different effects in the three periods examine here. For the earliest period controlling for GDP strengthen the differences between reference group and the other groups, while in the latest period (and negligible in the period before) the situation is the opposite. In those two latest periods (1995-2003 and 2004-2011) controlling for GDP minimized the effect of belonging to groups with different EU-status, which indicate that economic change had an intermediating effect on life expectancy at birth. Nevertheless, the results indicated that even if the countries experience similar GDP change, belonging to a specific group has a significant effect on life expectancy. Even though the effect reduces somewhat, the differences between groups remain the same. EU-member since 2007 shows the same tendency of turning the negative life expectancy development
trend as countries that joined EU in 2004. Estimates of a direct effect of percentage change in GDP on life expectancy at birth show a very little negative effect.

Controlling moreover for the changes in governmental health expenditure for the two latest periods (Table 2, Model 3), minimize further the effect of belonging to certain groups, nevertheless the pattern of those differences remains. The direct impact of public sector expenditure on health is positive on life expectancy at birth, which shows that increases in percentage governmental health expenditure contribute to mortality improvements.

To sum up, for females, the negative impact of not belonging to the core EU countries, persist over all three time-periods, but the reductions of that impact for countries who joined EU in 2004 (and to lesser degree for the EU 2007 member) observed in the latest period could indicate that accessing EU may have a positive effect on life expectancy at birth. Apart of economic change or governmental expenditure on health, females living in EU 2004 and EU 2007 countries experienced improvements in life expectancy at birth in the latest period which reduced the difference to core EU members.

Table 2. Result of regression analysis. Dependent variable: Females life expectancy at birth. Unstandardized Coefficients.

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<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
</tr>
<tr>
<td>Constant</td>
<td>79,03***</td>
<td>79,51***</td>
<td>81,65***</td>
</tr>
<tr>
<td>EU 2004^a</td>
<td>-4,02***</td>
<td>-4,38***</td>
<td>-4,64***</td>
</tr>
<tr>
<td>EU 2007^a</td>
<td>-4,52***</td>
<td>-4,67***</td>
<td>-6,64***</td>
</tr>
<tr>
<td>Non EU-members^b</td>
<td>-4,60***</td>
<td>-5,29***</td>
<td>-8,33***</td>
</tr>
<tr>
<td>GDP: annual change</td>
<td>-0,06**</td>
<td>-0,004</td>
<td>-0,005</td>
</tr>
<tr>
<td>Public sector expenditure on health</td>
<td></td>
<td>0,108^1</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>242</td>
<td>242</td>
<td>153</td>
</tr>
<tr>
<td>R^2</td>
<td>0,705</td>
<td>0,726</td>
<td>0,857</td>
</tr>
</tbody>
</table>

^a EU core members as a reference group: Austria, Germany, France, Italy and Sweden; EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine

^1 Not sign. F-change (sign 0,862)
^2 Not sign. F-change (sign 0,262)
Table 3. Result of regression analysis. Dependent variable: Males life expectancy at birth.

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<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
</tr>
<tr>
<td>Constant</td>
<td>72,05***</td>
<td>72,15***</td>
<td>75,49***</td>
</tr>
<tr>
<td>EU 2004*</td>
<td>-5,95***</td>
<td>-6,03***</td>
<td>-7,73***</td>
</tr>
<tr>
<td>EU 2007*</td>
<td>-3,84***</td>
<td>-3,88***</td>
<td>-7,51***</td>
</tr>
<tr>
<td>Non EU-members*</td>
<td>-7,73***</td>
<td>-7,88***</td>
<td>-14,07***</td>
</tr>
<tr>
<td>GDP: annual change</td>
<td>-0,013</td>
<td>-0,073</td>
<td>-0,074</td>
</tr>
<tr>
<td>Public sector expenditure on health</td>
<td>0,132</td>
<td>0,289*</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>242</td>
<td>242</td>
<td>153</td>
</tr>
<tr>
<td>R²</td>
<td>0,693</td>
<td>0,693³</td>
<td>0,822</td>
</tr>
</tbody>
</table>

* p<0.05, ** p<0.01, *** p<0.001

Table 3. Result of regression analysis. Dependent variable: Males life expectancy at birth.

The results for males’ life expectancy at birth as depending variable are slightly different than those for females even if showing the same negative effect of not being a member of the core EU countries. In the first model where only the EU-membership status examines (Table 3, Model 1), all groups have on average lower life expectancy at birth compare to reference group. Those differences vary more for males and for the earliest period are lowest for the EU 2007 member, who could expect on average 3.84 fewer years than reference group. For the EU 2004 members the average difference was 5.95 fewer years and 7.73 fewer years for non EU members. This gap continue to grow for the following periods resulting in the life expectancy differences of about eight years for EU 2004 and 2007 members, to more than fifteen years for non EU members compared to reference group. Introducing GDP change (Table 3, Model 2) strengthen the effect of belonging to EU groups at first but similarly as for females reduces that effect in two latest time periods while the direction of change remain the same. First when both GDP change and governmental expenditure on health includes (Table 3, Model 3), can a slight turnover in negative development for the most recent period.

³ Not sign. F-change (sign 0,666)
⁴ Not sign. F-change (sign 0,093)
⁵ Not sign. F-change (sign 0,184)
observes. In contrast to females’ life expectancy, for males controlling for economic change and governmental expenditure on health shows that all groups reduced somewhat the differences in life expectancy at birth in relation to core EU members. Nevertheless those differences was still bigger that for females, especially for the non EU members.

**Life expectancy at age 80**

**Descriptive statistics**
Similarly to life expectancy at birth, also 80-years old women and men living in the core EU countries could enjoy prospects of the longest average life expectancy compared to the other groups of countries. In contrast to the life expectancy at birth however, older women are more affected by belonging to certain groups of countries than males are, as the differences between core EU countries and other groups are bigger for 80 years old females than males. A comparison for different groups of countries (Table 4) reveals that in 1980, which is the beginning of examined period, the greatest difference in average life expectancy at age 80 was between women living in core EU countries and those living in Bulgaria (EU 2007). Bulgarian women could on average expect 1.28 fewer years of living, followed by women living in EU 2004 countries whose life expectancy was 0.81 years lower than for women in core EU countries. For women living in non EU countries the difference in life expectancy at age 80 compared to core EU countries was the smallest, on average 0.27 fewer years. Furthermore also for males in non EU countries the difference in life expectancy at age 80 was on average 0.27 fewer years compared to males living in core EU countries, while for males living in EU 2004 and EU 2007 countries the difference was bigger: 0.5 respective 0.52 fewer years.

**Table 4. The average life expectancy at 80 for different groups of countries. Selected years.**

<table>
<thead>
<tr>
<th></th>
<th>FEMALES</th>
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<th></th>
<th>MALES</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EU core members</strong></td>
<td>7,21</td>
<td>8,29</td>
<td>8,45</td>
<td>9,04</td>
<td>9,41</td>
<td>5,86</td>
<td>6,53</td>
<td>6,76</td>
<td>7,30</td>
<td>7,69</td>
</tr>
<tr>
<td><strong>EU 2004</strong></td>
<td>6,40</td>
<td>6,92</td>
<td>7,31</td>
<td>7,68</td>
<td>8,01</td>
<td>5,36</td>
<td>5,80</td>
<td>6,12</td>
<td>6,39</td>
<td>6,66</td>
</tr>
<tr>
<td><strong>EU 2007</strong></td>
<td>5,93</td>
<td>6,16</td>
<td>6,34</td>
<td>6,56</td>
<td>6,84</td>
<td>5,34</td>
<td>5,41</td>
<td>5,66</td>
<td>5,76</td>
<td>6,10</td>
</tr>
<tr>
<td><strong>Non EU members</strong></td>
<td>6,94</td>
<td>6,38</td>
<td>6,36</td>
<td>6,62</td>
<td>6,98</td>
<td>5,59</td>
<td>5,18</td>
<td>5,31</td>
<td>5,54</td>
<td>5,87</td>
</tr>
</tbody>
</table>

**Note:** EU core members: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom; EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine
The development which follows during the next thirty years appears to be relatively similar for both males and females. The annual change in females’ life expectancy at age 80 for different periods is presented in Figure 3 and for males in Figure 4.

**Figure 3. Average annual change in years for females’ life expectancy at age 80 between selected years.**

![Graph showing average annual change in years for females’ life expectancy at age 80 between selected years.](image)

**Note:** EU core members: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom; EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine

**Figure 4. Average annual change in years for males’ life expectancy at age 80 between selected years.**

![Graph showing average annual change in years for males’ life expectancy at age 80 between selected years.](image)

**Note:** EU core members: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom; EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine
In the same way as for life expectancy at birth, the differences between groups of countries increased in the first period, between 1980 and 1995. Similarly as for the life expectancy at birth, the core EU countries experienced the fastest pace of improvement in life expectancy at age 80 during that period whereas for the other groups the development was not as good. Moreover, in non EU countries the life expectancy development for males and females moved in opposite direction. Those two aspects caused the growth of differences between core EU countries and the other groups. A comparison of average life expectancy at age 80 (Table 4), shows that in 1995, 80-years old females living in Bulgaria (EU 2007) could on average expect 2.12 fewer years of living than females living in the core EU countries, while the corresponding number for non EU countries was 1.91 years and 1.37 for women living in EU 2004 countries. For males the differences increased most between core and non EU countries where in 1995 males could on average expect 1.35 fewer years of living. The differences were somewhat smaller for Bulgarian males (1.12 fewer years) and for EU 2004 countries (0.73 fewer years. Similarly as for life expectancy at birth, the differences in pace of positive development together with the negative development for non EU members contributed to growth of life expectancy gap between core EU countries and the other groups for that period. In contrast to life expectancy at birth, Bulgarian males at age 80 have also experienced positive development in life expectancy for that period, even if that progress was only about one tenth of that of core EU members (Figure 4).

In the following period, between 1995 and 1999, the pattern of life expectancy development changed for all groups of countries (Figure 3 and Figure 4). During that time females and males in countries of EU 2004 were experiencing the fastest increases in life expectancy at age 80. Compared to the period before that, the speed of increase in life expectancy in that group was almost three times faster for females and 2.5 faster for males than between 1980-1995. In core EU countries the speed of increase in life expectancy accelerated somewhat for males but not for females for whom the development slowed down compare to period before. Also Bulgarian males and females experienced improvements in life expectancy during that period. Even if that development was not as great as for EU 2004 countries it was however somewhat higher than in core EU countries. Unlike life expectancy at birth, for 80 years old Bulgarian males the prospects of life length have improved during that period. The same does
not apply to females in non EU countries as their life expectancy at age of 80 continued to decline (Figure 3). Males could however enjoy a positive development in that period (Figure 4). The rapid annual increase in life expectancy at age 80 for EU 2004 (and also for EU 2007) members in combination with reduced increases for the core EU members, contributed to reduction in the life expectancy gap between those groups. The difference between core EU countries and the other two groups continued to grow. A comparison of average life expectancy at age 80 (Table 4) shows that in 1999 80-years old females living in EU 2004 countries would on average expect 1.14 fewer years of living compared to the women in core EU countries. For Bulgarian women the difference was bigger - on average 2.11 fewer years which is very close to the difference which was observed for women in non EU countries (2.09 fewer years). For males the life expectancy distance to core EU countries was smaller 0.64 fewer years for males living in EU 2004 countries, 1.1 for Bulgarian males and 1.45 for males living in non EU countries. Unlike life expectancy at birth, the reductions in life expectancy gap between core and 2004 EU countries did not continued. A comparison of average life expectancy at age 80 shows that in the following periods the distance to the core EU countries continued to increase for both males and females.

Between 1999 and 2004 the pace of life expectancy at age 80 accelerated most in core EU countries. Compared to preceding period, the speed of development tripled for females and doubled for males. The pace of life expectancy increase accelerated also in non EU countries, which was especially important for females in that group as they finally started to increase the life expectancy at age 80. The rapid improvements observed in EU 2004 and 2007 countries in the previous period have now slowed down somewhat.

In the latest compared period, between 2004 and 2009, females and males in both core and 2004 EU countries loosened the speed of life expectancy increases compared to the period before. Despite that, the life expectancy improvements in the core EU countries continued however to be faster than in all other groups. Even though Bulgaria (EU 2007) and non EU countries increased the speed of life expectancy development in the latest period it wasn´t enough to be able to reduce the life expectancy gap to the core EU countries. In 2009 females living in EU 2004 countries would expect 1.4 fewer years of living than women living in the core EU countries, while in non EU countries the difference was 2.43 fewer years. In Bulgaria
females would expect 2.57 fewer years of living than women in core EU countries. For males the biggest distance to the average life expectancy at age 80 enjoyed in core EU countries was found for non EU members who would on average expect 1.82 fewer years of living followed by Bulgarian males who would on average expect 1.59 fewer years. Males living in the EU 2004 countries would on average expect 1.03 fewer years of living than males in core EU countries (Table 4).

To summarize, the belonging to different groups of countries have similar importance as for the life expectancy at birth. Women and men living in the core EU countries have the highest life expectancy at age 80 compared to the other groups of countries – a difference which besides a temporary decrease due to acceleration of pace of life expectancy increase between 1995 and 1999 in EU 2004 and 2007 countries, continued to grow in remaining periods. Furthermore, the observed differences in average life expectancy at age 80 between core EU countries and other groups are bigger for females than males which is the opposite to the life expectancy at birth, where the distance to the core EU countries was greater for males.

Regression analysis

In this part of analysis I will estimate the impact which being a member of different groups have on life expectancy at age 80. Similarly as for life expectancy at birth I will furthermore examine whether controlling for economic progress and also for governmental health expenditure of countries will change the outcome. The result of regression analysis is presented separately for females (Table 5) and males (Table 6).

In the results of models using life expectancy at age 80 as dependent variable (Table 5 & Table 6) belonging to group with different EU membership status proved to be statistically significant and have an effect which remains for both males and females through all three periods. Belonging to any other group of countries and not the group of core EU members (Table 5, Model 1) have a negative impact on females’ life expectancy at birth. The differences in the relation to the reference group for all other groups in the beginning of examined period are smallest for non EU members and highest for Bulgarian women. Those differences continued to increase in the following periods (1995-2003 and 2004-2011)
however with diverse intensity for different groups. In those periods the negative impact of belonging to some other group and not the group of core EU members changed to the advantage for the EU 2004 countries that had the smallest life expectancy gap to core EU countries.

In the second model, in which an indicator for economic change were introduced (Table 5, Model 2), the general pattern of the effect belonging to certain groups have, remains the same. Controlling for the economic change in countries gives different effects in the three periods examine here. For the two first periods controlling for GDP strengthen the differences between reference group and the other groups, while in the latest period the situation is the opposite. In the latest period (2004-2011) controlling for GDP minimized the effect of belonging to groups with different EU-status, which indicate that economic change had an intermediating effect on life expectancy at age 80. Nevertheless, the results indicated that even if the countries experience similar GDP change, belonging to a specific group has a significant effect on life expectancy. For women at age 80 members of all groups continue to increase the differences to core EU members over all three periods of time (Table 5).

Estimates of a direct effect of percentage change in GDP on life expectancy at birth show an effect which is not consistent over time. Controlling moreover for the changes in governmental health expenditure for the two latest periods minimize the effect of belonging to different EU groups between 1995 and 2003, but strengthen it in the latest period (Table 5, Model 3). The direct impact of public sector expenditure on health is more inconsistent for older women than it was for the life expectancy at birth.
Table 5. Result of regression analysis. Dependent variable: Females life expectancy at 80.

Unstandardized Coefficients.

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<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
</tr>
<tr>
<td>Constant</td>
<td>7.79***</td>
<td>7.94***</td>
<td>8.80***</td>
</tr>
<tr>
<td>EU 2004a</td>
<td>-1.13***</td>
<td>-1.24***</td>
<td>-1.50***</td>
</tr>
<tr>
<td>EU 2007a</td>
<td>-1.73***</td>
<td>-1.77***</td>
<td>-2.65***</td>
</tr>
<tr>
<td>Non EU-members</td>
<td>-0.89***</td>
<td>-1.11***</td>
<td>-2.34***</td>
</tr>
<tr>
<td>GDP: Annual change</td>
<td></td>
<td>0.015</td>
<td>0.015</td>
</tr>
<tr>
<td>Public sector expenditure on health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>242</td>
<td>242</td>
<td>153</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.512</td>
<td>0.532</td>
<td>0.859</td>
</tr>
</tbody>
</table>

$p<0.05$  $**p<0.01$  $***p<0.001$

$a$ EU core members as a reference group: Austria, Germany, France, Italy and Sweden, EU 2004. Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine

The results for males’ life expectancy at birth as depending variable are slightly different than those for females even if showing the same negative effect of not being a member of the core EU countries. In the first model where only the EU-membership status examines (Table 6, Model 1), all groups have on average lower life expectancy at birth compare to reference group. Those differences vary less for males and for the earliest period are lowest for the EU 2007 member, who could expect on average 0.82 fewer years than reference group. For the EU 2004 members the average difference was 0.71 fewer years and 0.59 fewer years for non EU members. This gap continues to grow for the following periods resulting in the increased life expectancy differences to reference group. Introducing GDP change (Table 6, Model 2) strengthen the effect of belonging to EU groups at first but similarly as for females reduces that effect in the latest time period while the direction of change remain the same. For 80 years old males the negative impact of not being a member of the core EU countries increases with time and even controlling for economic development and governmental expenditure on health (Table 6, Model 3) do not reveal any possible downward trend. Estimating the direct

$^6$ Not sign. F-change (sign 0,257)

$^7$ Not sign. F-change (sign 0,357)

$^8$ Not sign. F-change (sign 0,129)
effect of GDP percentage change for life expectancy at age 80 and furthermore public sector expenditure on health shows the same effect as for females.

Table 6. Result of regression analysis. Dependent variable: Males life expectancy at 80. Unstandardized Coefficients.

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<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
</tr>
<tr>
<td>Constant</td>
<td>6.25***</td>
<td>6.34***</td>
<td>7.05***</td>
</tr>
<tr>
<td>EU 2004(^a)</td>
<td>-0.71***</td>
<td>-0.78***</td>
<td>-0.95***</td>
</tr>
<tr>
<td>EU 2007(^a)</td>
<td>-0.82***</td>
<td>-0.85***</td>
<td>-1.56***</td>
</tr>
<tr>
<td>Non EU-members</td>
<td>-0.59***</td>
<td>-0.72***</td>
<td>-1.68***</td>
</tr>
<tr>
<td>GDP: Annual change</td>
<td>-0.012</td>
<td>0.008</td>
<td>0.008</td>
</tr>
<tr>
<td>Public sector</td>
<td></td>
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<tr>
<td>expenditure on</td>
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<tr>
<td>health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>242</td>
<td>242</td>
<td>153</td>
</tr>
<tr>
<td>R(^2)</td>
<td>0.362</td>
<td>0.376(^9)</td>
<td>0.854</td>
</tr>
</tbody>
</table>

\(^a\) EU core members as a reference group: Austria, Germany, France, Italy and Sweden, EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine

To sum up, for females and males, the negative impact of not belonging to the core EU countries, persist over all three time-periods and a reduction analogous to that in EU 2004 countries for life expectancy at birth observed in the latest period do not applies for 80 years old people. That could indicate that accessing EU may have a positive effect on life expectancy at birth but not for the older ages.

**Infant mortality**

**Descriptive statistics**

In a next step I explore the impact being a member of a certain country group have on infant mortality. In Table 7, I present the average number of infant deaths per 1000 live births for selected years and different groups of countries.

\(^9\) Not sign. F-change (sign 0.077)
\(^10\) Not sign. F-change (sign 0.108)
\(^11\) Not sign. F-change (sign 0.814)
\(^12\) Not sign. F-change (sign 0.563)
Table 7. The average infant deaths per 1000 live births for different groups of countries. Selected years.

<table>
<thead>
<tr>
<th></th>
<th>FEMALES</th>
<th>MALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU core members</td>
<td>10,79</td>
<td>4,92</td>
</tr>
<tr>
<td>EU 2004</td>
<td>17,12</td>
<td>10,45</td>
</tr>
<tr>
<td>EU 2007</td>
<td>17,24</td>
<td>12,97</td>
</tr>
<tr>
<td>Non EU members</td>
<td>18,77</td>
<td>13,17</td>
</tr>
</tbody>
</table>

Note: EU core members: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom; EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine

In 1980, the lowest average infant mortality was found in the core EU countries for both males and females. Females in all other groups had on average between 6.33 and 7.98 more infant deaths per 1000 live births, for males the values ranged between 9.03 and 11.62. The highest infant mortality was observed among non EU countries. Since 1980 until 2009 almost every group have experienced continued decreases in infant mortality. Only for males in Bulgaria (EU 2007) this trend reversed temporally between 1995 and 1999. The pace of decrease differed however for regions and time-periods, which is presented in Figure 5 for females and Figure 6 for males.

Figure 5. Average annual percentage decline in females’ infant deaths per 1000 live births between selected years.

Note: EU core members: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom; EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine
For EU core countries the pace of change has been varying slightly for the past thirty years, nevertheless it also is the group which have achieved very low infant mortality already in 1995, why large changes since that would be nearly impossible to obtain. For the other groups, the most rapid reductions in infant mortality occurred later periods. For EU 2004 countries, the period of most rapid infant mortality decline occurred between 1995 and 1999, followed by a period of slower decline between 1999 and 2004 and a new period of relative fast decline again in the most recent period. For non EU members the period of greatest decreases in infant mortality took place between 1999 and 2004, while during all other time-periods those changes shows lower pace of change. For Bulgaria (EU 2007) the most favourable period differ between males and females. Males in Bulgaria were first to experience more rapid decline in infant mortality, which took place between 1999 and 2004 but also continued with almost same relative speed of change between 2004 and 2009. Bulgarian females enjoyed fastest improvements in infant mortality during the latest time period, nevertheless they did not experienced the fall off that Bulgarian males did between 1995 and 1999.
Regression analysis

In this part of analysis I will estimate the impact which being a member of different groups have on infant mortality. In the analogous way as for life expectancy, I furthermore examine whether controlling for economic progress and also for governmental health expenditure of countries will change the outcome. The result of regression analysis is presented separately for females (Table 8) and males (Table 9).

Table 8. Result of regression analysis. Dependent variable: Females infant deaths per 1000 live births. Unstandardized Coefficients.

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<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
</tr>
<tr>
<td>Constant</td>
<td>7,21***</td>
<td>6,53***</td>
<td>4,01***</td>
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<tr>
<td>EU 2004^a</td>
<td>5,08***</td>
<td>5,59***</td>
<td>3,68***</td>
</tr>
<tr>
<td>EU 2007^a</td>
<td>7,16***</td>
<td>7,37***</td>
<td>8,70***</td>
</tr>
<tr>
<td>Non EU-members</td>
<td>6,57***</td>
<td>7,54***</td>
<td>6,97***</td>
</tr>
<tr>
<td>GDP: Annual change</td>
<td>0,087*</td>
<td>-0,056</td>
<td>-0,052</td>
</tr>
<tr>
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<tr>
<td>expenditure on</td>
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<tr>
<td>health</td>
<td></td>
<td></td>
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<tr>
<td>n</td>
<td>216</td>
<td>216</td>
<td>153</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0,503</td>
<td>0,519</td>
<td>0,573</td>
</tr>
</tbody>
</table>

^a EU core members as a reference group: Austria, Germany, France, Italy and Sweden, EU 2004; Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine

^13 Not sign. F-change (sign 0,220)
^14 Not sign. F-change (sign 0,059)
Table 9. Result of regression analysis. Dependent variable: Males infant deaths per 1000 live births. Unstandardized Coefficients.

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<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
</tr>
<tr>
<td>Constant</td>
<td>9.22***</td>
<td>8.20***</td>
<td>4.94***</td>
</tr>
<tr>
<td>EU2004</td>
<td>6.67***</td>
<td>7.44***</td>
<td>4.39***</td>
</tr>
<tr>
<td>Non EU-members</td>
<td>9.39***</td>
<td>10.84***</td>
<td>9.87***</td>
</tr>
<tr>
<td>GDP: Annual change</td>
<td>0.130*</td>
<td>-0.092</td>
<td>-0.088</td>
</tr>
<tr>
<td>Public sector</td>
<td></td>
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<tr>
<td>expenditure on</td>
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</tr>
<tr>
<td>health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>216</td>
<td>216</td>
<td>153</td>
</tr>
<tr>
<td>R²</td>
<td>0.528</td>
<td>0.549</td>
<td>0.650</td>
</tr>
</tbody>
</table>

* p<0.05  ** p<0.01  *** p<0.001

* EU core members as a reference group: Austria, Germany, France, Italy and Sweden, EU 2004: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia; EU 2007: Bulgaria; Non EU members: Belarus, Russia and Ukraine

Results of regression models using infant deaths per 1000 live births as dependent variable showed that belonging to group with different EU membership status is statistically significant and have an effect which remains through all three periods. Belonging to any other group of countries and not the group of core EU members have a negative impact on females’ and males infant mortality (Model 1, Table 8 and 9). The differences in the relation to the reference group are similar for both females and males. The smallest difference in infant mortality can be found for the group of EU 2004 countries followed by non EU members. The biggest negative impact on infant mortality has being a member of EU 2007 country (Bulgaria). This not applies however for males in the earliest period.

In the next step, I also controlled for the effect of economic change (Model 2, Table 8 and 9). When GDP change was held constant, the negative impact of being a member of other group and not core EU countries strengthens for the two first time-periods but then minimize in the last years. The reduction of the EU membership effect in the latest observed period suggests

15 Not sign. F-change (sign 0,079)
16 Not sign. F-change (sign 0,087)
17 Not sign. F-change (sign 0,067)
that some of the previous impact on infant mortality was due to the mediating effect of GDP. The direct effect of GDP annual percentage change for infant mortality is inconsistent over time.

Finally in the last model (Model 3, Table 8 and 9), I also control for the effect the governmental expenditure on health may have on differences in infant mortality for the different groups of countries. The results show that the negative outcome of not being a core EU member reduces further when both economic change and governmental expenditure are controlled for. For females and males from EU 2004 countries the negative impact of not being member of core EU countries reduces to very small impact which no longer is statistically significant. Introducing governmental expenditure on health in the model reduces the effect of EU group belonging which point toward the mediating effect of health expenditure on infant mortality. That impact is visible when the direct effect on infant mortality estimates. For both males and females increases in public sector expenditure on health reduce infant mortality.

To summarize, all groups of countries have reduced the difference in absolute number of infant deaths per 1000 live births compared to core EU countries. Analysis reveal also that only EU 2004 countries have started reducing the gap toward core EU countries already between 1995-2003, while Bulgaria (EU 2007) and non EU member continued to increase infant mortality gap toward core EU countries.

**Discussion**

In this paper, I studied two questions associated with mortality conditions in different regions in Europe. In my first research question I examined how EU membership status affected the development in life expectancy and infant mortality around the time of the most extensive enlargement of European Union in 2004. I hypothesized that countries who became EU members in 2004 will experience a faster pace of change in life expectancy progress around the time of EU enlargement. In my second research question, I furthermore examined whether
any trend toward a convergence in life expectancy between core EU members and countries who became EU members in 2004 appears.

Regarding my first research question on which addresses mortality affecting groups of countries differently around the time of EU enlargement in 2004, a few conclusions can be drawn. A comparison between groups showed for all mortality indicators studied that the EU 2004 countries experienced accelerated improvements in the period between 1995 and 1999. Regarding life expectancy at birth, women in EU 2004 countries continued to experience improvements faster than core EU countries also in the following two periods (1999-2004 and 2004-2009) only overtaken by non EU members faster development in the latest period. The accelerated improvements observed for the same period for males in 2004 EU countries declined in the following period but raised again in latest observable period, also here overtaken by accelerated development in non EU countries.

It is possible that the different development in life expectancy’s pace of growth was due to the political and economic changes for that period. I have proposed that joining European Union would affect mortality conditions in European countries with a possible explanation of importance of the social environment for the mortality development in Eastern and Central Europe in the period before and after 2004. I have pointed out difficulties with measuring such an effect as it can operate through other factors (e.g. life style behaviours). The effect of social environment can thus be only tested theoretically here. I claim that results conducted in this paper indicate that such an effect can be possible explanation to the development in EU 2004 countries in the period before joining EU. I suggest that the psychosocial stress which have been partly responsible for the increases in premature deaths in Russia during the period of transition from communism to a market economy system (Shkolnikov et al., 2004) can also operate in the opposite way. The process of joining Europe’s biggest economic and political partnership, European Union can possibly reduce social stress and moreover affect mortality conditions positively. In contrast to the unstable situation which followed regime change exemplified by Russia, the process of applying for membership in EU pushed the applicant countries toward positive socio-economic development through adapting the rules and
regulations required by the EU. The structural changes required by the EU can also affect mortality on the individual level. If the future prospects are bright, people may feel more secure and hopeful, while the feeling of control over their own life increases. Studies about the lack of control and negative health outcome have been earlier found in several countries of former communist countries (Marmot, 2004, p.212-214). The wealth of the European Union and the help received from the EU during the application period can possible decrease social stress. This process is also similar to the process of German reunification, however in Germany the political, social and economic changes was initiated immediately after reunification, with the aim of adjust all areas to the levels of West Germany. The process leading to EU membership is however more time undefined and depends on each countries progress. Furthermore applicant countries do not adjust to one country’s standards, rather to a group of countries which are all members of the European Union, but which wealth of countries is varying. The process of application and negotiations for the candidate countries put their efforts toward the implementation of reforms required to achieve the accession criteria. The negotiation period can vary between countries and its length depends on how fast the necessary reforms and adaptations will be accomplished. The limitation of this study is not examining the process of application and controlling for the timing of attained goals during that process. A deeper analysis of the application period in each country and the mortality development during that time would add valuable evidence for the role of pre- and pro enlargement period in the life expectancy changes. The social environment can furthermore affect mortality through life style behaviours which also can only be discussed theoretically here. The improvements in the social environment can possibly be reflected in positive changes in alcohol and cigarette consumption leading to lower mortality related to alcohol and smoking consumption. The EU membership can nevertheless affect life style behaviours more directly, which can be exemplified by the legalisation for smoke-free environments in EU. In a European Commission recommendation (Council of the European Union, 2009) member countries invites to adopt and implement relevant laws and policies which will protect their citizens from the exposure to tobacco. The impact of EU membership on mortality which would here operate through changed life style behaviours can nevertheless be uncertain due to the time-lag effect (Lopez, Collishaw and Piha, 1994; Thun, Peto, Boreham, & Lopez, 2012).
Previous research confirmed the role of health care for mortality development, which can be negative because of insufficient health care as in Russia (Shkolnikov et al., 2004) or positive due to the improvements as those observed after the reunification in Germany (Gjonça et al., 2000). Based on the results found in Eastern and Central Europe (Billingsley, 2011), I also argued that the economic development is expected to have mediating effect on mortality. In the analysis that I conducted in this paper public sector expenditure on health have been proved to positively affect mortality conditions in the examined groups of countries, however being inconsistent for age 80. Those results can indicate that the improvements in health care were more important overall, than specific for the older ages. It is furthermore possible that the health care measure used here is not sufficient to measure progress in countries during their application period. Moreover, the impact of GDP annual percentage change on mortality indicators used here has not been consistent over time. Such results can indicate some lagged effect not included here or that GDP and the measure on public sector expenditure on health correlate with each other. It is furthermore possible that GDP is not an adequate measure for the economic progress of countries being in the process of application. The European Union support candidate countries during the negotiation process, which also include financial support (http://europa.eu/about-eu/countries/joining-eu/index_en.htm). In the analysis I conducted in this paper there is the possibility that the measure of economic progress used here is not valid because it does not include the financial means obtained in the process preceding EU membership or because the increases in GDP are not equally distributed across the population (e.g. if GDP increases affect the richest people most, the health outcome might be less affected than if GDP would affect the poorest people most). Furthermore when analysing the trends for the groups of countries, it is important to point out that there is a possibility that the results can be affected by a selection mechanism. That selection mechanism concerns the level of development of applying for membership countries. It is possible that countries applying for EU membership have attained a certain level of development even before their application process started and that those countries differ in advancement (e.g. most advanced countries of Central and Eastern Europe) from other Central- and East-European countries.
My second research question addresses a possible convergence in life expectancy between earlier (prior to 2004) and newest (since 2004) EU members.

The gap in life expectancy at birth between core EU countries and other groups which increased substantially between 1980 and 1995, started to reduce for women and men from EU 2004 countries already in the next period, between 1995 and 1999 – several years before enlargement of EU in 2004. During the same time-period non-EU members and Bulgaria (EU 2007) did not experienced any reductions in the life expectancy gap.

Another interesting finding is that the reductions in life expectancy at birth gap between core EU- and EU 2004 countries differ for males and females. For women in EU 2004 countries the trend in minimizing the gap continued for the all examined periods, while for men in EU 2004 countries a temporary reversal occurred between 1999 and 2004, that is to say around the EU enlargement in 2004. Those results confirm the pattern also found in Germany where mortality for males aged 16-65 increased in East Germany around the time of reunification (Gjonça et al., 2000). An escalation in deaths related to car accidents, associated with a substantial increase in car ownership along with inexperienced young drivers which took place in the years around reunification have been held responsible for the mortality increases in East Germany for that period (Winston, Rineer, Menon, & Baker, 1999). It is possible that even in EU 2004 countries, economical changes required for the EU membership, affected male mortality in a similar way. In that case, the EU would have an effect on mortality through improved economic situation in the joining countries.

The evidence I found in the conducted analysis, does not show entirely the same trend for the older ages as it have been found in Germany (Gjonça, Brockmann, & Maier, 2000; Scholz & Maier, 2003; Vaupel, Carey, & Christensen, 2003). For the 80 years old EU 2004 and EU 2007 member, the life expectancy gap to the 80 years old core EU countries decreased temporally between 1995 and 1999 followed by continued increases in the life expectancy gap. The analysis of annual pace of life expectancy growth reveals furthermore that females and males in EU 2004 countries experienced the fastest increases in life expectancy during the period of 1995-1999, but reduced the pace of increase in the following periods, which coincide with accelerated life expectancy increases for core EU countries (between 1999-2003
and 2004-2009). Those results differ thus from the results found in the analysis of the German mortality convergence, where the greatest contributor to the mortality gap convergence were increases in life expectancy at older ages, which were bigger in East Germany after reunification (Gjonça et al., 2000). In my study, the positive effects of joining the European Union have probably affected older ages in EU 2004 countries to smaller degree. A more comprehensive analysis of age-specific contributors to increases in life expectancy would reveal for which age groups in EU 2004 the EU enlargement was most beneficial.

The results of the analysis I conducted show though that for the group of countries that are not an EU member, life expectancy gap to the core EU countries continued to increase for the same period. The period between 1995 and 1999 contain the economic crisis in Russia in 1998, but even when controlling for the annual change in GDP, the non-EU members continued to increase the life expectancy gap to core EU countries, until the latest observed period, when all groups managed to reduce this gap. The limitation of this study has been to not calculate average life expectancy for every single year of the analysis. It would give the possibility to closer investigate the differences between EU core members and the other groups and estimate more accurate when the convergence took place.

The results found in this study point out some observable trends which I argued can be triggered by the process of enlargement of European Union. The definition of EU effect is nevertheless not easy to operationalize, why different definitions of such effect may result in different research results. However, this study is mostly limited to describing existing trends with help of descriptive statistics while many factors can only be tested theoretically. Because of time and size limitations, this study was limited to testing statistical significance and controlling for effects of only selected variables. A future analysis may possibly reveal different factors affecting mortality conditions in examined countries.
Conclusion

In summary, this thesis verified previous research by making calculations based on descriptive statistics for life expectancy and infant mortality in countries of Central and Eastern Europe along with core EU countries. Results have shown that countries that became EU members in 2004 experienced increased life expectancy and infant mortality pace of improvements few years before joining the EU, which can be attributed to the application process requiring many changes before the applicants can become members of EU. Those results are important as they have contributed to further understanding of how changes in political and economic context of a country can affect mortality conditions and the development of life expectancy in the short term. Future research could enhance the understanding of the role of EU enlargement process for mortality in the new potential candidate countries through further analysis of age specific contributors to mortality decline. Another possible area for improvements for the analysis conducted here would be to adjust for the role of application period for each country.

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