HOW AVOIDABLE MORTALITY AFFECTS LIFE EXPECTANCY IN EAST-EUROPE

Frontrunners and followers in quality of healthcare

Abstract

Major differences can be seen in healthcare systems in East-Europe, as well as between West -and East-Europe. Health is the most important aspect of overall living conditions of a human being. The European Union aims to improve these living conditions. This research aims to understand what the main pressure points in the quality of healthcare systems in East-Europe are. Furthermore, it compares EU member states to non-EU countries in the region and intends to give corresponding policy recommendations. It is embedded within the epidemiological transition theory and the Convergence-Divergence Framework and aims to identify frontrunners and followers within the region. Population and avoidable mortality data has been used to perform cause of death analyses to gain insights on quality of healthcare systems in East-Europe. The main pressure points of healthcare systems in East-Europe are circulatory diseases, whereas these are cancers in West-Europe. This is an indicator of East-Europe lacking behind West-Europe regarding health transition. Within the region, Slovenia is a frontrunner on healthcare, with Poland, Serbia, Croatia, the Czech Republic, Turkey, and Bosnia & Herzegovina closely following behind. The rest of the East-European region is lacking regarding their healthcare systems. Policy recommendations should focus on lowering preventable mortality yet focusing on amenable mortality might prove more successful in the short term. Further research on cultural -and lifestyle differences would be beneficial in implementing fitting policy.

Keywords

Avoidable mortality, Preventable mortality, Amenable mortality, East-Europe, Health transition, Life expectancy, Circulatory disease, Cancer

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Introduction

Health is the most important aspect of overall living conditions of a human being. Without proper health, all other aspects in life cannot be fully engaged. The goal of the European Union is subsequently to ensure good health for its citizens as well as an increasing standard of these living standards. This goal applies to all EU member-states and could also be applied to potential new member states in the future as well. Moreover, member-states of the European Union hold the responsibility to organize and deliver health services and medical care to its citizens (European Commission, 2022b). This is embedded within a framework of high standards in several areas which a potential member-state agrees upon to enter the European Union (European Commission, 2022a). Albania, Montenegro, North Macedonia, Serbia, and Turkey are in negotiations with the European Union, as well as simultaneously in the process of complying to the EU standards (European Commission, 2022c). Recently, Georgia, Moldova, and Ukraine have been added to this list due to recent geopolitical events. These countries are still in need of necessary reforms, yet already show great signs of willing to rapidly implement these to accelerate the accession process towards the European Union (European Parliament, 2022). Furthermore, Bosnia & Herzegovina and Kosovo are currently seen as potential candidates yet are still far away from these EU standards (European Commission, 2022c). In short, before entering the European Union, a country must show the willingness to improve in numerous areas. After entry, the European Union will help the new member-state to further improve. The latter is done through the EU4Health programme, the Horizon Europe health cluster, and EU cohesion funds (European Commission, 2022b).

These EU initiatives tend to focus on the newer member-states as healthcare systems usually tend to be lacking compared to prior member-states. From the establishment of the European Union (earlier known as the European Coal and Steel Community) to 1995, member states all originated from West-Europe, yet the European Union currently encompasses the entirety of West-Europe. Nevertheless, all West-European countries can be considered as frontrunners regarding the quality of their healthcare systems (Aburto & van Raalte, 2018; Vallin & Meslé, 2004; Vågerö, 2010).

A common method to measure the quality of healthcare systems is looking at life expectancy. Studies have shown that healthcare has a significant impact on life expectancy and vice versa (Papavlassopulos & Keppler, 2011). Furthermore, life expectancy can be seen as an indicator of quality of living (Sajid, et al., 2008) and quality of the environment (Gulis, 2000). To summarize, life expectancy data is crucial in determining a country's healthcare systems, which is visible throughout other sectors as well. It can be seen as the key factor for assessing population health (Roser, et al., 2019).

The difference in life expectancy between West-Europe and East-Europe is convincing (Aburto & van Raalte, 2018; Vågerö, 2010). While all West-European countries have shown an increase in life expectancy since World War II, this is not the case for East-Europe (Leon, 2011). East-Europe is continuously adopting more West-European healthcare interventions, which would suspect that life expectancy generally converges with the West-European standard, yet this is not the case. Even though, most East-European countries do show improvement in life expectancy, the gap between this and West-Europe is currently still apparent. Furthermore, this gap seems to be diverging in other countries, such as Russia and Ukraine. (Vallin & Meslé, 2004). West-Europe generally has invested a considerably large number of resources in improving healthcare systems, both the treatment of diseases, as well as more recently, the prevention of diseases. The latter is usually done through public health interventions and examples of this are vaccines, disease screening, smoking bans, and many others. Public health interventions are directly used to battle common diseases and increase quality of life (Frieden, 2010). In many cases, this is extremely necessary as the treatment of certain diseases is problematic and preventing them is a significantly better option. The most straightforward examples of these diseases are lung cancer and cardiovascular diseases (Eyre et al., 2004). Even though it is possible to attract these diseases with a healthy lifestyle, there are strong links between smoking and lung cancer, as well as unhealthy eating patterns and cardiovascular disease. Both examples are related to lifestyle and lifestyle is an important public health topic as lifestyle can be changed. Even though lung cancer and cardiovascular diseases can be cured, it is a hard process, especially in the later stages of such a disease. Therefore, public health interventions are an effective way of preventing morbidity due to the effect on diseases similar to these. Prevention methods are currently highly integrated within West-European healthcare systems, even though they are not optimized fully (Pardell et al., 2001). In East-Europe, the integration of disease prevention methods is lacking, healthcare provision remains deficient, and public access to healthcare is low, compared to West-Europe (Aburto & van Raalte, 2018; Romaniuk & Szromek, 2016). Yet, the main problem lies in the prevention of these diseases and signifies the importance of preventing disease instead of treating them (Eyre et al., 2004; Frieden, 2010; Vågerö, 2010; Vallin & Meslé, 2004).

As of 2019, life expectancy at birth throughout Europe differs significantly, going from 84,16 years in

Liechtenstein to 71,83 years in Ukraine (World Health Organization, 2019). This is a difference of more than 10 years in the European continent. West-Europe is the frontrunner regarding life expectancy at birth, yet within East-Europe there is an indication that a clear difference between (potential) EU member-states and other European countries, usually based more towards Central Asia. Even though the recent developments of a possible accession of Moldova and Ukraine negate this difference. It is important to look at potential EU member-states and their respective quality of healthcare systems to assess what the European Union could provide to improve them. Moreover, the gap between West -and East Europe does not seem to be converging, rather diverging slightly, which would be a step in the wrong direction regarding the goals of the European Union on quality of health. Accession to the European Union for countries that are lacking behind could be of great help to curve this divergence to a more converging situation. Yet, most European countries that are not currently in the European Union do have to improve their political -and healthcare systems significantly before they are ready for accession into the European Union. Therefore, assessing the current state of the healthcare systems of East-European countries is helpful to measure which countries in the region can be considered leaders and which are more lacking. As health is a key factor in quality of life, looking into the quality of healthcare in East-Europe is of high societal relevance. Furthermore, the quality of healthcare systems in East-Europe will influence the future policy direction of the European Union greatly, which indicates the political relevance.

However, looking at overall life expectancy numbers does not give sufficient insights in determining the quality of a country's healthcare system. A more in-depth analysis is necessary to determine which parts of a healthcare system are lacking, as well as which diseases pose the biggest challenges to improving life expectancy. One of the most important tools in an analysis such as this is avoidable mortality data derived from cause of death data. Some deaths are deemed avoidable through prevention or treatment, whereas some deaths cannot be avoided (i.e., deaths of old age, untreatable diseases). Looking at avoidable mortality can help comprehend what healthcare systems struggle with. For example, a high number of deaths due to lung cancer in all probability is a cause of a high number of smokes, which could indicate a lacking form of smoking prevention set in place (Walser et al., 2008). This link can be established with many diseases, which can indicate the need for necessary improvements in both prevention and treatment methods and availability. Solely looking at life expectancy does not tell the entire story regarding quality of healthcare. Additionally, there are numerous external factors that influence health outside of what can be regulated through improving healthcare systems.

Nevertheless, there are abundant research articles available on the topic of life expectancy in East-Europe, both for the entirety of the region and the individual countries as well. Few of these also touch upon the subject of avoidable mortality, which mostly are articles focused on one country instead of the entire region. Furthermore, the potential importance of the European Union for development of East-European healthcare systems is not covered explicitly in currently available literature, which indicates a literature gap. Yet, East-European countries could benefit greatly from EU policy and researching the key challenges that these countries' healthcare systems are facing is valuable in bridging this literature gap.

To summarize, this research tries to gain insights on what issues East-European healthcare systems are facing and what the key factors are in accelerate the process of convergence between East -and West-Europe. This research is using life expectancy and avoidable mortality as tools to measure the quality of healthcare systems in East-Europe. It uses West-Europe as a baseline quality of healthcare and compares it to the current East-European EU member-states and non-EU East-European countries. Subsequently, the main question this research poses to answer is: "What are the main pressure points in the quality of healthcare systems of East-European countries?". Furthermore, it will juxtapose current EU member-states and non-EU countries within East-Europe to gain insights on the differences between and within these regions. Then it investigates which diseases relatively influence the gaps between these regions the most, as well as try to answer whether these gaps can be addressed through improving treatment or prevention methods.

Theoretical Framework

Epidemiological transition theory

How healthcare systems are implemented is strongly connected to what diseases those systems are facing. As there are different types of diseases, such as infectious diseases and communicable diseases, it is valuable to assess what types of diseases are present. Omran (1971) developed a theory regarding the mechanism societies undergo that predicts this, the epidemiological transition theory. His theory introduces the concept of countries undergoing different stages in prevalence of diseases that require a corresponding approach to improve health. Currently, not all countries are in the same stage of health policy as the prevalence of diseases differ greatly. In Europe, one could argue that West-Europe has passed through one or two stages more than East-Europe. Yet, Omran's research suggests that countries successively transition through these stages, even though some are lacking behind others.

This model features three states (or ages) that societies generally transition between, namely: "The Age of Pestilence and Famine", "The Age of Receding Pandemics", and "The Age of Degenerative and Man-Made Diseases" (Omran, 1971). The first respectively characterizes a state of high and fluctuating mortality rates, variable life expectancy at birth and a low average life span. The second phase features a notably declining mortality rate, as well as an increase of life expectancy at birth and an eventually exponential population growth. The last phase is marked by the disappearance of infectious diseases, which are replaced by communicable diseases. This is where declining mortality rates and a further increase of life expectancy take place.

Convergence-Divergence Framework

The Divergence-Convergence framework proposed by Vallin & Meslé (2004) builds upon the epidemiological transition model introduced by Omran and expands it. Together with many others, such as McKeown (2009), Vallin & Meslé argued that the Omran's model is too broad and does not account for more recent developments within the changing patterns of population dynamics, such as the cardiovascular revolution and the global rise of HIV/AIDS. Moreover, the way regions progress through the stages of epidemiologic transition highly depends on socio-economic factors and might not be as linear as implied in Omran's theory (Mackenbach, 2022; McKeown, 2009, Vallin & Meslé, 2004). Subsequently, Vallin & Meslé (2004) take the entirety of Omran's theory as one stage of health transition, namely the 'vanquishing of infectious diseases', followed by 'the cardiovascular revolution', and 'the fight against ageing'. The cardiovascular revolution is somewhat represented in Omran's model, whereas the fight against old age is not. Vallin & Meslé (2004) have constructed a new way of addressing health transitions based around divergence-convergence processes that are consequences of major health improvements, which are initiated and retained by national socio-economic capacity.

The Convergence-Divergence Framework of Vallin & Meslé (2004) is strongly linked to the concept of frontrunners and followers, where the frontrunners would be the most qualitative and innovative countries regarding healthcare and the followers would be the lacking countries. The followers would be inclined to "follow' the frontrunners to improve the situation and converge the gap between the frontrunners and followers. Following this concept, one could argue that the all countries in West-Europe are frontrunners and all countries in East-Europe are followers, trying to improve their healthcare systems to become as qualitative as the current frontrunners. Improvements in the following region is necessary to achieve this goal and would lead to convergence instead of the divergence between West -and East-Europe of the past. The question is what these improvements would entail and what the following countries must do to converge towards West-Europe or at least start to diverge from the rest of the East-European region.

Whereas West-Europe has generally transitioned into a stage where the battle against old age and cancers is more prominent, East-Europe is facing a high number of deaths due to cardiovascular disease. (Vallin & Meslé, 2004). This is a sign that East-Europe is lacking behind West-Europe in this regard and can be considered a more developing region in contrast to the more developed region of West-Europe. Both regions still have high occurrences of both cancers and cardiovascular disease, yet the distribution of these causes of death are different. The battle against old age; the third stage introduced in Vallin & Meslé (2004) goes hand in hand with morbidity due to cancers as the chance of attracting cancer increases with age and is 11 times increased in ages above 65 compared to the younger population (Browner, 2022). Subsequently, due to a rising global life expectancy, expectations are that prevalence of cancer will double before 2035 (Pilleron et al., 2018). This will lead to a high impact on healthcare systems around the globe and to a greater extent in regions where cancers currently are not considered to be the main avoidable cause of death (Pilleron et al., 2018), which East-Europe would be an example of.

The concept of avoidable mortality is believed to be introduced by J.J. Schifferes' his book "How to Live Longer", which was published in 1949. His main message personal of nature, yet statistical and mortality data have been used to support it (Stieglitz, 1949). The results are mainly focused on how a person could live longer by avoiding certain life paths (Stieglitz, 1949). The idea of using mortality data to measure patterns in societies is not new. However, using it to measure quality of healthcare has been first proposed by Rutstein and colleagues in 1976 (Barry, 1992). Subsequently, this method gained traction and has been used by numerous health authorities as an indicator of quality of healthcare in the past (Barry, 1992). The actual definitions of avoidable mortality, however, have changed significantly since then due to the quality of healthcare improving and more knowledge being available on the subject. Nevertheless, defining avoidable mortality is extremely difficult, especially on a large scale. For example, what can be considered as avoidable in one country might not be in another as different diseases are prevalent in different countries, whereas the quality of the healthcare systems might differ as well. However, when in theory one country can avoid certain deaths due to their healthcare systems, another country should be able to do so as well. Subsequently, when comparing countries' healthcare systems, using avoidable mortality is one of the most applicable ways to measure quality of healthcare, as avoidable deaths would not take place when optimal healthcare is supplied.

The practical application of avoidable mortality has and will keep evolving together with new healthcare developments. At first, avoidable mortality in scientific research translates to what 'amenable mortality' is, which can be defined as deaths that could have been avoided through appropriate health care interventions (OECD & Eurostat, 2019). In current research a distinction is being made between amenable and 'preventable mortality' where the latter can be construed as deaths that could have been avoided through appropriate public health interventions (OECD & Eurostat, 2019). Only deaths due to the quality of actual treatment of patients have been encapsulated in the earlier definitions of avoidable mortality, yet this was deemed insufficient as prevention plays a large role in avoidable mortality, especially regarding cardiovascular diseases and cancers (Nolte & McKee, 2004; Vallin & Meslé, 2004). Nevertheless, avoidable mortality is seen to be one of the key factors in battling a low life expectancy and has the most potential in improving life expectancy. The relation between avoidable mortality and life expectancy is strong. The strength of this relation varies from country to country, yet it is always present (Aburto et al., 2018; Bahk & Jung-Choi, 2020; Benavides et al., 1992). Specific interventions targeting the common avoidable causes of death usually are the most straightforward policy recommendations for improving life expectancy.

The current main causes of death in the entirety of Europe are circulatory diseases, cancers, respiratory diseases, Alzheimer's disease, accidents, diabetes, and suicide (OECD & European Union, 2020). Circulatory diseases were the most prevalent until 2005, which were replaced by cancers as the most prevalent afterwards (CBS, 2020). All these causes of death can be deemed avoidable, yet some more than others (OECD & Eurostat, 2019). These causes of death make up 83 percent of total mortality in Europe (OECD & European Union, 2020). One could argue that looking at the largest portion of mortality would be beneficial to analyze why people are dying if not of old age. Subsequently, only looking at life expectancy and generic avoidable mortality does not paint the entire picture. The distribution of which avoidable causes of death are impacting life expectancy the most in certain countries can recommend areas of interest for future policy effectively. Even though the main causes of death mentioned before are largely corresponding to avoidable causes of death, this is not entirely the case. For example, Alzheimer's disease cannot be considered avoidable at this time, as well as not all forms of cancers and all forms of diabetes are avoidable through healthcare. Furthermore, many mortality cases can be intertwined with alcohol -and drug abuse. These cases, however, are not always deemed alcohol -and drug related deaths due to it being a factor in developing other avoidable causes of death such as circulatory diseases and cancers (Spear, 2015). Even though, it is proven that alcohol use has a high impact on life expectancy, which is the case in East-Europe (Jasilonis et al., 2020). Therefore, this research will also take these causes of death into account. Besides all causes of death mentioned, there are numerous other avoidable causes of death that do not fall under one of them. Important examples of this are infant mortality and infectious diseases, where the first is still prevalent in Europe and the latter practically is not.

Accession into the European Union will generally be beneficial for the newly admitted member state, yet this is strongly dependent on the nation's willingness to innovate and profit from the benefits provided by the EU (Vallin & Meslé, 2004). As mentioned before, certain political, economic, and cultural developments are necessary on a national level before accession to the European Union is possible. Otherwise, providing funding to lacking regions might be ineffective as poorer countries will be limited in improving healthcare systems solely by throwing more money at the problem (Romaniuk & Szromek, 2016). Subsequently, how successful this national transformation has been, can be an indicator of the effectiveness of future EU funding.

Linking previous theories to the situation in Europe results in the conceptual model as seen in Figure 1. The entire model relates to measuring quality of healthcare systems.

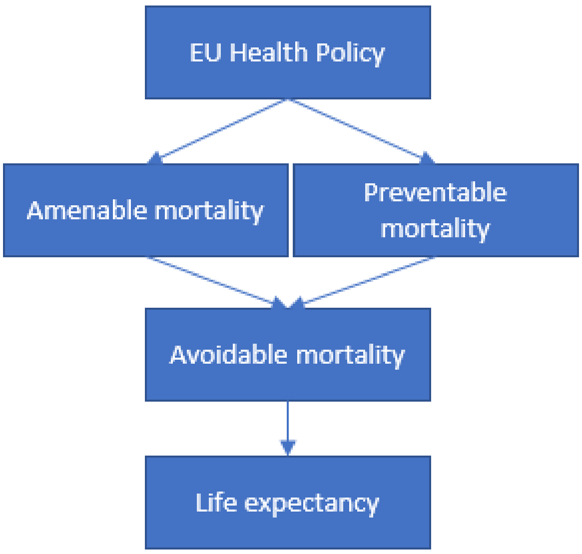

Figure 1. The conceptual model on how EU Health Policy is linked to life expectancy.

Following the divergence-convergence theory would imply that East-Europe should feature significant intraregional differences regarding quality of healthcare. Due to socio-economic differences together with the European Union's goal to improve socio-economic factors, the expectation is that the difference between EU member states and non-EU countries' healthcare systems will be present, where EU member states will be frontrunners of the East-European region, whereas non-EU countries will be lacking behind.

Additionally, differences between the East-European EU member-states will also be present. Whereas West-European countries generally are close to the region's overall healthcare quality average, the expectation for East-Europe is that it is not.

Methodology

Data

Specific causes of death per country in Europe were necessary to perform the required analysis. Data from the WHO (World Health Organization) Mortality Database is arguably the most structured database available regarding this type of data and features the highest data availability. Therefore, the specific causes of death per country were solely taken from this database. Additionally, this also resolves the issue of data comparability. Some countries East-European countries are not available within the WHO Mortality Database. However, they were in others such as the Human-Cause-of-Death Database and the Human Mortality Database (HMD). Converting data within these other databases to the main one used for this research is nearly impossible as the WHO Mortality Database features explicitly detailed data on causes of death. The data availability in the WHO Mortality Database is a direct consequence of the willingness of the respective countries' civil registration systems to supply the WHO with this data (World Health Organization, 2022). Firstly, 2016 was chosen as the central year data would be taken from, as this year is the most represented in the WHO Mortality Database as well as being sufficiently recent. Yet not all European countries were represented in this data year and the decision has been made to take cause of death data from three years prior to 2016 and three years after, making the data range from 2013 to 2018 respectively. Using data from solely 2016, or any more recent year for that matter, would have resulted in a small dataset, sometimes only featuring half of East-Europe.

Beforehand, Andorra, Liechtenstein, San Marino, Monaco, and Vatican City were already cut from the analysis due to their population being too small; annual cause of death data and subsequent analysis would not be eligible. Due to data availability, as mentioned before, the countries Russia, Ukraine, Albania, Azerbaijan, Kosovo, and Montenegro were also eliminated from the dataset. The first two countries due to the usage of a different codebook than the ICD-10 detailed mortality tabulation, only using the 103 (1000-1103) group codes for cause of death specification rather than using the over 10.000 codes large, detailed specification (A00.0-X89.9) The definition of avoidable mortality is quite strict on what falls under it and does not work well with generic codes used in the case of Russia and Ukraine.

Furthermore, Bosnia & Herzegovina, Finland, Kazakhstan, and Slovenia make use of a lesser detailed cause of death specification than the rest of the WHO dataset of Europe. Namely, a codebook that ranges from A00 to X89, without the decimal separator. This posed a few challenges in a small portion of the causes of death listed in the definition of avoidable mortality by the OECD & Eurostat (2019). The codes INF05, INF06, INF14, INF17, INF18, INF20, INF21, CNC16, EAM04, CRC05, CRC07, DIG06, DIG07, GEN07, DRG01, and DRG02 (the definition of these, and the remaining codes are located in Appendix A) were defined using a number behind the decimal separator and therefore the data given for the named countries were not specific enough. The data of these specific causes of death were transformed using educated estimations to fit the rest of the dataset's structure. These estimations are made using averages of surrounding countries that did included the specific causes of deaths. For example, Finland only defines the entire category of "Other bacterial infections", yet the only cause of death within this category that is deemed avoidable is "Haemophilus influenzae infection". Which comes down to the difference between ICD-10 code A49 and A49.1. The average percentage of cases of A49.1 compared to A49 of the surrounding countries was used to estimate the cases of A49.1 in Finland. In almost half of these cases, specific cause of death numbers resulted in 0, which can be fully accounted for. The remaining cases on the other hand, might differ slightly from the factual data. The impact of the estimations can be considered undoubtedly small. The gist of the story told by the results of the analysis does not seem to be impacted by using these estimations.

This encapsulates all the necessary data that is used to calculate avoidable mortality, yet to measure what impact this has on life expectancies the corresponding population and general mortality data are also necessary. This is to create life tables and calculate the life expectancy at birth per country. The general mortality data was also included within the WHO Mortality Database and was selected based on which year the specific mortality data originated from. The WHO Mortality Database also included a section with population and live births, which has been used to fulfil the population data needs for the analysis. Yet, this data was not always adequate or missing. For these specific cases, the Demographic Yearbook data of the respective countries and years were used (Estonia 2017, France 2015, and Spain 2016).

To summarize, WHO Population Data and Mortality Data from the year 2016 have generally been used with some exceptions. An overview of all countries in the dataset, together with exceptions made regarding data use, is visible in Table 1.

Country:	Population Data:	Mortality Data:
Belarus	WHO 2018	WHO 2018
Estonia	DY 2017	WHO 2017
France	DY 2015	WHO 2015
Iceland	WHO 2018	WHO 2018
Ireland	WHO 2015	WHO 2015
Kazakhstan	WHO 2017	WHO 2017
North Macedonia	WHO 2013	WHO 2013
Serbia	WHO 2015	WHO 2015
Slovakia	WHO 2014	WHO 2014
Spain	DY 2016	WHO 2016
Armenia, Austria, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, Georgia, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Sweden, Switzerland, Turkey, United Kingdom	WHO 2016	WHO 2016

Table 1. An overview of all countries in the dataset, as well as country-specific data use.

Naturally, using data from different years within the same dataset might sound impossible, as comparison between countries will pose differences to reality. While this is the case, a comparison would otherwise not be possible at all due to the lack of data availability. Furthermore, population -and mortality trends do not change rapidly from year to year. Even though, these are not the most adequate circumstances for an analysis such as this, it still points out important features regarding avoidable mortality in Eastern Europe. Instinctively, the results might have been slightly different theoretically comparing them to results that would have features data from solely 2016. In addition to that, the data used is generally over five years old, yet more recent data is highly unavailable or lacking in specificity. This does, however, mean that certain situations and processes mentioned by this research, might have changed slightly in current reality.

Methods

Firstly, life expectancy had to be calculated regarding every singular European country in the dataset using base life tables, resulting in a life expectancy at birth and a life expectancy per age group. The $_na_x$ used to complete these life tables are taken from the World Population Prospects dataset (United Nations, Department of Economic and Social Affairs, Population Division, 2019). This dataset only features merged period life tables in time periods of five years. The $_na_x$ is taken from the respective period the population -and mortality data correspond to. Even though the used $_na_x$ does not correspond to the exact year of the dataset, this number does not fluctuate significantly and should be close enough to reality in a way that it should not result in a different analysis outcome. The specific WPP $_na_x$ reflects the situation better than using 2,5 as the specific $_na_x$ is generally higher than 2,5 which shows that people averagely die later in their respective age group. In my opinion, outweighs the fact that the used $_na_x$ is not exactly corresponding to the data's year. After the computation of each country's life expectancy, and average of West-Europe was calculated as the analysis will not compare to each individual West-European country, rather to a West-European average. Since differences between countries in West-Europe are relatively small, this resembled the best option to compare East-Europe to the West-Europe average and baseline.

Secondly, avoidable mortality per country had to be calculated using the OECD & Eurostat (2019) definition of it. A subdivision has been made regarding preventable and amenable mortality using the same definition. The corresponding WHO data codes for each section in the definition have been grouped in new codes and were extracted from the WHO Mortality Database. These codes, together with the code definition and their corresponding WHO data codes can be found in Appendix A. These codes have been grouped together to coincide with the division of causes of death introduced before, resulting in the following eight groups: circulatory system diseases, cancers, diabetes mellitus, diseases of the respiratory system, alcohol -and drug related deaths, accidents and injuries, suicide, and other avoidable deaths. All these categories include certain specific causes of death, whereof the specifications are included in Appendix A. The first seven categories are strongly linked with the main causes of mortality in Europe (OECD & European Union, 2020), while the eighth category groups the rarer causes of death. A notable example in the WHO Mortality Database would be infectious diseases, which contributes almost half of the causes of death to the category. Naturally, infectious diseases are more apparent in other parts of the world, yet are quite rare in Europe, both East and West. This, together with non-recurrent causes of death, such as diseases of the digestive -and genitourinary system, as well as a few others, make up the entirety of the 'other avoidable diseases' category. The eight subdivisions of avoidable mortality and their respective mortality data per age group are transformed to life tables that feature life expectancy without the subdivision of avoidable mortality. The OECD & Eurostat (2019) focuses on the part of the population from ages 0 to 75. While there are scientific incentives to change this strict age threshold, there currently are no measures available to successfully expand this definition beyond this threshold. For example, some diseases that people older than 75 years old attract, might still be deemed avoidable, yet for other cases it might be vice versa. Avoidable mortality would best be measured through case-by-case analysis, though that would be extremely cost-inefficient. Moreover, due to an averagely rising life expectancy at birth, the threshold of 75 could be raised to a higher age, yet there currently is no research available that would suggest a certain age. This still is a recurring struggle in avoidable mortality research and more study is necessary assisted by medical professionals to change this age threshold. Subsequently, this avoidable mortality analysis will likewise use the age threshold of 75 years old.

Lastly, the impact of avoidable mortality on life expectancy at birth is measured, which is illustrated by the arrow in Figure 1. This was achieved using age -and cause-specific decomposition as explicated in Preston et al. (2001). This compares the total number of deaths in each age group to the total number of deaths in each age group minus the number of deaths belonging to all eight subdivisions of avoidable mortality. This difference expressed as $_n\Delta_x$; this number corresponds with the total number of years of life lost per age category. The following equation (Preston et al., 2001) is used to calculate $_n\Delta_x$:

$$_n\Delta_x = \frac{l_x^1}{l_0^1} \times \left(\frac{_nL_x^2}{l_x^2} - \frac{_nL_x^1}{l_x^1} \right) + \frac{T_{x+n}^2}{l_0^1} \times \left(\frac{l_x^1}{l_x^2} - \frac{l_{x+n}^1}{l_{x+n}^2} \right)$$

The respective countries' life tables were used as population 2 and their corresponding life tables without each subdivision of avoidable mortality have been used as population 1. The sum of these contribution in years result in the total years of life lost due to avoidable mortality:

$$\sum e_0^0(1) - \sum e_0^0(2) = \sum{}_x {}_n\Delta_x$$

The results of each individual country's age group were used to create bar plots featured in the results section. These bar plots show how much avoidable deaths in each age group contribute to life expectancy, as well as the type of avoidable deaths. Especially looking at the impact of circulatory diseases and cancers on life expectancy will show the quality of healthcare systems. This is strongly connected to whether a country is currently facing more problems matching the cardiovascular revolution or the battle against old age, where the latter is a sign of being more advanced and a manifestation of being further along the health transitions introduced by Vallin & Meslé (2004). The impact of overall life expectancy at birth and the corresponding years of life lost due to avoidable mortality were used to create an overview of life expectancy versus avoidable mortality in Eastern Europe.

On a side note, it is worth mentioning that the difference between men and women is not considered within this research. Usually, men tend to have a higher susceptibility to avoidable mortality than women (Lefèvre, 2004). Yet, this research has its focus on intraregional differences regarding overall avoidable mortality. Therefore, gender differences regarding avoidable mortality have been disregarded.

Results

To reiterate, this analysis is trying to gain insights on what the main pressure points of East-European healthcare systems are. Afterwards, it will compare these to understand what the differences between EU member states and non-EU countries within East-Europe. Lastly, it tries to interpret treatable and preventable mortality data to give directions to EU policy on how to address these healthcare systems to improve life expectancy.

Firstly, Table 2 (on the next page) shows the contribution in years of eight avoidable causes of death categories to life expectancy at birth for the East-European countries in the dataset, as well as the West-European average. These numbers are added together resulting in the total contribution of avoidable mortality to life expectancy at birth (e0). It does not include the individual countries' results of West-Europe as the goal is to gain insights regarding the East-European region and use the West-European average as method for comparison.

To figure out what the main pressure points are in East-Europe, it is needed to compare the contribution of the eight avoidable mortality subdivisions to the European frontrunner West-Europe. Without context, these individual contributions do not provide useful information. The total contribution of avoidable mortality to life expectancy at birth in West-Europe is 3,692 years. This subsequently means that life expectancy at birth in West-Europe would theoretically be 85,77 years instead of 82,08 years when all avoidable deaths would not occur. Figure 2 demonstrates a visual representation of the comparison between the 20 East-European countries in the dataset regarding life expectancy and the years of life lost due to avoidable mortality. The latter corresponds with the earlier definition given of deaths that have occurred between the ages of 0 and 75 years old. Data used in Figure 2 coincides with the data given in Table 2 under 'Total contribution (years)' and 'Life expectancy at birth (e0). The comparison takes the West-European average as a baseline rather than showing the base values of the two variables. The West-European average in the dataset is a life expectancy at birth of 82,08 years old and 3,692 years of life lost due to avoidable mortality.

The main pressure points of healthcare systems in East-Europe are circulatory diseases. The contribution of circulatory diseases to life expectancy in the region is 3,191 years, whereas this contribution is 0,881 years in West-Europe. This is a significant difference. Circulatory diseases in East-Europe almost make up half of the entire contribution of avoidable deaths to life expectancy. Additionally, the contribution of all other categories to life expectancy is higher in East-Europe, where some are more apparent than others. Cancers, diabetes mellitus, and suicide seems to be similarly prevalent in the region compared to West-Europe. Yet, the contribution of respiratory diseases, alcohol -and drug related deaths, accidents and injuries, and other avoidable deaths on life expectancy is considerably higher in East-Europe. A visual depiction of the subdivision of the contribution of avoidable mortality to life expectancy of both East -and West-Europe can be seen in Figure 3 and 4.

Furthermore, only one country features a considerably higher effect of cancers compared to circulatory diseases, which is Slovenia. Currently, this seems to be the only country that has fully transitioned past the third stage of health transition featuring man-made diseases. However, Poland, Serbia, Croatia, the Czech Republic, Turkey, and Bosnia & Herzegovina are following behind. The results of these countries signify being in the middle of this third stage of health transition and need to lower their prevalence of circulatory diseases to lower their life expectancy at birth and join Slovenia's frontrunner status. The other countries in the East-European region are lacking behind and still require significant improvement in preventing diseases man-made diseases to improve their healthcare systems. Especially Moldova and Belarus can be considered the most lacking countries in the dataset in this regard. Figure 2 likewise shows that Slovenia can be seen as the frontrunner of East-Europe, featuring a situation close to the West-European average. In contradiction to Moldova, which has the lowest life expectancy at birth of the dataset together with an extremely high number of years of life lost due to avoidable mortality, which can be contributed mostly to a high prevalence of circulatory diseases, which is seen in Table 2.

	Circulatory diseases	Cancers	Diabetes mellitus	Respiratory diseases	Alcohol -and drugrelated deaths	Accidents and injuries	Suicide	Other avoidable deaths	**Total contribution (years)**	**Preventable mortality**	**Amenable mortality**	**Life expectancy at birth (e0)**
West-Europe	0,881	1,323	0,096	0,240	0,298	0,271	0,230	0,354	3,692	2,374	1,318	82,08
East-Europe	3,191	1,435	0,158	0,376	0,492	0,572	0,235	0,657	7,117	4,376	2,741	76,81
East EU	2,825	1,584	0,115	0,317	0,572	0,533	0,296	0,512	6,751	4,269	2,482	77,10
East Non-EU	3,557	1,287	0,200	0,435	0,412	0,611	0,185	0,803	7,480	4,457	3,023	76,58
Armenia	3,332	1,291	0,339	0,423	0,268	0,493	0,039	0,763	6,949	3,864	3,085	75,22
Bosnia & Herzegovina	1,720	1,339	0,281	0,181	0,146	0,524	0,000	0,558	4,748	2,680	2,068	76,27
Belarus	5,595	1,258	0,030	0,247	0,704	0,768	0,359	0,449	9,410	6,010	3,400	74,56
Bulgaria	2,898	1,263	0,109	0,302	0,311	0,453	0,139	0,611	6,086	3,274	2,812	74,89
Croatia	1,955	1,797	0,157	0,191	0,363	0,391	0,277	0,449	5,580	3,554	2,026	78,19
Czech Republic	1,769	1,345	0,150	0,354	0,352	0,416	0,269	0,401	5,056	3,105	1,951	79,16
Estonia	2,677	1,450	0,104	0,201	0,985	0,424	0,362	0,426	6,629	4,483	2,146	78,43
Georgia	1,479	1,171	0,105	0,371	0,107	0,725	0,085	0,910	4,954	2,677	2,277	72,74
Hungary	2,995	2,129	0,142	0,423	0,512	0,406	0,283	0,452	7,342	4,865	2,477	76,27
Kazakhstan	1,886	0,956	0,253	0,970	0,797	0,920	0,363	1,002	7,146	4,698	2,448	73,05
Lithuania	4,955	1,415	0,068	0,301	0,792	0,842	0,548	0,730	9,651	6,249	3,382	74,90
Latvia	4,302	1,385	0,138	0,302	0,804	0,835	0,370	0,683	8,818	5,748	3,070	75,19
North Macedonia	2,134	1,371	0,267	0,227	0,165	0,333	0,152	0,852	5,501	2,934	2,567	75,48
Moldova	12,264	1,349	0,110	0,594	1,275	0,932	0,295	0,950	17,770	11,280	6,489	72,29
Poland	1,537	1,681	0,132	0,329	0,487	0,502	0,267	0,456	5,391	3,413	1,978	78,01
Romania	4,333	1,634	0,082	0,622	0,557	0,652	0,181	0,672	8,733	5,203	3,530	75,22
Serbia	1,791	1,682	0,179	0,320	0,173	0,331	0,214	0,630	5,319	3,020	2,299	75,33
Slovakia	2,566	1,609	0,119	0,331	0,561	0,556	0,198	0,506	6,447	3,845	2,602	77,02
Slovenia	1,082	1,711	0,063	0,132	0,567	0,389	0,363	0,243	4,551	3,224	1,328	81,23
Turkey	1,815	1,168	0,237	0,584	0,074	0,476	0,063	1,110	5,526	2,953	2,574	78,20

Table 2. The main results of the cause-of-death analysis showing the impact (in years of life) of the eight subdivisions of avoidable mortality on life expectancy at birth (e0), as well as the contributions of preventable -and amenable mortality, in 20 East-European countries and the West-European average.

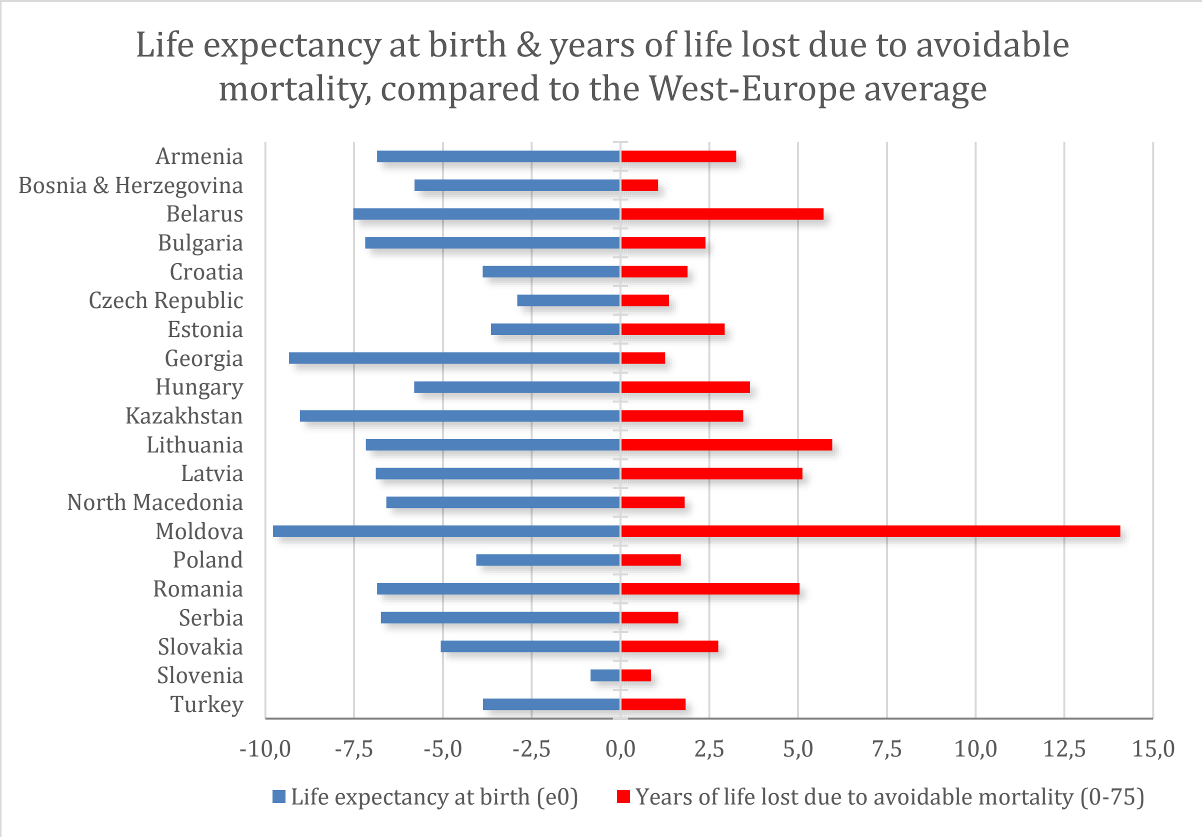

Figure 2. A visual representation of life expectancy at birth & years of life lost due to avoidable mortality, compared to the West-Europe average.

The current trend in avoidable causes of death in West-Europe is visible in the proportion of the population that die due to cancers versus diseases of the circulatory system. Cancers are increasingly apparent as a main cause of death compared to circulatory diseases, which was the leading cause of morbidity of populations in West-Europe until around 2005. West-Europe features relatively qualitative health care systems together with a strong governance towards a healthy lifestyle. This is visible in Figure 3, which shows that causes of death besides cancers and circulatory diseases do not impact life expectancy at birth significantly and are, relative to the rest of the world, rarely occurring. Evidently, the West-European average still bodes challenges in healthy ageing and tackling cancers and circulatory diseases. This is entirely different form the East-European average visible in Figure 4, which mainly highlights the high contribution of circulatory diseases to life expectancy in the region.

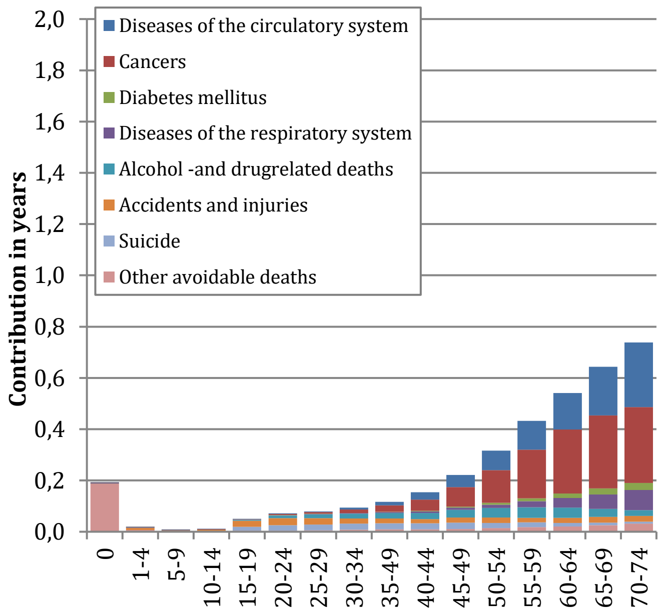

Figure 3. An average of the age and cause of death decomposition regarding avoidable mortality in West-Europe.

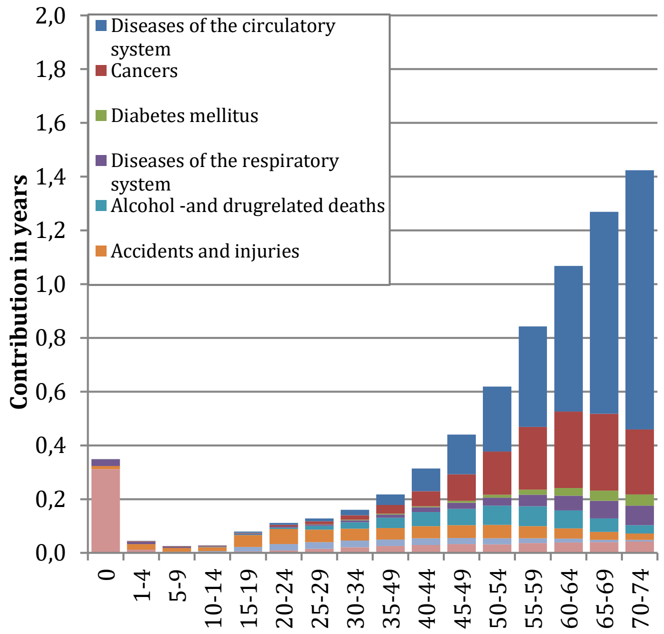

Figure 4. An average of the age and cause of death decomposition regarding avoidable mortality in East-Europe.

To gain more insights on intraregional differences within East-Europe, the results of the country-by-country cause-of-death decomposition have been grouped through historical and geographical factors together with a country's European Union membership status. Comparisons will be made between and within these country groups and ultimately compared to the West-European baseline seen in Figure 3, and the East-European average seen in Figure 4. The groups featured in this analysis are the Baltic States (Estonia, Latvia, Lithuania), Former USSR – West-Central Asia (Armenia, Georgia, Kazakhstan), Former USSR – Eastern Europe (Belarus, Moldova), Former Yugoslavia – EU (Croatia, Slovenia), Former Yugoslavia – Non-EU (Bosnia & Herzegovina, North-Macedonia, Serbia), EU Member States – Entry in 2004 (Czech Republic, Hungary, Poland, Slovakia), EU Member States – Entry in 2007 (Bulgaria, Romania) and Turkey.

Baltic States (Estonia, Latvia, Lithuania)

The Baltic States are quite similar regarding the main contributing diseases to life expectancy. All three countries feature an expanding influence of cancers and diseases of the circulatory system in higher age groups. Yet, compared to the West-Europe average, this contribution starts in earlier age groups as it starts around the age group 40-44 in Estonia as well as Latvia and one could argue this is already the case in the age group 35-39 for Lithuania. Moreover, this contribution is significantly higher in earlier age groups than in West-Europe.

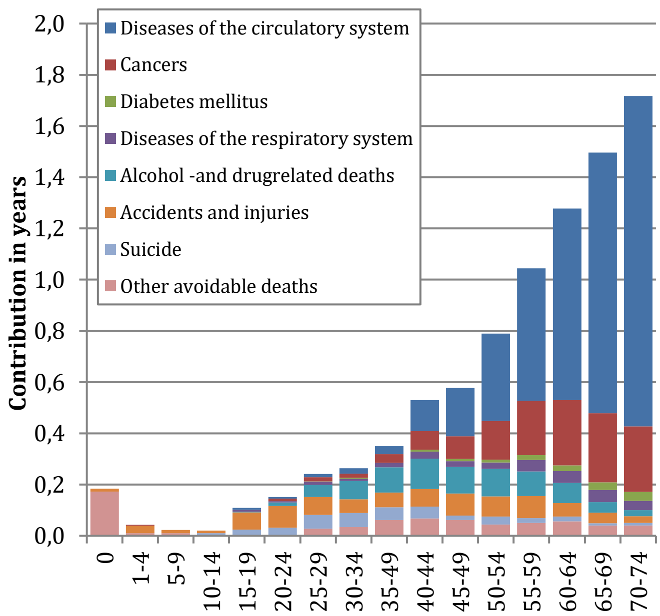

Figure 5. Age and cause of death decomposition regarding avoidable mortality in Latvia in 2016.

Furthermore, Figure 5 shows that especially alcohol -and drug related deaths as well as accidents and injuries are averagely twice as apparent in the Baltic States than in West-Europe. This is a strong indicator that the area is lacking in tackling preventable mortality. Latvia and Lithuania are comparable regarding their life expectancy and avoidable mortality, yet Estonia seems to be the frontrunner of the area, featuring a significantly higher life expectancy and trends towards avoidable causes of death being solely present in higher age categories.

Former USSR – West-Central Asia (Armenia, Georgia, Kazakhstan)

On the other hand, this dataset's countries located in West-Central Asia have considerably worse healthcare systems. In Kazakhstan, which of its cause of death decomposition is visible in Figure 6, one can see that the avoidable causes of death are most apparent in the age category 65-69. Kazakhstan features on of the lowest life expectancies at birth in the dataset and this seems to be a common denominator for countries with a low life expectancy. Whereas, in West-Europe, avoidable deaths are mainly prevalent in the higher age groups and do not even count towards the avoidable mortality data anymore. Moreover, child mortality is still significantly higher in West-Central Asia than the rest of Europe. It features a contribution of avoidable deaths in the age category 0 of between 0,4 and 0,6 years, which is more than double the contribution in more developed countries in Eastern Europe in this age group.

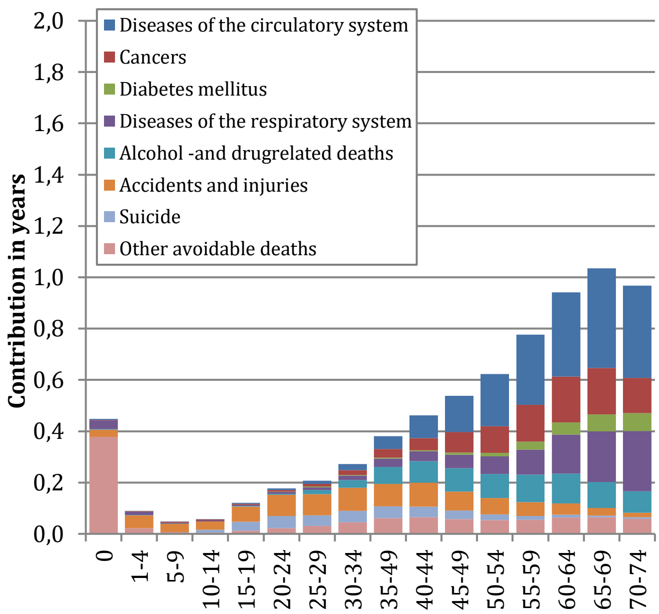

Figure 6. Age and cause of death decomposition regarding avoidable mortality in Kazakhstan in 2017.

Furthermore, Georgia has one of the lowest numbers of years of life lost due to avoidable mortality in Eastern Europe, yet their cause of death composition looks reasonably alike to that of Kazakhstan. Armenia, on the other hand, features a cause of death decomposition that is like those of the Baltic States, yet show higher child mortality numbers. Armenia shows a high prevalence of diseases of the circulatory system in later age groups, whereas Georgia and Kazakhstan have a more evenly balanced distribution between cause of death categories.

Another important aspect to note is that the prevalence of respiratory diseases is quite apparent in the higher age categories in Kazakhstan, which is the only occurrence throughout this dataset. There is no exact reason for this high prevalence, yet one of the explanations could be the significantly higher air pollution in Kazakhstan due to coal production (Akhmetov, 2014).

Former USSR - Eastern Europe (Belarus, Moldova)

Both in Belarus and Moldova cardiovascular disease is a prime factor in the high number of years of life lost due to avoidable mortality, which is visible in Figure 7. The contribution of the age group 60-74 is significantly higher in Moldova than the rest of Europe. Where the rest of Europe does not feature a contribution in years above 2 per age group, Moldova's dataset features a contribution in years of almost 4,8 in the age group 70-74. This is over 90 percent due to cardiovascular disease, which highlights the epidemiological transition in Moldova and can be deemed as a problem in the region. This is also the case in Belarus, yet it does not feature as extreme numbers as in Moldova. Furthermore, the data implies that child mortality is a larger problem in Moldova than in Belarus, which highly corresponds with the 'Other avoidable deaths' category. Child mortality in Belarus is lower than the West-European average, which is not the case in Moldova.

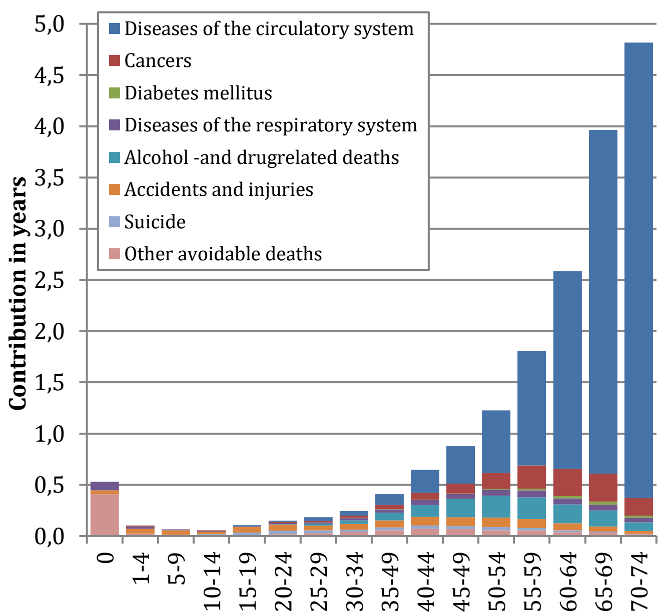

Figure 7. Age and cause of death decomposition regarding avoidable mortality in Moldova in 2016.

Former Yugoslavia - EU (Croatia, Slovenia)

The countries in the dataset that were formed through the fall of Yugoslavia in 2003 and have joined the European Union have a different story. Both Slovenia and Croatia are featuring avoidable mortality numbers close to the West-European average. Slovenia is the frontrunner of East-Europe regarding avoidable mortality, which is linked to their significant higher life expectancy than the rest of Eastern Europe, which is also visible in Figure 1. Croatia is slightly behind Slovenia in both areas, although it can be seen as one of the frontrunners as well.

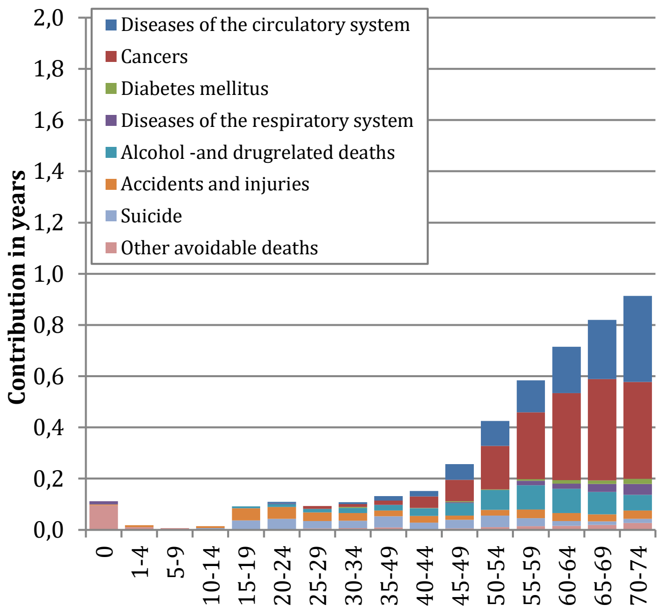

Figure 8. Age and cause of death decomposition regarding avoidable mortality in Slovenia in 2016.

Figure 8, together with Figure 7, shows the contrast between the more developed and the less developed countries in Europe. It seems that in Croatia and Slovenia, the cardiovascular revolution has come somewhat to an end and both countries have transitioned towards a situation where morbidity due to cancers is more apparent, just as in West-Europe. This transition is at a further stage in Slovenia than in Croatia, with Croatia still featuring a higher impact of cardiovascular disease towards life expectancy.

Both Croatia and Slovenia are progressing towards the West-European standard, yet some areas of avoidable mortality seem to still be more apparent here. Alcohol -and drug related deaths, as well as accidents and injuries are of higher impact in this region than in West-Europe. Especially Croatia stills features a life expectancy that is significantly lower than West-Europe, and Slovenia for that matter, yet this is not especially apparent in the cause of death decomposition regarding avoidable mortality.

<u>Former Yugoslavia - Non-EU (Bosnia & Herzegovina, North-Macedonia, Serbia)</u>

The countries of Former Yugoslavia that are not affiliated with the European Union are somewhat similar in avoidable mortality compared to the countries that are. Yet there are some important factors that separates the non-EU region from the EU-region, such as significantly higher infant mortality, which is especially the case in North-Macedonia, higher prevalence of diabetes mellitus, and a higher avoidable mortality impact in lower age categories under 75. Where Croatia and Slovenia have the highest impact of avoidable mortality in the 85+ age category, this is the 75-79 age category for Serbia, North-Macedonia, and Bosnia & Herzegovina., which is also visible in Figure 9.

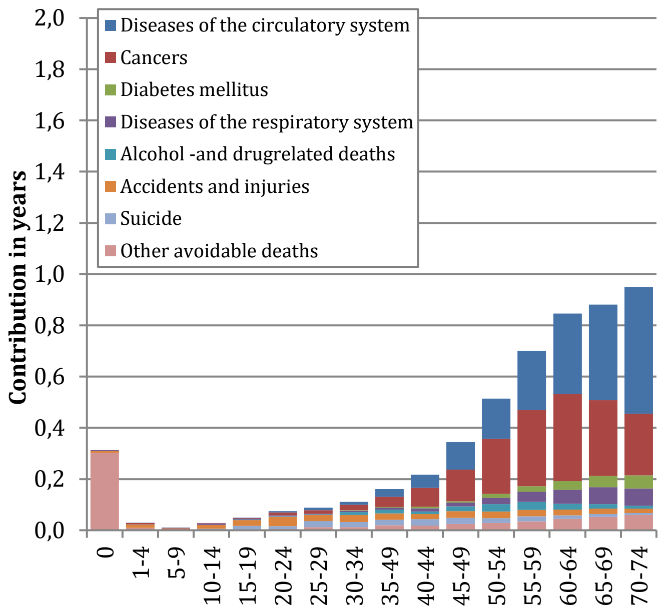

Figure 9. Age and cause of death decomposition regarding avoidable mortality in Serbia in 2015.

Within this region, North-Macedonia seems to be the least developed country regarding avoidable mortality as its impact is higher than in the other two countries, yet the entire region features a life expectancy of a little over 75 years old. Nevertheless, the years of life lost due to avoidable mortality is relatively low compared to other regions within East-Europe. This signifies that the region is putting emphasis on creating a healthy environment for their citizens, as this situation has improved significantly over the last 20 years. Which also is an indicator that Serbia, North-Macedonia and Bosnia & Herzegovina indicate to be willing to tackle the challenges posed by the European Union. Subsequently, all three countries are seen as strong potential candidates for the EU for the future, with all countries already being in some form of negotiations with the EU (European Commission, 2022).

<u>European Union Member States - 2004 (Czech Republic, Hungary, Poland, Slovakia)</u>

Whereas Slovenia and Croatia can be considered frontrunners of the East-European region, the EU member states that entered the European Union in 2004, the Czech Republic, Hungary, Poland, and Slovakia, can be seen as the region that is following closely. The Czech Republic and Poland are to be the most advanced in this region, whereof the age and cause of death decomposition can be seen in Figure 10. Both countries seem to be in the process of transitioning from the third stage of health transition towards a fourth stage as cancers are slowly becoming more prevalent and circulatory diseases are having less impact on healthcare. This is not yet the case in Hungary and Slovakia, even though these countries are not lagging far behind.

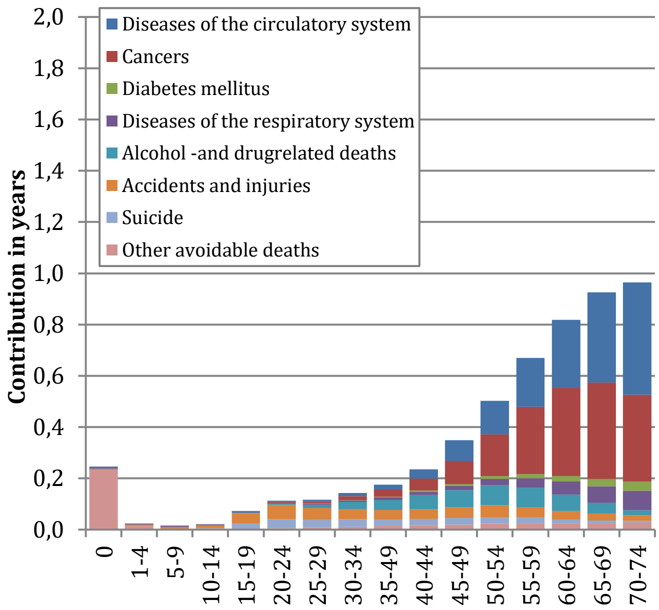

Figure 10. Age and cause of death decomposition regarding avoidable mortality in Poland in 2016.

The differences within this region are small, yet Hungary seems to be the country that is lacking the most, as it features the lowest life expectancy of 76,27 years old, as well as the highest contribution of avoidable mortality to life expectancy, which is 7,342 years. Where the Czech Republic and Poland relatively feature less circulatory diseases, this is also the case for alcohol -and drug related deaths, even though this difference is relatively small.

European Union Member States - 2007 (Bulgaria, Romania)

Compared to the EU member states that have entered in 2004, Bulgaria and Romania are considerably worse regarding avoidable mortality and their corresponding healthcare systems. Circulatory diseases have a significantly higher impact on life expectancy compared to Poland for example. This difference is visible when comparing Figure 10 to Figure 11, where the latter features the age and cause of death decomposition of Romania in 2016.

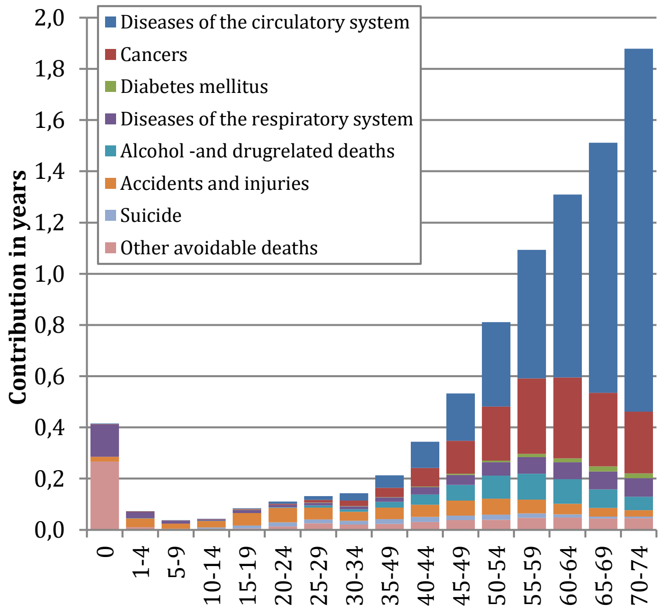

Figure 11. Age and cause of death decomposition regarding avoidable mortality in Romania in 2016.

Bulgaria possesses the most effective healthcare system of the two, as it features considerably less deaths due to circulatory diseases, respiratory diseases, and alcohol -and drug related deaths. Nevertheless, both countries are somewhat average when comparing their data to the East-European average and require considerable improvement in battling avoidable mortality to converge to the frontrunners of the East-European region. Even though, Bulgaria and Romania both joined the European Union a mere three years later than the Czech Republic, Hungary, Poland, and Slovakia, the difference in healthcare quality is apparent. Moreover, it does not seem likely that the 2007 entries will converge towards the 2004 entries within these three years in the future. This is due to both healthcare systems continuously improving, which makes convergence difficult.

Turkey – Non-EU

Turkey is a region of its own in this analysis as it geographically does not have strong ties to other East-European countries. It does, however, feature the largest populated country in the region as it populated more than a third of the entire population of East-Europe in this dataset. Turkey subsequently takes a large part in the calculation of the average life expectancy in East-Europe, and it features a life expectancy that is currently higher than the average.

Nevertheless, it features quite high child mortality and respiratory diseases compared to the other regions. However, it does indicate that Turkey is successfully transitioning into a fourth health transition stage as circulatory diseases are less apparent than average and are slowly decreasing towards the prevalence of cancers.

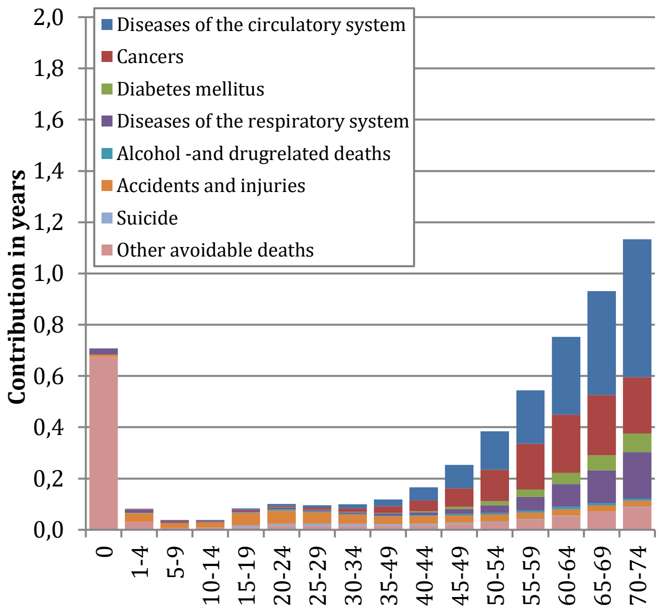

Figure 12. Age and cause of death decomposition regarding avoidable mortality in Turkey in 2016.

Intraregional differences

Differences between West -and East-Europe are significant, yet differences between the East European regions are also apparent. These differences, however, are less significant than expected. Even though, life expectancies of EU member states are generally higher than the respective life expectancies of non-EU member states, the cause of death decomposition averages are similar. Figures 13 and 14 show that besides more impactful infant mortality, as well as a slight distribution skew towards diseases of the circulatory system instead of cancers, the graphs are identical. The remaining categories are very similar, even though some categories are a little more apparent in one region and others in the other region.

The expectation was to see bigger differences between the two regions. Even though it is still apparent that East-European member-states averagely have better healthcare systems, the differences are small when looking at Figure 13 and 14. Nevertheless, the EU member states possess a better foundation to build upon due to EU funding programs, which could result in differences becoming bigger in the future.

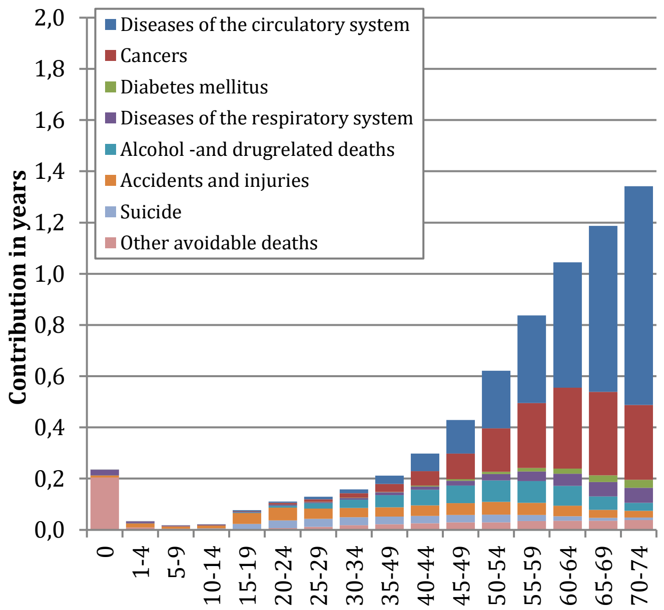

Figure 13. An average of the age and cause of death decomposition regarding avoidable mortality of EU member states in East-Europe.

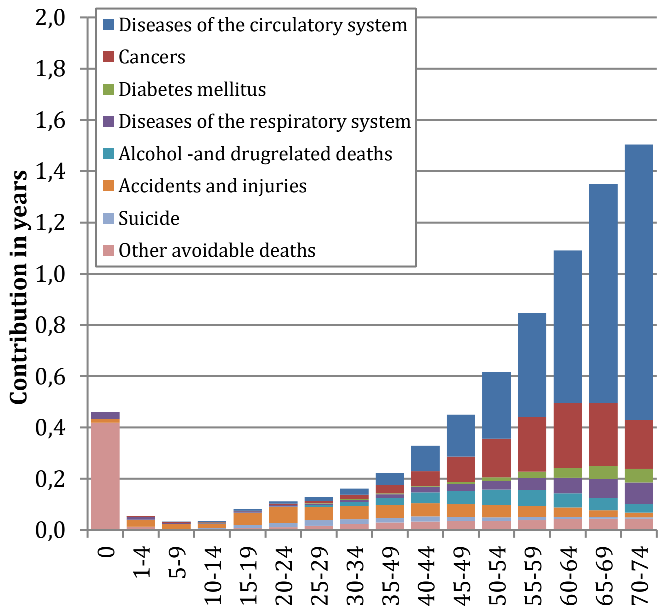

Figure 14. An average of the age and cause of death decomposition regarding avoidable mortality of non-EU member states in East-Europe.

Preventable and amenable mortality

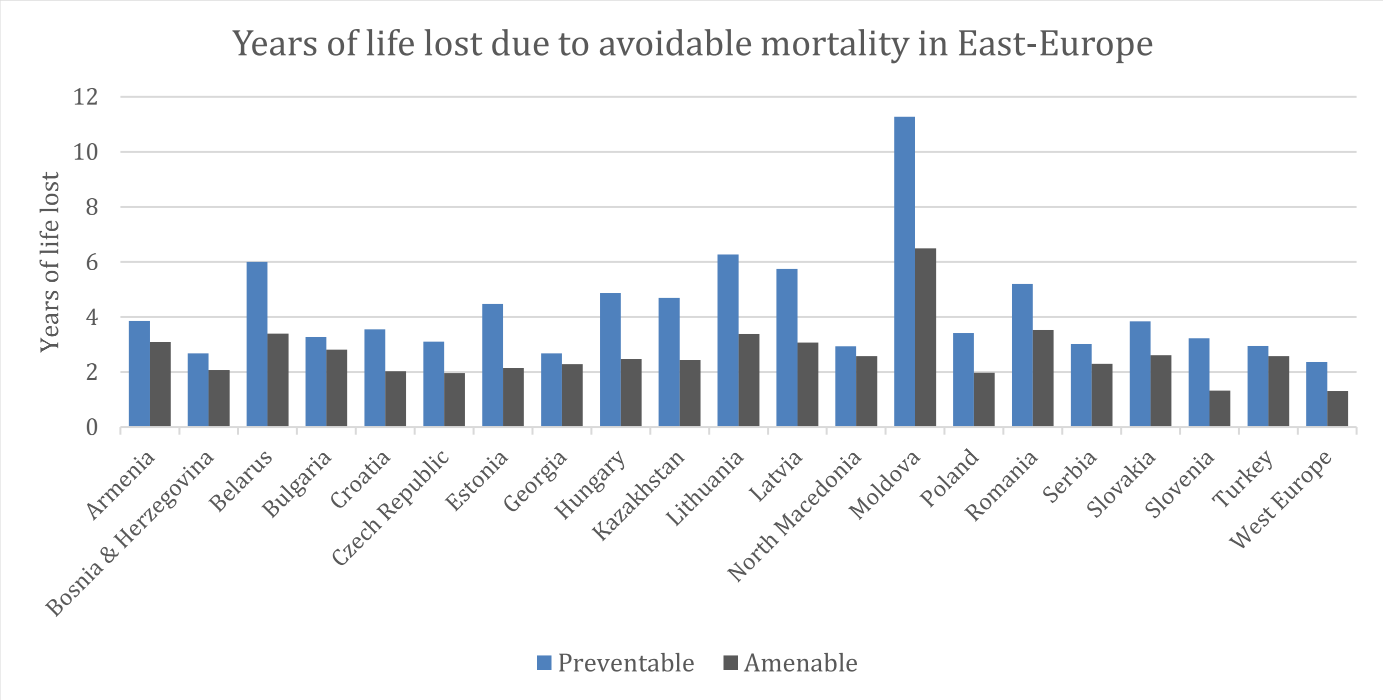

Figure 15. A comparison of preventable and amenable mortality in East-Europe, measured in years of life lost.

Lastly, to measure whether future policy should focus relatively more on improving the ability to treat diseases or the prevention of diseases, it is possible to look at preventable -and amenable mortality. As mentioned before, these two categories form avoidable mortality. Figure 15 shows this distribution of avoidable mortality in East-Europe using years of life lost, which entails the number of years lost should this form of avoidable mortality not be present. What immediately become apparent is that preventable mortality in East-Europe is a considerably bigger issue than amenable mortality, which is also the case in West-Europe. Yet, some countries do feature preventable -and amenable mortality that are similar. When comparing East-European to West-Europe, it is visible that both preventable -and amenable mortality are significantly higher, which already became apparent through other results. Nevertheless, preventable mortality being higher in all countries is not a reason to solely focus future policy on the prevention of diseases. Even though this would in theory lead to a situation where the treatment of diseases is not necessary anymore, treatment is extremely important in healthcare. Improving the ability of healthcare systems might even be less difficult with sufficient funding from the European Union. As this process features a more direct return on investment, this could be more effective in lowering amenable mortality and improving life expectancy. Improving lifestyle standards is a large part in lowering preventable mortality, which is a battle both West -and East Europe are facing, whereas the data suggests that amenable mortality is solely a large factor in most of East-Europe. Nevertheless, any EU funding towards the lacking regions in East-Europe would be beneficial in improving life expectancy in the future.

Discussion

Firstly, drug -and alcohol related deaths in some countries in East-Europe seem relatively low regarding prior research, an important thing to notice in this regard is that some cause of death categories are overlapping in some way. This is due to the WHO Mortality Database solely stating the first cause of death and not underlying factors. For example, research by Janssen et al. (2021) has shown that the impact of lifestyle-related mortality is high throughout Europe, yet this is especially the case in East-Europe. Smoking, alcohol-abuse, and obesity are the most prevalent causes of death due to lifestyle. Although the occurrence of these causes of death are quite low in Table 2, these are underlying factors that generally result in a cause of death that is categorized under cancers, circulatory diseases, and diabetes mellitus. The prevalence of preventable causes of death does, however, showcase the instances of lifestyle-related causes of death.

Furthermore, some countries feature significantly lower avoidable mortality numbers than expected beforehand. The main three countries that have low avoidable mortality compared to what prior research would show, are Georgia, and North Macedonia. Even though, life expectancy at birth in all these countries are one of the lowest in the region, the contribution of avoidable mortality on life expectancy at birth is relatively low as well. One would assume that this would be the other way around, as the relationship between these two variables is usually a negative one. This could possibly be a result of lacking or a different system data collection by the corresponding civil registration and vital statistics departments. However, it is difficult to measure if this is the case in practice. There are big indicators that the data quality is lacking in some areas. For example, suicide-related mortality in Bosnia & Herzegovina in 2016 is exactly 0, which is difficult to believe. Generally, data supplied by the World Health Organization is seen as of high quality and these data anomalies could have a different cause. The main message of this research would, however, likely not change as these differences are small.

When applying the epidemiological transition model to East-Europe, one would assume that cancers would not be as prominent as the data shows. The effect of cancers on life expectancy at birth is highly comparable between West - and East-Europe. Yet, where West-Europe has entirely shifted towards the health transition stage that features a battle against old-age, East-Europe seems to be transition into this stage, yet also highly being present in the previous stage: the battle against man-made disease. The fact that West-Europe only features high cancer occurrence and East-Europe features both high cancer and circulatory disease prevalence indicates that this is the case. This also signifies the difficulty of improving healthcare systems in East-Europe as these systems must deal with high occurrences of different types of diseases at the same time. Moreover, the effect of all other disease categories on life expectancy at birth are higher than in West-Europe, which truly signifies the strain on East-European healthcare systems.

The data suggest that most of East-Europe currently enduring the third health transition stage, whereas West-Europe seems to already be in a fourth, or even a fifth stage. Within East-Europe a high amount of divergence is present, yet the region's data does imply to be converging towards West-Europe. Most countries seem to undergo the same health transition stages that West-Europe has, even though this is happening in a more fragmented way. Accession of more East-European countries in the European Union would likely be beneficial in converging the regional differences regarding quality of healthcare. The European Union's goal of raising living standards for all its citizens and additional funding will be beneficial for new EU member states. Subsequently, European countries that will not enter the EU will have a more difficult task of improving their healthcare systems. Even though non-EU West-European countries such as Switzerland and Norway have achieved these high-quality healthcare systems, it will be more difficult for East-European countries to single-handedly achieve this as well. This is mainly due to the current disadvantage compared to surrounding EU member states and cultural differences, as this was not the case for Switzerland and Norway.

Differences between EU member states in East-Europe and non-EU member states are visible, yet less significant as was expected. Circulatory diseases are relatively more prevalent, whereas cancer incidence is not. This is a key factor in assuming that, averagely, the non-EU member states in East-Europe are slightly lacking behind the EU member states. This can also be seen as an indicator of EU health policy being successful. Naturally, these differences are only apparent for this dataset. The situation sketched by the results will presumably differ quite significantly when Ukraine, Russia, Albania, Azerbaijan, Kosovo, and Montenegro would be included within the dataset as all these countries are non-EU member states and do not feature relatively high-quality health care systems. An educated guess would presume that the regional differences within East-Europe would be more significant when these countries are included.

Even though the analysis touched upon cultural and regional differences with East-Europe, it is not comprehensive enough to understand the possibilities in changing lifestyle and addressing preventable mortality. This is also the case with amenable mortality, as the successful treatment of diseases requires a qualitative healthcare system with proper equipment, as well as sufficiently educated personnel. Lifestyle and education are entwined within a country's culture and are important in addressing high prevalence of avoidable mortality, especially cardiovascular disease (Anand et al., 2020). This research gives policy recommendations on whether a focus on improving a healthcare system's ability to tackle preventable or amenable diseases is necessary, yet in practice this requires more in-depth research on the receiving country's culture and lifestyle to sufficiently decide what type of policy focus would be most beneficial.

Another important difference between the quality of healthcare systems of West –and East-Europe is the prevalence of child mortality. This is not explicitly measured in the results and health transition theories do not focus on this subject either. Yet, child mortality impacts average life expectancy greatly as these deaths occur within the first age group. Child mortality is one of the biggest drivers of the height of the 'Other avoidable deaths' category and features both preventable -and amenable deaths. Even though child mortality is an element in avoidable mortality, it can be seen as a measurement tool for the quality of healthcare systems by itself (Gonzalez & Gilleskie, 2017). Comparing overall avoidable mortality data to child mortality data in East-Europe follows the division of frontrunners and followers within the region. Even though this research does not incorporate child mortality incidence in East-Europe within its analysis, further research would be beneficial to understand how child mortality affects the region.

Conclusion

To restate, the main question this research attempts to answer is: "What are the main pressure points in the quality of healthcare systems of East-European countries?". Following the results, a conclusion can be made that the main pressure point in East-Europe is mortality due to circulatory diseases. The contribution of mortality related to this category is almost four times as high compared to West-Europe. Differences within East-Europe regarding circulatory diseases are omnipresent. Furthermore, avoidable mortality has a significantly higher impact on life expectancy at birth in East-Europe than in West-Europe. Even though the main pressure point is circulatory diseases, accidents and injuries, respiratory diseases, alcohol -and drug related deaths, and other avoidable deaths feature a contribution to life expectancy of almost twice as high as seen in West-Europe, whereas cancer and suicide incidence is comparable between the two regions.

The intraregional differences within East-Europe are apparent, as the effect of circulatory diseases on life expectancy is higher in the non-EU countries compared to the EU member states. Furthermore, the same effect of cancer is lower when comparing the two regions. Whereas preventable mortality is somewhat similar, the main difference between the regions is seen in the amenable mortality category. This highlights the lacking ability to treat diseases through healthcare in non-EU countries in East-Europe. The differences between these regions would possibly be even more significant with the inclusion of all East-European countries in the analysis as it currently does not. These intraregional differences showcase the divergence within the region where all non-EU countries can be considered as followers regarding quality of healthcare. However, within East-Europe, Slovenia can be seen as the frontrunner regarding quality of healthcare. Poland, Serbia, Croatia, the Czech Republic, Turkey, and Bosnia & Herzegovina are close to Slovenia regarding quality of healthcare, following closely, whereas the rest of the region is lacking.

It would be recommended to strengthen policy focus on circulatory diseases, as well as further enhance treatment potential in East-Europe. Even though preventable diseases are the biggest healthcare pressure point, implementing prevention methods changing people's lifestyles takes a high amount effort and time. Amenable mortality is twice as high in East-Europe compared to West-Europe. Focusing future EU policy on both mortality types seems to be beneficial. Yet, amenable mortality might be easier to address in a shorter term as funding would have a more direct impact on the situation.

Future research would be beneficial to expand the current knowledge on avoidable mortality in East-Europe. As mentioned before, gender differences are included within this research. Yet, this would be valuable in understanding what role gender plays in avoidable mortality in East-Europe. Furthermore, child mortality seems to be key in understanding the quality of healthcare systems. More research on this topic in the context of avoidable mortality in East-Europe would be useful for grasping whether a healthcare system's pressure points are more based around preventable or amenable mortality. Lastly, in-depth case studies per country are necessary to understand what future policy should entail, as cultural and lifestyle differences between countries are determinant factors in the effectiveness of policy. This research only slightly touches upon cultural differences. Some of these countries' case studies are currently available, yet these are not comprehensive and complete.

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Appendix

Appendix A

Cause of death group:	OECD & Eurostat:	Preventable	Amenable	WHO data codes:	Code:
Other avoidable deaths	Intestinal diseases	x		A00-A09	INF01
Other avoidable deaths	Diphtheria, Tetanus, Poliomyelitis	x		A35, A36, A80	INF02
Other avoidable deaths	Whooping cough	x		A37	INF03
Other avoidable deaths	Meningococcal infection	x		A39	INF04
Other avoidable deaths	Sepsis due to streptococcus pneumonia and depsis due to hemophilus influenzae	x		A40.3, A41.3	INF05
Other avoidable deaths	Haemophilus inflenza infections	x		A49.2	INF06
Other avoidable deaths	Sexually transmitted infections (except HIV/AIDS)	x		A50-A60, A63, A64	INF07
Other avoidable deaths	Varicella	x		B01	INF08
Other avoidable deaths	Measles	x		B05	INF09
Other avoidable deaths	Rubella	x		B06	INF10
Other avoidable deaths	Viral Hepatitis	x		B15-B19	INF11
Other avoidable deaths	HIV/AIDS	x		B20-B24	INF12
Other avoidable deaths	Malaria	x		B50-B54	INF13
Other avoidable deaths	Haemophilus and pneumococcal meningitis	x		G00.0, G00.1	INF14
Other avoidable deaths	Tuberculosis	x	x	A15-A19, B90, J65	INF15
Other avoidable deaths	Scarlet fever		x	A38	INF16
Other avoidable deaths	Sepsis		x	A40 (excl. A40.3), A41 (excl. A41.3)	INF17
Other avoidable deaths	Cellulitis		x	A46, L03	INF18
Other avoidable deaths	Legionnaires disease		x	A48.1	INF19
Other avoidable deaths	Streptococcal and enterococci infection		x	A49.1	INF20
Other avoidable deaths	Other meningitis		x	G00.2, G00.3, G00.8, G00.9	INF21
Other avoidable deaths	Meningitis due to other and unspecified causes		x	G03	INF22
Cancers	Lip, oral cavity and pharynx cancer	x		C00-C14	CNC01
Cancers	Oesophageal cancer	x		C15	CNC02
Cancers	Stomach cancer	x		C16	CNC03
Cancers	Liver cancer	x		C22	CNC04
Cancers	Lung cancer	x		C33-C34	CNC05
Cancers	Mesothelioma	x		C45	CNC06
Cancers	Skin (melanoma) cancer	x		C43	CNC07
Cancers	Bladder cancer	x		C67	CNC08
Cancers	Cervical cancer	x	x	C53	CNC09
Cancers	Colorectal cancer		x	C18-C21	CNC10
Cancers	Breast cancer (female only)		x	C50	CNC11
Cancers	Uterus cancer		x	C54, C55	CNC12
Cancers	Testicular cancer		x	C62	CNC13
Cancers	Thyroid cancer		x	C73	CNC14
Cancers	Hodgkin's disease		x	C81	CNC15
Cancers	Lymphoid leukaemia		x	C91.0, C91.1	CNC16

Cancers	Benign neoplasm		x	D10-D36	CNC17
Other avoidable deaths	Nutritional deficiency anaemia	x		D50-D53	EAM01
Diabetes mellitus	Diabetes mellitus	x	x	E10-E14	EAM02
Other avoidable deaths	Thyroid disorders		x	E00-E07	EAM03
Other avoidable deaths	Adrenal disorders		x	E24-E25 (except E24.4), E27	EAM04
Other avoidable deaths	Epilepsy		x	G40, G41	NRV01
Circulatory system diseases	Aortic aneurysm	x	x	I71	CRC01
Circulatory system diseases	Hypertensive diseases	x	x	I10-I13, I15	CRC02
Circulatory system diseases	Ischaemic heart diseases	x	x	I20-I25	CRC03
Circulatory system diseases	Cerebrovascular diseases	x	x	I60-I69	CRC04
Circulatory system diseases	Other atherosclerosis	x	x	I70, I73.9	CRC05
Circulatory system diseases	Rheumatic and other heart disease		x	I00-I09	CRC06
Circulatory system diseases	Venous thromboembolism		x	I26, I80, I82.9	CRC07
Respiratory disease	Influenza	x		J09-J11	RSP01
Respiratory disease	Pneumonia due to Streptococcus pneumonia or Haemophilus influenza	x		J13-J14	RSP02
Respiratory disease	Chronic lower respiratory diseases	x		J40-J44	RSP03
Respiratory disease	Lung diseases due to external agents	x		J60-J64, J66-J70, J82, J92	RSP04
Respiratory disease	Upper respiratory infections		x	J00-J06, J30-J39	RSP05
Respiratory disease	Pneumonia, not elsewhere classified or organism unspecified		x	J12, J15, J16- J18	RSP06
Respiratory disease	Acute lower respiratory infections		x	J20-J22	RSP07
Respiratory disease	Asthma and bronchiectasis		x	J45-J47	RSP08
Respiratory disease	Adult respiratory distress syndrome		x	J80	RSP09
Respiratory disease	Pulmonary oedema		x	J81	RSP10
Respiratory disease	Abscess of lung and mediastinum pyothorax		x	J85, J86	RSP11
Respiratory disease	Other pleural disorders		x	J90, J93, J94	RSP12
Other avoidable deaths	Gastric and duodenal ulcer		x	K25-K28	DIG01
Other avoidable deaths	Appendicitis		x	K35-K38	DIG02
Other avoidable deaths	Abdominal hernia		x	K40-K46	DIG03
Other avoidable deaths	Cholelithiasis and cholecystitis		x	K80-K81	DIG04
Other avoidable deaths	Other diseases of gallbladder or biliary tract		x	K82-K83	DIG05
Other avoidable deaths	Acute pancreatitis		x	K85.0, K85.1, K85.3, K85.8, K85.9	DIG06
Other avoidable deaths	Other diseases of pancreas		x	K86.1, K86.2, K86.3, K86.8, K86.9	DIG07
Other avoidable deaths	Nephritis and nephrosis		x	N00-N07	GEN01
Other avoidable deaths	Obstructive uropathy		x	N13, N20-N21, N35	GEN02
Other avoidable deaths	Renal failure		x	N17-N19	GEN03

Other avoidable deaths	Renal colic		x	N23	GEN04
Other avoidable deaths	Disorders resulting from renal tubular dysfunction		x	N25	GEN05
Other avoidable deaths	Unspecified contracted kidney, small kidney of unknown cause		x	N26-N27	GEN06
Other avoidable deaths	Inflammatory diseases of genitourinary system		x	N34.1, N70-N73, N75.0, N75.1, N76.4, K76.6	GEN07
Other avoidable deaths	Prostatic hyperplasia		x	N40	GEN08
Other avoidable deaths	Tetanus neonatorum	x		A33	PRG01
Other avoidable deaths	Obstetrical tetanus	x		A34	PRG02
Other avoidable deaths	Pregnancy, childbirth and the puerperium		x	O00-O99	PRG03
Other avoidable deaths	Certain conditions originating in the perinatal period		x	P00-P96	PRG04
Other avoidable deaths	Certain congenital malformations (neural tube defects)	x		Q00, Q01, Q05	MAL01
Other avoidable deaths	Congenital malformations of the circulatory system (heart defects)		x	Q20-Q28	MAL02
Other avoidable deaths	Drugs, medicaments and biological substances causing adverse effects in therapeutic use		x	Y40-Y59	CAR01
Other avoidable deaths	Misadventures to patients during surgical and medical care		x	Y60-Y69, Y83-Y84	CAR02
Other avoidable deaths	Medical devices associated with adverse incidents in diagnostic and therapeutic use		x	Y70-Y82	CAR03
Accidents and injuries	Transport Accidents	x		V01-V99	INJ01
Accidents and injuries	Accidental Injuries	x		W00-X39, X46-X59	INJ02
Suicide	Intentional self-harm	x		X66-X84	INJ03
Accidents and injuries	Event of undetermined intent	x		Y16-Y34	INJ04
Other avoidable deaths	Assault	x		X86-Y09	INJ05
Alcoholrelated -and drug related deaths	Alcoholspecific disorders and poisonings	x		E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K85.2, K86.0, Q86.0, R78.0, X45, X65, Y15	DRG01
Alcoholrelated -and drug related deaths	Other alcoholrelated disorders	x		K73, K74.0-K74.2, K74.6	DRG02
Alcoholrelated -and drug related deaths	Drug disorders and poisonings	x		F11-F16, F18-F19, X40- X44, X85, Y10-Y14	DRG03