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NOTHING IS CERTAIN BUT DEATH – SCENARIOS OF THE MORTALITY IN GERMANY UP TO 2060

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Abstract:
This thesis deals with the developments in mortality in Germany in 2060 and the resulting implications for policymaking. The topic of this thesis is located in the discipline of demography, but the methodological approach of foresight methods is rooted in future studies. This research aims to reduce uncertainty about mortality trends in Germany in the coming decades by providing planning bodies and policymakers with insights into future healthcare needs. The topic is approached through two research questions.

1. How will mortality patterns transform under the influence of climate change and lifestyle change in Germany in 2060?
2. Which measures could be suitable for reacting to the transformations under investigation?

The data gathering to answer the research questions was carried out in two iterations of a policy Delphi process. The expert panel on *Mortality in Germany in 2060* consisted of a total of 16 researchers with predominantly medical backgrounds and expertise in at least one of the relevant fields to the study, namely public health, environmental health, lifestyle medicine, demography, epidemiology, and healthcare policy. The data from the first round was analyzed using a mixed-methods approach of cluster analysis and conventional qualitative content analysis. Scenarios presented the data results based on the identified clusters through the quantitative data and the storylines drawn from the qualitative data. In total, five scenarios - *Mental Health Inferno*, *Socio-economic Mortality Patterns*, *Disturbed Human-Environment Relationship*, *Anticipatory Policy*, and *Gender-Specific Health* – were derived. The scenarios covered causes of death composition from 12 categories clustered according to ICD-10 standards, life expectancy forecasting, as well as risk and life-prolonging factors of lifestyle and climate change. In the second policy Delphi round, the expert panel formulated policy recommendations for each scenario, which were analyzed using conventional qualitative content analysis.

The key finding of this study was that life expectancy is projected to rise slower than in all other findings presented in the literature review. Some estimations from the panel even predicted a stagnating or declining trend of life expectancy in Germany in 2060 compared to 2020 under the influence of lifestyle developments and climate change.

Keywords: Policy Delphi, Scenarios, Mortality, Germany, 2060, Lifestyle, Climate Change

Table of contents

List of figures

List of tables

1 INTRODUCTION

Since 2020, the Federal Institute for Population Research in Germany has recorded a slight decline in life expectancy in the aftermath of the COVID-19 pandemic and unusually strong waves of influenza since the 2000s (Bundesinstitut für Bevölkerungsforschung 2023; Destatis 2023d). The last bigger decreases in life expectancy were reported between the 1940s and early 1970s as delayed health effects of the Second World War (ibid.). The life expectancy gap between Eastern and Western Germany has been closing for a few years now, while a north-south divide trend is emerging (Bundesinstitut für Bevölkerungsforschung 2023). These examples illustrate that life expectancy is not static and not necessarily, as is often assumed, steadily increasing, but rather subject to profound changes. So how will the life expectancy curve evolve?

This thesis deals with the developments in mortality in Germany up to 2060 and the resulting policy implications. For this purpose, five scenarios, derived through a Delphi study, on the causes of death composition and life expectancy development are created.

Scenarios are a valuable method for short-term to long-term planning "[…] to estimate the need for schools, hospitals, and other public services; to help inform infrastructure investment with long-term benefits […] and to invest wisely in health research and development resources" (Vollset et al. 2020, 1286). Life expectancy and mortality projections are contributing to the estimation of "[h]ow many hospitals, retirement residences, and nursing homes will be needed to accommodate expected numbers of older aged people ten, twenty, or thirty years from now" (Bell 2004, 236). Accordingly, the relevance of health and life expectancy scenarios to provide planning bodies and policymakers with an idea of future healthcare needs is evident.

Tightly connected with life expectancy are mortality patterns, such as the cause of death composition. As described, the study results consist of scenarios on life expectancy projections and cause of death development. Scenarios are a valuable tool in situations of profound changes and high uncertainty, whereby life circumstances are subject to stark changes. But how is the current situation? As of 2021, circulatory system diseases are the most prevalent cause of death, accounting for a third of all deaths (Destatis 2023a). Followed by malignant neoplasms, which are responsible for more than a fifth of the deaths (ibid.). The greatest variance in the cause of death statistics, which have remained relatively constant in recent years until the turn of the 2020s, is likely to have come in the aftermath of the COVID-19 pandemic (Destatis 2023b). How will causes of death evolve in the future under current trends, such as prolonged daytime sitting, which is risky for health, especially in younger age cohorts (Manz et al. 2022, 31)? Or the increase in overweight caused by unhealthy dietary and exercise habits. According to figures from the Robert Koch Institute (2021), half of all women and two-thirds of all men in Germany

are overweight. The institute warns of secondary diseases, such as cardiovascular diseases or malignant neoplasms, bearing high costs for the health care system. The consequences of climate change can increasingly be identified as further threats to health. The Federal Environment Agency (Umwelt Bundesamt 2023) warns, for example, of the increase in heatwaves, storms, floods, infectious diseases caused by ticks and mosquitoes, increased mental stress, anxiety, trauma, and depression, and the deteriorating quality of drinking water and air. How will those and other climate change-related hazards affect health in the future? Within this thesis, concerning the mortality in Germany in 2060, such questions shall be investigated.

The topic of mortality in Germany in 2060 is approached through the research questions of 'How will mortality patterns transform under the influence of climate change and lifestyle change in Germany in 2060?` and 'Which measures could be suitable for reacting to the transformations under investigation?'.

The research process is described in the following nine steps:

1. Conduction of an extensive literature review on life expectancy forecasting, causes of death forecasting, mortality forecasting methods, Delphi applications to mortality research, and climate change and lifestyle impact on health
2. Explanation of theoretical concepts on the development of mortality, causes of death, and life expectancy, as well as health policy theories, lifestyle, and climate change impact theories on health
3. Description of policy Delphi as the selected method for data collection, which includes the origin of the method, different Delphi approaches, the process of a policy Delphi, and the policy Delphi expert panel
4. Operationalization of concepts for this study based on the theoretical explanations
5. Reflection upon the discussion of the two rounds of policy Delphi
6. Addressing the data analysis methods of cluster and qualitative content analysis
7. Classification of the validity and reliability of the study results
8. Presentation of the results through five scenarios derived from the first round's outcomes and policy statements for each scenario from the second-round output
9. The results shall briefly be summarized and discussed as well and closing remarks shall be made, including answering the research questions

The year 2060 serves as the time horizon for this work as the effects of today's lifestyle trends will only become apparent in a few decades. Assuming a life expectancy of roughly 80 years, 40-50% of the people currently living in Germany will still be alive in 2060 (see Destatis 2023c). Approximately 40 years seems reasonable for a long-term unfolding, as is the case with demographic developments. In addition, the life expectancy projections of the Federal Statistical Office in Germany until 2060 serve as reference and comparison material for this study. This thesis shows, that by approaching the research questions with

a Delphi study, it is possible to shed some light on the future developments in mortality in Germany up to 2060 and to contribute to the scientific discussions of this focal topic.

2 STATE OF RESEARCH

To the author's best knowledge, no other study has been published gathering data through Delphi to forecast mortality through causes of death growth rates and life expectancy. However, several national and international research has been carried out on mortality forecasting in Germany, mostly using statistical modeling.

2.1 Mortality Patterns in Germany from the Past to the Future

Nolte, Shkolnikov, and McKee (2000) investigated the long-term trend in mortality patterns in Germany from 1960 to 1997. In post-war divided Germany, female life expectancy developed more or less at the same pace, while the East German males experienced a faster improvement than their Western counterparts, which reversed in the 1970s (ibid., 892). In the late 1980s, especially the lowering of infant mortality drove the increase in life expectancy (ibid., 895). In West Germany at that time, both genders profited from the decrease in cardiovascular diseases, as well as reduced deaths caused by injuries (ibid. 895). Kibele's (2012, 210) findings support that this frequently studied East-West difference hardly plays a role in mortality recently but instead, the North-South gap increases, as Southern Germany holds a higher life expectancy. Further, she found that differences in mortality in Germany are driven by income, socioeconomic status, being privately or publicly insured, and residential areas (ibid., 207-209).

The future mortality pattern in Germany, when it comes to the increase or decrease in mortality rates, depends among other things on the fertility rate, as well as net migration. The higher the net migration, the less negative the balance of births and deaths and vice versa (Destatis 2022a). A high negative balance indicates more deaths than births in a population, which leads to a decrease in the population. The Federal Statistical Office (Destatis) in Germany has been carrying out the best-known population forecasts since 1966 (Vanella & Deschermeier 2020, 516), regularly publishing a population projection with a holistic consideration of a variety of demographic determinants. In its 15th coordinated population projection, Destatis estimated an increase in life expectancy for all scenarios, to varying degrees, in Germany until 2070 (Destatis 2022a). Thus, a large part of the population accumulates in the older age cohorts, which in any case indicates a negative balance between births and deaths, thus a higher mortality rate (see also Babel et al. 2006, 547). Vanella & Deschermeier (2020, 529) come to a similar conclusion of an increasing mortality rate until 2045. Similarly, Simon et al. (2012, 941) forecast an increase in mortality by 2050, represented as a death rate per 1,000 inhabitants, from 10.5 in 2009 to 15.5 in 2050. In absolute numbers, the mortality is projected to rise from 854,544 deaths per year in 2009 to 1,077,000 in 2050. As the population size is projected

to be significantly smaller than in 2009, the rise in mortality cannot be led back to an increase in population but is rather affected by other aspects.

2.2 Life Expectancy Forecasting for the Case of Germany

Life expectancy projections vary greatly due to the forecasting models applied. In the following, a few studies are compared, whereby the estimations on life expectancy will be compared with the material from this study in the section Discussion (see Table 6 Life Expectancy Forecasting Germany 2030-2060 - A Comparison). Firstly, the forecasting scenarios for the population projections of the Federal Statistical Office are calculated with the help of the cohort component method based on assumptions concerning the extent of fertility, life expectancy, and net migration in the upcoming decades, combined with 30 components resulting in nine variants (Destatis 2019, 13; 16). For all scenarios, a continuous increase in life expectancy is assumed, as this has been the case over the past century (ibid., 39). Further, the higher level of life expectancy in countries close to and similar to Germany indicates a rise in the future (ibid.). The older age cohorts will affect life expectancy more, as the survival rate among the younger population has already increased over the past century (ibid.). Scenarios on life expectancy by Destatis are based on the assumptions of either the long-term trend of rising survival age since the 1970s, the short-term trend of slowing down of the curve, or both combined (ibid.). The more the overall life expectancy increases in the scenario, the more the gender-specific gap closes, as the main drivers are medical improvements and preventive measures (ibid., 40).

Secondly, Fuchs et al. (2018) also using the cohort-component method considered the components of fertility, mortality, migration, and naturalization. Generally, the cohort-component method is a common way to project population structure, such as age distributions and life expectancy. Destatis (2022b) arrives at lower outcomes in the life expectancy forecasting than in their version from 2019, as the data of the mortality tables of 2018/2020 including the effects of the COVID-19 pandemic lowered the life expectancy. The estimations from Fuchs et al. (2018) based on data from 2013 are in line with the outcomes from Destatis (2019) but not with Destatis (2022b). The reason for this difference is the different actuality of data and accordingly changes in mortality in that time span.

Thirdly, Vollset et al. (2020, Appendix 2, 21) use the Autoregressive Integrated moving average model, which is used to forecast time series data. Further, they used a random walk model to add a random deviation to each forecasted value to explore randomness and uncertainty. Linear regressions are applied, to consider several variables such as age-related fertility, education, and contraception. Migration, war, sociodemographic, and population growth were considered. Uncertainty intervals were

added from past data. Vollset et al. (2020) arrive at a higher variance in life expectancy with a lower estimation for the lowest scenario and a higher value for the highest scenario than Destatis (2022b). The higher variance can partly be explained by the random walk application, as well as the reliance on different datasets. Interestingly, Vollset et al. (2020, 1298) observed a worldwide slowing down in the rise of life expectancy, where the central European region slowed down less than other regions.

Babel et al. (2006, 547; 543) are using the discrete-time model according to a modified Bomsdorf and Trimborn (1992) method. The model projects age- and sex-specific mortality rates and based on that life expectancy rates. The data is based on the year 2002 and no migration, nor fertility were included in the calculations. However, randomness was incorporated into the model. As an outcome, an enlargement of the gender gap in life span is suggested. Even though Babel et al.'s (2006) estimations rely on older data than Destatis (2022b), were performed before the life expectancy slowing down trend of 2010/2012 and did not incorporate the same number of variables, they managed to arrive at similar outcomes as Destatis (2022b). This fact might be due to the incorporation of randomness or precisely through not considering migration and fertility.

Lastly, using age- and sex-specific survival rates and partly the Lee-Carter Model, in the realm of the principal component model, Vanella (2017, 550) reports a stark rise in life expectancy for females and males up to 2060 and beyond. Principal component models to detect patterns in data sets by reducing their complexity. Vanella's (2017) calculations rely on the Human Mortality Database with data available until 2014. The components of age and sex, but no migration or fertility are considered. This model provides a simple technique to forecast life expectancy, however, trade-offs have to be made in the flexibility to uncertain events. Vanella's (2017) estimations exceed all other presented values by far.

The growth curve of life expectancy began to slow down in 2010 (Destatis 2019, 37). Similar trends are witnessed in other countries such as the USA and Central European countries. The reasons are thought to be drug abuse and bottlenecks in the healthcare system due to financial crises (ibid.). But recently also, covid accounts for a majority of death being the third leading cause of death in the U.S. (National Center for Health Statistics 2021). Especially the cohorts below 60 did not return to pre-pandemic mortality rates but rather experienced further drops, due to an existing mortality crisis among middle-aged U.S. Americans (Schöley et al. 2022, 1654). In Germany, increasing excess mortality due to flu outbreaks in the winter months is suspected as the cause of the declining life expectancy curve (Destatis 2022b). The actual causes of the slowdown in life expectancy, however, are still under research (ibid.). Improved living conditions, such as housing environment, occupational safety, nutrition, health care, and prosperity have so far led to an increase in life expectancy (ibid., 38). To identify further factors for the increase in life expectancy, Destatis (2019, 38) refers to the Global Burden of Disease

Study, which states the most common health risks in Germany are smoking, alcohol abuse, obesity, and suicide among children (ibid.). Smoking as the greatest health risk in Germany has the potential to be reduced in the coming years and thus contribute to an increasing life expectancy (ibid.). This effect could be stronger for men, as the proportion of women starting to smoke has increased recently, which could lead to a reduction in the gender gap in life expectancy (Rapp & Klein 2020, 204). Alcohol abuse is declining, which should translate into an increase in life expectancy (Destatis 2019, 38). The suicide rate was declining until 2010, after which this trend stagnated (Schelhase 2022, 6-7). Obesity has increased in recent years, especially among children and adolescents. However, the trend is slowing down or stagnating, which could lead to an increase in life expectancy (Destatis 2019, 38f.). Destatis (2019) also notes that the increase in life expectancy can only take place if sufficient preventive measures are available.

2.3 Causes of Death Forecasting in the Case of Germany

The literature on cause-of-death projections is very scarce in Germany. Most studies refer to the entire world and differentiate by region rather than by country. Wengler et al. (2021, 138) calculated current Years of Life Lost for causes of death categorized according to the International Classification of Diseases, Tenth Revision (ICD-10) system retrospective. Non-communicable diseases were responsible for 96% of all deaths in Germany in 2017 (ibid.). The biggest contributors to Years of Life Lost are malignant neoplasms and cardiovascular diseases (ibid.). Further, digestive diseases and neurological disorders contributed to Years of Life Lost, while infectious diseases have one of the lowest impacts (ibid.). The Years of Life Lost concept takes into account the determinant age; thus, the main causes of death vary strongly when different age cohorts are considered (ibid., 139).

A reduction of 331 out of 100,000 cancer cases in Germany in 2030 that are caused by obesity, was estimated through a dual-module modeling of Body-Mass-Index and the projected population groups on Body-Mass-Index distributions (Webber et al. 2014, 3). Currently, approximately 30,000 cancer deaths are caused by obesity and adiposity (Deutsches Krebsforschungszentrum 2023). Webber et al.'s (2014) estimation would thus correspond to a reduction of approximately 1% of obesity-related causes of cancer-related death in 2030 compared to 2023, which is not a lot. The outcome of this thesis also suggests an increase in obesity-related deaths.

In their reference scenario, Foreman et al. (2018, 2052) display an increase in life expectancy mainly due to a reduction of chronic respiratory, cardiovascular, cirrhosis, and other chronic liver diseases in Western Europe, including Germany, in 2040. Diseases that will slightly negatively affect the life expectancy in Western Europe are mental

disorders and diabetes, urogenital, blood, and endocrine diseases (ibid.). For the current event of the COVID-19 pandemic, Schöley et al. (2022, 1649) found that "[…] most western European countries are expected to partly recover from the losses observed in 2020, while other countries (including the United States and Russia) will suffer further LE [life expectancy] declines". In this case, Germany also did not recover as fast as other European Countries from the COVID-19-related drop in life expectancy (Schöley et al. 2022, 1660).

2.4 Delphi Approaches to Mortality Forecasting

No comparable Delphi study could be found through the literature search. Nevertheless, the health sciences are the most common field of application for Delphi studies and thus some studies on individual causes of death have been published (Flostrand et al. 2020, 4). However, those are mostly treatment- and patient-oriented and do not address the overall health of the population. One example of a disease-specific Delphi is Strupp et al.'s (2014) performance of a Delphi and Expert Workshop on palliative care for multiple sclerosis patients. Another specific example is Castello Botia and Wanden-Berghe's (2011, 124) Delphi study, which attempts to contribute to filling the gap of classifying nutrition-related mortality, which is not sufficiently covered in the ICD-10 system. The panel consisted of 11 doctors with expertise in clinical nutrition (ibid., 122).

Other similar Delphi applications address the question of the preventability of mortality and associated costs. For instance, the burden of disease in North Rhine-Westphalia was researched by Pöttgen and colleagues (2011). The data was retrieved from the World Health Organization and used by the Global Burden of Disease Study to calculate Years of Life Lost, Disability-Adjusted Life Years and Years Lived with Disability (ibid.). For the diseases with the highest burden, experts discussed in a Delphi study about preventive measures. The highest burden consists of neuropsychiatric diseases, for instance, Epilepsy, Parkinson's disease, Alzheimer's disease, cardiovascular diseases, malignant neoplasms, and external causes such as injuries (ibid.). The experts suggested prevention through lifestyle changes, such as more physical activity, less smoking, and healthier diets. Further, the strengthening of mental support through social inclusion and psychological care was suggested (ibid.).

Hoffmann et al. (2013, 201f.) conducted the Amenable Mortality in the European Union: towards better Indicators for the Effectiveness of Health System (AMIEHS) project within a literature-based Delphi study on the cases of England and Wales. The aim was to detect causes of death that could be avoided due to the overall performance of the healthcare system, and existing medical treatment (ibid., 201). They were able to identify a list of 14 causes of death that could be classified as amenable mortality, through

a panel of 23 experts on health system performance (ibid., 202). Out of this list, the expert panel reached a consensus about malignant neoplasm of the rectum and colon, malignant neoplasm of cervix uteri, and cerebrovascular disease as amendable causes of death, suitable to evaluate a healthcare system (ibid., 204). In Germany specifically, lung cancer, followed by ischemic heart diseases and alcohol-related diseases were the leading preventable and amenable causes of death in 2017 (Blümel et al. 2020, 236). In this thesis, most of these amenable diseases fall into categories that have been suspected to decline in many of the scenarios. Only for diseases of the urogenital system, a rise is anticipated in two scenarios, due to bad diet habits and the aging population. Lastly, Bohnet-Joschko et al. (2021, 8; 25; 14-22) were able to identify 58 diagnoses among 117 diseases after the ICD-10 system that caused unnecessary hospitalization and costs, through a Delphi study.

2.5 Climate Change-Driven Mortality Forecasting for the Case of Germany

As this study aims to focus on climate change- and lifestyle-driven mortality, therefore, the state of research concerning these aspects should be examined besides general mortality forecasting. Zacharias and Koppe (2015, 33) describe the human body to function best in an optimal composition of weather, thus changes in that state, such as temperature and humidity, put stress on the organism, which might drive diseases or even deaths. How the state of weather will change in the course of climate change in Germany and which implications it holds for health were investigated in several studies.

Even though cold weather currently poses a higher risk to life in Germany, it is expected that in the baseline scenario coldness-related stress load will decline, while heat-related stress and mortality will significantly rise in the second half of the century (Huber et al. 2020, 7; 5; Zacharias & Koppe 2015, 72). Coldness, however, is associated with an increase in blood pressure, causing mortality through cardiovascular diseases and narrowing of the bronchial tubes, causing deaths through respiratory diseases (ibid., 35). Cold weather events also favor Infectious and rheumatic diseases (ibid., 36).

Zacharias and Koppe (2015, 72) project an increase of 80% in thermal-related mortality risk in the 2070s in Germany, especially in the valleys of Rhine, Danube, and Lusatia. Heat is associated with a decrease in blood pressure and risk of dehydration, accounting for a rise in morbidity and mortality through cardiovascular diseases. Further, dehydration and other heat-related hazards cause renal colic, and for example, pollen rests longer time in the air due to the absence of rain, which among other things, causes respiratory diseases (ibid., 35). Besides a general increase in temperature, Zacharias and Koppe (2015, 76) project a stark rise in the frequency and length of heat waves, especially

in South Germany. The number of days with heat waves is expected to be approximately 40 days, thus half of the summer, in the 2070s (ibid.). But also, the risky combination of heat and humidity with deadly implications for the human organism is subjected to approximately double by 2050 (ibid., 78). Hertig et al. (2023, 14) summarized the eight biggest climate change-related risks to health in Germany in the upcoming decades. Among those are, heat stress, ultraviolet-related damages, allergic reactions, increase in potentially harmful microorganisms and algae, distribution and abundance change of possible vectors, issues with the respiratory system due to air pollution, injury and fatalities resulting from extreme weather events, and impact of extreme weather on the health care system. Hertig et al. (2023, 19) project different scenarios on how weather change impacts a rise in mortality due to chronic lower respiratory diseases until 2050 to the extent of 150% and 260% up to 540% by the end of the century, due to increased heatwaves. The scenarios also contain an increase of mortality through ischemic heart diseases by 90%-150% until 2050 and 330%-900% by the end of the century (ibid.). Those estimations imply a significant influence of climate change on mortality in Germany by the middle until the end of the century. Hereby, Hertig et al. (2023, 19) stress that even in the scenarios with the least changes, climate change-related mortality will rise.

The lowest vulnerability for warm temperature extremes was found in Bremen, and the highest in Frankfurt (Huber et al. 2020, 4). A general observation was that cities located next to the seaside are less affected by peaks in heat (ibid., 8). Yet, water temperature in the North and Baltic Seas is subject to rise, increasing the frequency of vibrions, thus bacteria living in salty water, bear the risk of infectious diseases of humans and animals in Germany (Hertig et al. 2023, 17-18). Floods, like in the Ahr Valley in Rhineland-Palatinate and North Rhine-Westphalia in 2021, will probably increase, which in combination with changed environments, further fosters the expansion of infectious diseases and the spread of vectors to transmit illnesses (ibid., 17).

Further, periods of drought are expected to lengthen themselves in the realm of climate change, with consequences of shortages in water and food supply. A heightened risk of forest fires also results from drought in Germany (ibid.). Besides heat and drought, an increase in air temperature is another health hazard stemming from climate change. Hertig et al. (2023, 18) project a rise in infections from contaminated food through higher air temperature, which has already been observed increasingly in Germany in recent years. Moreover, ground-level ozone is expected to increase through temperature developments, leading to more respiratory diseases, such as asthma, lung cancer, and cardiovascular diseases, potentially leading to death (ibid., 19). Another aspect, which Hertig et al. (2023, 18) judge as one of the most significant drivers of climate change-related increase in morbidity and mortality is the increase in antimicrobic resistance, thus bacteria that

develop resistance towards antibiotics. As a result, the treatment of illnesses with the aid of antibiotics poses a higher challenge.

Huber et al. (2020, 2) used temperature projections of the Inter-Sectoral Impact Model Intercomparison Project for the 12 major German cities up to 2100 in relation to changes in the daily death rate from 1993 to 2015. To meet uncertainty, the authors incorporated the Monte Carlo simulation (ibid., 4). Their study, however, did not consider demographic change and the increasing vulnerability of the aging population to heat (ibid., 7). On the opposite, Rai et al. (2019, 5f.) considered within a similar study, about Bavaria, different age cohorts and found that almost exclusively the age group over 75 will be concerned with temperature-associated death, both peaks in coldness and heat. The targeted period in this study was between 2083 and 2099, with a projected significant rise in temperature-related mortality by approximately 30% (ibid.). Rai et al. (2019, 10) conclude that the high number of elderly people in the German population in the future will create a large vulnerable group to extreme temperatures. A similar result stems from research with the time horizon of 2071-2100 by Hübler et al. (2008, 391) suggesting pressure on the elderly, especially in southern Germany, through high temperatures in the future. This would be particularly problematic, as in 2060 approximately 10% of the population is suspected to be 80 years or older (Blümel et al. 2020, 3). Hübler et al. (2008, 392) are calculating a six-time higher cost through heat-related hospitalization in the targeted period in comparison to 2008. Additionally, Hertig et al. (2023, 14) express the vulnerability of multi-morbid patients to weather changes.

Nowak (2019) warns that if the Paris Climate Agreement of 1.5°C will not be adhered to, there could be an estimated 1,000 additional heat-related fatal heart attacks in Germany every year. For comparison, in 2021 45,181 people died because of a myocardial infarction (Destatis 2022c). Even though the number is relatively small compared to the total mortality, Nowak (2019, 519) stresses, that as the temperature rises, so does the actual number of deaths. Further, the risk of deadly hospital pathogens also increases as the temperature rises (ibid.).

Concerning climate change-related mortality, the most frequent policy recommendation is to keep global warming under 2°C from pre-industrial times and take adaptive measures for vulnerable groups (e.g., Rai et al. 2019, 10; Nowak 2019, 519; Huber et al. 2020, 9). Nowak (2019, 519-520) additionally demands training for medical staff to protect vulnerable groups from heat and a national heat action plan. To mitigate anthropologically induced environmental changes, Liebig-Gonglach et al. (2020, 612-614) recommend low-emission zones in the city with a ban on vehicles that are not low-emission, reduction of noise and improvement of air quality through plants, compensation for heat through land sealing and lack of fresh air corridors by creating more green spaces in city centers, and community gardens to give access to green space, which is associated with positive effects on physical and mental health. Restrictions on individual motorized

mobility, environmental protection measures, and taking advantage of the benefits of community gardens are three of the suggestions made by the panelists of this study to mitigate future health challenges.

The exemplary research results presented demonstrate the relevance of climate change's impact on mortality in Germany. This study is intended to help assess how strongly climate change will affect mortality patterns, such as causes of death and life expectancy, through the evaluation of experts.

2.6 Lifestyle-Driven Mortality Forecasting for the Case of Germany

Through literature searches, few explicit lifestyle-related mortality predictions could be found. Solely, consensus prevails about current trends in smoking and diet being the main health risk factors leading to death in the future (Vanella & Deschermeier 2020, 517). Blümel et al. (2020, 11) summarize, that in Germany currently, 40% of all deaths are behavioral driven, mainly by diet, smoking, drinking, and physical inactivity. While Lhachimi et al. (2016, 7, 9) differentiate by gender and identify Body-Mass-Index as the greatest lifestyle-driven risk factor for women's health and alcohol as the one for men, in their monitoring of risks for European public health with a period of ten years.

In Foreman et al.'s (2018, Appendix 2, 58) study about the global burden of diseases, risk factors such as diet, alcohol abuse, and smoking, but also risk factors for diabetes such as blood pressure, body mass index, and physical inactivity, cholesterol, and fasting blood glucose were considered. The authors calculated Pearson correlations between risk factors and all causes of death with the aim of meeting the complexity of a large number of causes of death, risk factors, and their relationships (ibid., 3650-3659). As well as, how they correlate with time, capita, interventions, health system, and education (ibid., Appendix 1, 6). This holistic and extensive approach makes Foreman et al.'s (2018) study especially informative in comparison with other mortality forecasting as the Lee-Carter-Model or the Cohort Component Method, which found its application at Destatis. Foreman et al.'s model goes beyond predicting mortality rates and life expectancy and processes more information in the analysis. The added value of Foreman et al.'s (2018) study is thus significantly higher than what a master's thesis could contribute. However, the aim of their article was to make a worldwide comparison and analyze global health trends. A comparable holistic analysis on a national level is missing so far, whereas this thesis offers a first mixed-method approach.

2.7 Mortality Forecasting Models – A Comparison

The recently mentioned model by Foreman et al. (2018, Appendix 1, 7) uses logarithms with socioeconomic status and time as components and cause-specific covariates. The model is intervened by the correlations of risk factors and diseases leading to death and is supplemented by ARIMA (Autoregressive integrated moving average) for the unexplained remainder. The data was retrieved by the Global Burden of Diseases study. The mortality scenarios for the year 2040 were constructed by manipulating the logarithms into the 85th (best) and 15th (worst) percentile. The outcome of the application was life expectancy, years of life lost, and causes of death by sex, age, and location estimations (ibid., 8). The advantages of this model are the holistic view of the complex construct of risk factors, causes of death, and the relationship of multiple diseases, therefore, multimorbidity. In addition, global mortality trends are considered together.

One of the most common models for mortality and especially life expectancy prediction is the Lee-Carter Model, which was introduced by Lee and Carter in 1992 as further development and simplification of the Age-Specific Mortality Rates method, invented by Bell and Monsell in 1991 (Vanella & Deschermeier 2020, 516). The data used for Lee-Carter-Model analysis consist of time series, thus, data collected over a certain period, and is particularly suitable for trend analyses as it tackles the issue of uncertainty (Booth et al. 2006, 291; 10). The Lee-Carter-Model requires only a one-time series due to its low number of principal components but is also more prone to errors due to the small number and thus might underestimate future uncertainty, such as the component of migration and fertility (Bell 1997, 288; Vanella & Deschermeier 2020, 518). To approach mortality forecasting, the Lee-Carter Model uses the least square solution.

The case of Germany has rarely been investigated through the Lee-Carter-Model so far, one of the few examples is Vanella (2017). The Lee-Carter-Model is a statistical method to forecast mean life expectancy and mortality patterns in a country. Therefore, the forecasting is based on the assumption of a continuous rise in life expectancy. The strength of the Lee-Carter Model lies in life expectancy and mortality rate projections of a population, as the purpose, contrary to for instance the Foreman et al. (2018) model, is not to contribute to cause-specific mortality research.

The cohort component method was first used by the Census Bureau of England and Wales in 1863 (Vanella & Deschermeier 2020, 515). Destatis has been applying this method for population projection for the first time in Germany in 1966 and still uses it today (ibid., 516). For the cohort component method, data is used, that is retrieved annually at the same time and is divided into gender and age categories (Destatis 2014, 3). The data used in this method is organized as period life tables (Destatis 2019, 36). As components, the mortality and fertility rate, as well as emigration and immigration are

considered (Destatis 2014, 3). All those components are being calculated individually and based on several assumptions (Vanella & Deschermeier 2020, 516). The calculations depicted combined are used for creating scenarios on possible population projections (ibid.). Therefore, the main purpose of this model is population forecasting, which produces mortality, fertility, and migration forecasting as a basis. Again, the idea is not to produce cause-specific mortality forecasting. Thus, the output scope of this method is very similar to that of the Lee-Carter model, with the difference in considering the components of migration and fertility.

Nonstatistical approaches to mortality research are less common. Nevertheless, Lutz et al. (1998, 141) argue that demographic trends can be hard to estimate through statistical models as human behavior poses a high factor of uncertainty and thus highlights the utility of nonstatistical methods. This, with a qualitative approach, is also where the study of this thesis comes in to contribute to this rarely addressed area of mortality research. Booth and Tickle (2008, 8) describe such approaches of mortality forecasting, in which experts are asked to estimate future mortality trends, for example through a Delphi application. They mention the risk of panelists relying on outdated beliefs and thus biased answers. However, the qualitative nature of the present study allows the consideration of all kinds of components, such as migration and fertility, by the experts, which could not all be included in quantitative methods. Further, experts are able to consider social aspects, such as behavior, in their estimations, which is difficult to translate into statistical modeling. Lastly, experts can contemplate shifting parameter dynamics of a model. Through the extensive consideration of various aspects, the Delphi application helps with meeting future uncertainty and is a crucial contribution of this study to research. Lastly, experts of a region, in this case Germany, can consider the specific context. This cannot be achieved by statistical methods, especially when applied in an international comparison, and also does not correspond to the claim of such methods. Here, however, qualitative methods as used in this study can contribute to filling a research gap.

3 THEORETICAL CONCEPTS

In demographic research, mortality can be defined as the endogenous leaving of individuals from a population due to death, not emigration (Vallin 2006, 11), death being "[…] the final event by which an individual exists a population" (Vallin 2006, 13). To approach forecasting, life expectancy is used as a measure of mortality, relying on an assumption set about certain developments in the future (Booth & Tickle 2008, 8). Thus, within this thesis mortality is understood as a derivation of life expectancy, for example, used by Fries (2003, 456). Furthermore, cause-specific mortality for instance researched by Foreman et al. (2018) is crucial to approach the research question of "*How will mortality patterns transform under the influence of climate change and lifestyle change in Germany in 2060?*" The concepts of life expectancy and cause-specific mortality are brought together in this thesis to display mortality patterns. In a second step based on the detected mortality patterns, the thesis aims to answer the research question of "*Which measures could be suitable for reacting to the transformations under investigation?*".

Since there is not one suitable theory for the research object of this study, various theoretical concepts are presented which, as a sum, shall prove useful in answering the questions. Therefore, in the following, theoretical concepts concerning lifestyle impact on health, climate change's impact on health, the development of mortality, morbidity, and life expectancy, as well as health policy theories are explored to build the foundation for the empirical part.

3.1 Theories of the Development of Mortality, Causes of Death, Morbidity and Life Expectancy

In the past, shifts in mortality occurred mainly through the reduction of infant mortality through medical advancements. Nowadays, infant mortality reached the minimum level in affluent countries, so the mortality rate is reduced mostly by the increase in life expectancy in older ages (Ebeling 2018, 1888). Some projections over the development of mortality even foresee a great increase in life span, thus the maximum age a human being can reach, in the future due to technologies that slow down the cellular aging process and regenerate damaged body parts (Bell 2004, 254). From natural sciences, on the contrary, comes the assumption, that there is a limit to increase the life span, but the exact number is uncertain (ibid., 238). Carlsson (1976, 387-388) states, that the development of mortality generally is tied to the three variables of living conditions, or lifestyle, especially the diet, secondly the economic development of a country, and thirdly medical standard or innovation. Bell (2004, 237) adds the variables of physical engineering, for instance, improvements of safety measures, and social engineering, for

example, the advanced access to health supply as variables of death growth rates. The variables of living conditions, medical innovation, physical engineering, and social engineering will be explored further in the empirical part of this thesis. Carlsson (1976, 387-388) explores further the idea of assuming that the current life circumstances of the population groups that are well-off will apply to the whole population in the future and thus the life expectancy and mortality patterns of that group will apply to everyone. The underlying implication of this assumption is that the future will be a better version of today. Carlsson (1976, 387-388) acknowledges, that some developments, for instance, medical innovations and behavior, are greatly underestimated. Further, the scenarios as a result of this work with the growth rate of causes of death, as well as the evolution of life expectancy will ponder whether mortality patterns will always evolve to a better version of today.

However, theories regarding cause-specific mortality trends are sparse and mostly focus on mortality projections in developing countries with lessons learned from developments in industrialized nations over the last century (e.g., Fries 1980). This gap can be subsidized by theories of morbidity, that is, theories of the development of disease burden in a population. Blüher and Kuhlmey (2016, 315-316) contrast two theses here. On the one hand, morbidity, which is the burden of disease, could increase because of rising life expectancy, the so-called medicalization or expansion thesis. On the other hand, the disease phase could be shortened through prevention and lifestyle adjustments, according to the compression or morbidity compression hypothesis. These theses come with implications for expected costs, as well as the quality of life of the population, especially in old age. Of course, both these are ideal types and not applicable to all individuals in a population. For this reason, the bi-modality was formulated. Here, factors such as socioeconomic status, medical care, and genetic predisposition are acknowledged. In general, however, this mixed type also implies an increase in life expectancy with an increase in the quality of life in old age. This opens a gap between population groups that will benefit more from the compression of morbidity in the future, while others will be increasingly affected by the expansion, therefore, chronic diseases and limitations (ibid., 316; Fries 1980, 131). Morbidity will thus become more of an issue of social justice and inequality. Fries (1980, 133) argues that in the future, this makes morbidity a bigger issue than mortality, because of the trend of a rectangularization of the mortality curve. Thus, the years lived with diseases and disabilities increase and strain the healthcare expenditure more. In order to reduce the costs caused by diseases, morbidity needs to be postponed to the years added to human life through the increase in life expectancy (Fries 2003, 455).

Concerning morbidity Fries (2003, 455-457) introduces three possible scenarios. First of all, the life span could be lengthened due to current trends, however, the entry into the age-related illness phase remains the same, and thus, morbidity is prolonged. Secondly, with increasing life expectancy, the phase of illness remains the same time span, but the

entry point shifts according to the increase in additional years to a higher age. In contrast, in a third scenario, Fries describes how due to measures and innovations morbidity could be compressed. The third scenario assumes rather individualized health trajectories, highly tied to people's socio-economic status, as well as an emphasis on the quality of the end-of-life phase.

As introduced, an ideal theoretical state of mortality in the case of the morbidity compression hypothesis is the rectangularization of the mortality curve, which is applied widely as an analytical tool in mortality research (Fries 1980, 131). A rectangular curve equals a theoretical state in which all individuals in a population have the same chance to survive at the same age and basically, everyone dies at the same age (ibid.). However, risk factors, such as genes, lifestyle, accidents, and socio-economic differences, prevent the realization of rectangularization of the mortality curve since there will be premature deaths in any case (ibid., 132). Ebeling et al. (2018, 369) developed Fries' framework further by adding the concept of the maximum inner rectangle approach (MIRA) and thus, adapting the framework to the trend of demographic change. Fries' (1980) assumption about a natural maximum life expectancy and that the differences in life expectancy between population groups will be reduced in the future has been proven wrong in recent decades. Ebeling et al.'s (2018) MIRA approach can be applied to display the relation between mean life expectancy and variability, and therefore, the social stratification in mortality. Fries' model is used as a reference and is equated with maximum life expectancy as the outer rectangularization. The average life expectancy serves as the inner rectangularization. Thus, the extent to which a population reaches the highest life expectancy is put into relation.

This approach can indicate strong inequality in a society concerning life expectancy distribution if the ratio is low.

As life expectancy is determined largely by access to education, labor, and health care, thus it indicates the level of inequality in a population (Bell 2004, 243; 250). Ebeling et al. (2018, 376) acknowledge, that the ratios vary starkly among countries, but they detected an overall trend of premature death of up to 15 percent in a population. Interestingly, countries where women die more often because of pregnancy and childbirth tend to have a lower gender-specific difference in life expectancy or even a higher life expectancy of men. In countries where this is not the case, women tend to live considerably longer, which leads to the assumption, that women naturally have a higher life expectancy than men (Bell 2004, 243). Based on their research, Ebeling et al. (2018, 377) assume a continuous rise in life expectancy and an increase in life expectancy equality due to improvements and measurements. This hypothesis of a continuation in life expectancy is to be empirically tested in this paper.

3.2 Health Policy Theories

The term Salutogenesis was coined by the Medicine Sociologist Aaron Antonovsky in the 1970s (Petzold & Bahrs 2020, 90). This theorem considers risk factors and resources when speaking about health. This approach differs from other concepts in its focus on health instead of illness. Salutogenesis addresses the question of whether a focus on disease would make people sick and, consequently, whether a focus on health would make people healthy. As an answer, the sense of coherence was formulated (ibid.; Blättner 2007, 67). The sense of coherence is an important concept in the theory of Salutogenesis, it describes the mental ability to cope with stress factors on health and to mobilize resources to maintain health. Depending on the extent of the sense of coherence, health could be fostered or impaired. This competence is not part of personal identity but is rather embedded in the socio-historical context and financial possibilities. Further, life circumstances decide over the exposure to stress factors (ibid., 68-69; Blüher & Kuhlmey 2016, 317). Humans are in a constant state of change between sickness and health, which are closely linked. On this spectrum, being healthy is strived for, but it also allows people with congenital diseases or disabilities to be considered healthy (Petzold & Bahrs 2020, 92). In the Salutogenesis framework, the sense of coherence is replacing the term health and stands for the consistency of individual feelings with the position on the disease-health spectrum (ibid.). The psyche mediates between genes and the environment, and its state is responsible for the emergence of a sense of coherence (ibid., 97). There are three phases of sense of coherence, firstly, the motivation for action, second, the action itself, depending on the availability of resources, and thirdly the assessment and reflection of the outcome, which presupposes a capacity for learning and reflection on the part of individuals (ibid., 98-99). In practice, the theory withholds how practitioners regard the patient's situation and how the patient perceives their situation. Thus, the theory is tightly connected to how a diagnosis is communicated and how the change in viewpoint on the treatment can improve the health situation of individuals (ibid., 108). However, Blättner (2007, 67) criticizes the theory for the non-implementable ability of the theoretical interventions in practice, as well as logic gaps in the theoretical conception. Others, such as Blüher and Kuhlmey (2016, 317), see Salutogenesis more in terms of the health policy aspect of prevention. They distinguish between primary, secondary, and tertiary prevention. Thus, it describes the prevention of diseases, the detection and treatment of existing diseases at an early stage and preventing further diseases resulting from existing disease. Blüher and Kuhlmey (2016, 317-319) concentrate on the elderly and stress the importance of activity, mobility and autonomy, social integration and participation, as well as prevention of malnutrition as key aspects for effective prevention in old age. This is aimed at delaying the need for care and thus improving the quality of life for those

affected, as well as easing the burden of the shortage of caregivers and the challenges of an aging population (ibid., 319).

However, prevention reaches the population differently, depending on gender or socio-economic status (ibid.). For this reason, the offloading of responsibility for one's own health through health behaviors is viewed critically in the social sciences in the context of unequal distribution of opportunity. As the chances of engaging in conducive health behaviors are shaped by factors such as income, work situation, values, and cultural embedment (Kriwy, P. – M. Jungbauer-Gans 2020, 5). Another concept is health promotion, which is basically used interchangeably with disease prevention, with the first one activating behavior, while the second one aims to avoid risk (Krajic et al. 2020, 138-139). The idea is that health can be improved by influencing the behavior or the surroundings of an individual. The promotion can be done via education or training, economic incentives or social restrictions, as laws or prohibitions (ibid., 138). The interventions can target the macro layer, thus in a societal, political, or state way, or on the meso layer, thus individual environments, organizations, or on the micro level by targeting individual action (ibid., 141). Prevention promises not only to make society more resilient but also to enable individuals to live longer with a higher quality of life.

3.3 The Concept of Lifestyle and its Impact on Health

The sociology of health and health sciences in general are primarily empirically oriented with little reliance on theoretical frameworks, and when they do, they focus on political influence, individual behavior, and health inequities (Gerlinger 2020. 124-126). Thus, the following is an accumulation of stratified, gendered, and age-divided empirical data to formulate general statements on dimension-dependent lifestyle behavior and to define lifestyle and its impact on health.

Rapp and Klein (2020, 194-195) define lifestyle as health behavior, equating the two terms for three reasons:

1. Individual behavior remains relatively stable over an individual life course even in the case of transformations such as in work and family life, the area of living, or mobility.
2. Health-related behaviors are mutually dependent and thus trigger a particular lifestyle. For example, the behavior of doing a lot of sports might come with implications for the diet, consumption of tobacco and alcohol, choice of clothing, and how leisure time is spent.
3. Lifestyle is embedded in the context of culture and beliefs. For example, religious or geography-related diets or cultural beauty standards trigger a certain health-related behavior that sums up a certain lifestyle.

Diet, sports, body weight, smoking, and alcohol consumption as aspects of lifestyle are the most relevant behaviors affecting health (ibid., 194). Thereby, the increase in obesity due to diet and physical inactivity is currently expected to be the biggest health hazard in affluent countries in the future (ibid.). First, it is important to look at diet as a whole instead of individually consumed goods. Diet patterns provide more holistic information about their influence on health. For example, vegetarian and vegan diets, as well as less-proceed food, are associated with better health according to current research (ibid., 195). But diet patterns reciprocally influence other areas of lifestyle that affect health, for example, a healthier diet triggers more active and sportive leisure activity, and the other way around (ibid., 201). The recent trend in higher accessibility of fresh vegetables and fruits fostered the possibility for a healthier and more balanced diet. At the same time, high-proceed and convenience foods managed to establish themselves increasingly, posing more risks to health (ibid., 199). This trend was paved the way by the change in family and work structures, which complicate the time-consuming preparation of meals at home (ibid., 200). Further dimensions like marital status, layer affiliation, and gender are shaping the diet. For example, singles tend to eat less healthily than people who are in a relationship, but their quantities of food intake is smaller (ibid., 201). Further, social class-specific differences in the diet patterns have been observed, the lower the socio-economic status the higher the consumption of soda, meat, and sausages. This is due to the higher prices of healthy food, better education about healthy diets among the higher layers, and higher food consumption among the lower layers due to the stress load in more precarious job situations. The tendency toward class-specific friendships solidifies dietary patterns (ibid., 200). Considering the gender dimension, on average, women eat more health-conscious foods than men (ibid., 201).

While current work and mobility trends in Germany are moving towards low activity in leisure and working times, physical inactivity poses the risk of developing cardiovascular diseases, diabetes, dementia, and colon and breast cancer. Hereby, health and sports are mutually dependent, those who do more sports tend to stay healthier, but only healthy people can do a lot of sports (ibid., 196). For decades sports activity has increased through the decrease of manual work and the higher relevance for leisure time, which applies especially to younger generations (ibid., 201). Considering the socioeconomic status, people from higher social layers are more active than people from lower layers, this is mainly due to a different value set (ibid., 202). The marital status shows, that singles are more active in sports than couples, especially among young people (ibid.).

Further, the factor of body weight is determined by genes, diet, and physical activity, and is mainly measured through the Body Mass Index. A higher Body-Mass Index poses a risk of developing diseases of the cardiovascular system and diabetes. Further, cancer and dementia can be caused by a high Body-Mass Index (ibid., 198). Body weight poses

a high risk to health, as the average weight in Germany has risen over the past decades according to the Body-Mass-Index, both as an average increase over the whole population and in the group of starkly obese people (ibid., 203). This is partly due to a decrease in sleeping, less smoking, temperature changes, increasing usage of medical drugs, and novel entities that trigger obesity, as well as the aging society (ibid.). People belonging to lower social layers are more at risk of a higher Body-Mass Index, partly due to their layer-specific diet and sports patterns, but also due to their lower income and knowledge (ibid.). Due to the tendency to inherit the behavior patterns through socialization through the family and the societal surroundings. Generally, Rapp and Klein (2020, 206) recommend, that public health measures should be targeted toward people with lower socio-economic status, as health-promoting behavior is tightly connected with social position. Considering marital status, due to the higher amount of food consumption in combination with a lower physical activity among people in relationships creates a greater risk for them to develop a higher Body-Mass Index after some time (ibid., 204).

Consumption behavior, for example, smoking is connected with other behavior patterns, such as alcohol consumption. Smoking is mainly associated with several cancers and cardiovascular diseases, but also mental illness can be caused by smoking. Alcohol consumption to a lesser extent is beneficial to health, while excessive consumption is associated with lower life expectancy, cardiovascular disease, diabetes, and dementia. Gender differences need to be considered, as well as a higher risk for addiction if the consumption starts early (ibid., 198-199). The number of smokers decreased over the past decades, especially among the younger generations. However, the percentage of female smokers decreased slowly, thus the gender gap in smokers narrowed. Smoking poses the biggest difference in layer-specific risk factors for health, with members of the lower social layers smoking more frequently (ibid., 204). First of all, the stress in precarity job situations, as well as lower income, are stressful and cigarettes provide a fast and easy way to reduce stress (ibid., 205). Secondly, Rapp & Klein (2020, 205) argue that lower layers are less futures-oriented, thus the known consequences of tobacco and alcohol do not affect the consumption decision. Further, the social context of people with lower socio-economic status fosters smoking in the group itself, but also through external factors as being the target of the advertisement (ibid.). The consumption of alcoholic beverages has decreased steadily for decades, especially binge drinking, and is the same among all layers (ibid., 204). Women belonging to the higher societal layers are at higher risk of drinking (ibid., 204). And singles are more likely to smoke and drink than couples (ibid., 205).

3.4 Concept of Climate Change and its Impact on Health

Theories on how the impact of climate change on health will unfold could not be found when making this literature review. As research about the impact of climate change has been sufficiently covered in the chapter on the state of research, this section will be a brief definition of the conception of climate change within this thesis, as well as a theoretical statement about how environmental effects unfold differently among societal layers. Within this thesis, climate change is understood as human-made warming in global mean surface temperature, changes in air- and water quality, precipitation patterns, increased natural disasters, and other related phenomena. This paper is about how the effects of climate change affect health. However, there were points of overlap with the term environment, which more than the natural environment, also includes the social environment (Liebig-Gonglach et al., 2020, 606). Socio-economic status determines how much a person is affected by environmental impact due to the access to clean air and green spaces, and the living environment (ibid., 607). Members of the lower social layers are more affected by local environmental hazards (ibid.). Contrary to lifestyle and health behavior, environmental hazards are something that cannot be influenced by the individual (ibid., 609). Exposure to pollutants from the anthropogenically modified environment also has crucial effects on health (ibid.). But also, high exposition to noise, for instance living next to a busy road, can cause mental health issues and behavioral disorders, while fine dust pollution, among other things caused by road traffic, is associated with respiratory and cardiovascular diseases (ibid., 610-611).

4 METHODOLOGICAL PART

4.1 Delphi Method for Data Gathering

4.1.1 Origin and Development of the Delphi Method

Delphi is an expert-based foresight method in which estimations about future developments are made. The assumption behind the method is that the outcome of experts' discussion about the future is more accurate than that of lay people. For this study, the Delphi method contributes especially through the experts' panel capability of considering development dynamics of mortality that are hard or even impossible to grasp in statistical approaches.

The term 'Delphi' as the ancient Greek mystical oracle, is lent by Kaplan, who worked with the RAND Corporation, for an expert-based research method (Gordon 2009, 1; Loo 2002, 762; Dayé 2018, 851). The Delphi method was first applied in the mid-1950s in the military context of the Cold War (Zolingen & Klaasen 2003, 318; Brockhaus & Mickelsen 1977, 103). The founding fathers of Delphi were Dalkey and Helmer, colleagues of Kaplan, who used the method as the first, to research the possibility of a conflict outbreak, involving nuclear weapons (Gordon 2009, 1; Zolingen & Klaassen 2003, 318). The initial idea was to get a conclusive statement from a group of experts without letting group effects of hierarchy, dominance, social pressure, and desirability shape the outcome (Zolingen & Klaassen 2003, 318; Dalkey & Helmer 1963, 459). Dalkey (1969, iii; v) himself describes the attempt to rely on experts' opinions on issues that unfold in the long term, with high uncertainty in knowledge to support policy formulation. Characters of Delphi, apart from further developed models, emerged from that background – anonymous discussion among experts through a questionnaire, with iterations and controlled feedback, as well as the statistical aggregation of individual estimations in the last round (ibid., v; Gordon 2009, 1).

While Delphi was initially considered less appropriate for policymaking, it was later developed out of the military context and into academia, where it was applied to policymaking processes by Linstone and Turoff (Brockhaus & Mickelsen 1977, 106; Turoff 1970, 151-154; Barnes & Mattsson 2016, 201). In the 1960s and 1970s, the method was applied in business, the public sector, and research, especially in the natural sciences, technology, environmental studies, social and political developments, and more (Zolingen & Klaassen 2003, 318; 323; 321; Brockhaus & Mickelsen 1977, 103; 106; Gordon 2009, 1-2). In the beginning, it was predominantly used in physical sciences and engineering and least in biological sciences and medicine (Brockhaus & Mickelsen 1977,

106). While the Delphi method grew its' popularity in most research fields, its application is nowadays dominated by health science, which carries out between 70-80% of all Delphi studies (Flostrand et al. 2020, 4; Gordon 2009, 2). The Delphi method is used for topics "[...] that lack historical data and require the collection of expert opinions" (Pätäri 2010, 97).

In health sciences, the Delphi method is less applied as a foresight tool but rather focuses on finding consensus, which is calculated using statistical measurements, such as the median (Niederberger & Spranger 2020, 1; 5). With the help of Delphi, the state of research can be supplemented regarding topics that cannot be investigated due to a lack of resources, ethical issues, and are characterized by uncertainty (ibid., 2). The most frequently applied variant in health sciences is the classical Delphi, consisting of two to three rounds (ibid., 4; 6).

When in the mid-1970s increasing criticism was voiced regarding the reliability and accuracy of the predictions, poor quality of the questionnaires, and non-response of the participants, new variants of the classical Delphi method were developed (Tapio 2002, 86). Among those was the Policy Delphi, which emerged at the end of the 1960s to explicitly address political issues (Turoff 2002, 80). The difference to the classical approach of the method lies according to Turoff (2002, 80) in the panel selection. While in the classical Delphi, experts are sought, informed advocates for political decisions are required for the policy of Delphi. Another difference is that consensus is not aimed for in policy Delphis, but rather a set of policy options while the elucidation of the consensus is the highest priority in classical Delphi (ibid.). Thus, the policy Delphi does not intend to replace research, it is seen as a tool to identify and formulate options (ibid., 83). Classical Delphi's are predictive, thus asking the panel about exact estimations about the future (ibid., 94; Cuhls 2019, 10). On the contrary, policy Delphi's aim is for panels' judgment about the desirability and possibility of certain predictions (Turoff 2002, 94). Panelists are asked to justify their quantitative responses, resulting in a large amount of qualitative data. It is necessary to analyze this data thoroughly and to summarize it in a way that reduces it to the key takeaways (ibid., 92). Despite the advantage that policy Delphi holds compared to the classical approach, for instance, no forced consensus, two problems need to be addressed at this point. First of all, Turoff (2002, 95) describes the policy Delphi as a 'decision-analysis tool' that facilitators of Delphi studies misuse as a 'decision-making tool'. Secondly, the lack of an epistemological background in Delphi generally gets criticized, as contrary to other social research, theories are not tested in Delphi processes (Tapio 2002, 91).

4.1.2 Comparison of Delphi Method Approaches

The goal of the thesis to create scenarios on mortality in Germany in 2060 was supported by the meaningful application of a policy Delphi study. It allows the coverage of a wider spectrum in the scenario construction through the involvement of more people as opposed to a single researcher (Glenn 2009, 18). So far, the classical and the policy variants of the Delphi method have been described. The following clarifies why the policy Delphi was used for this study in distinction with a variety of possible applications in the methodological context. However, there is no claim to completeness. First, allowing for dissension is an advantage of the policy application over other variants for the purpose of creating a set of scenarios (see Table 1 Comparison of Delphi Approaches). Second, the typical fields of application of social sciences and policy issues seem to fit the topic related to demography and public health better than for example the purpose of decision-making. Third, having several iterations in an anonymous and virtual setting seemed to create meaningful outcomes, prevent group biases, and be an easily accessible format for the panelists. The opposite of this would have been, for example, a single-session group workshop, which, however, is better done in organizations where all participants are known to each other. A disadvantage of the policy approach in comparison with other variants is that the organizational and personal level of the experts can be mixed, and it is not distinguishable whether answers are given out of belief or actual expertise.

Table 1 Comparison of Delphi Approaches

	Classical Delphi	(Disaggregative) Policy Delphi	Decision Delphi	Group Delphi/ Expert Workshop	Real-time Delphi
Con-sent	Consensus [1]	Dissension[2]	Consensus[1]	Both possible [13]	Consensus [4]
Anony-mity	Yes [1]	Possible. Not mandatory	Panelists know each other. Answers are anonymous [1]	Virtually possible. Not aiming for it [5]	Yes [4]
Field of Application	Any issue that needs specific expertise [1]	• Social Sciences [1] • Policy-issues [3]	Decision-making and application [13]	• ERA [1] • Issues in need of interdisciplinarity [3]	• ICT • Security • Logistics[6]
Experts	Identified experts for the topic [1]	Identified experts or 'lobbyists' for an opinion [1]	Same hierarchical level in an organization [1]	Selected group of panelists [3]	Identified experts [4]
Itera-tions	Two or more [3]	Two up to five [37]	Several [8]	Several rounds in one day [1]	Continuously [4]
Modes	Online or paper-based questionnaires	Online or paper-based questionnaire	Online or paper-based questionnaires	• Virtually • In-person • Workshop • Interviews [5]	Online and computer-based [3]
Advantage s	Mitigate group effects through anonymity [9]	No enforced consensus [10]	• 'Forced' activity • Avoid power effects • Employee involvement in decision-making [1]	Rapid feedback, also about the consensus-building process [3]	Immediate feedback and results, that are constantly available [3]
Disadvanta ge	Time-consuming [4]	non-explicit view on different levels (e.g., personal vs. organization) [1]	Everybody involved in the issue must be included in the panel[1]	Risk of group biases [3]	• Advanced programs • Cluttered panel activity [3]
Char acter	Prognostic [3]	A multitude of scenarios [6]	No prediction, reality interactively defined by decision-makers, [7]	Assessment of decisions and probability[11]	Prognostic[12]

[1] (Zolingen & Klaassen 2003, 318; 319; 321; 320; 322; 323; 324)
[2] (Loo 2002, 763; 764; 767)
[3] (Cuhls 2019, 10; 11; 12; 13)
[4] (Gnatzy et al. 2011, 1681; 1682; 1686; 1683)
[5] (Gordon 2009, 5; 6; 7)
[6] (Aengenheyster et al. 2017, 15)
[7] (Tapio 2002, 85; 88; 92)
[8] (Rauch 1979, 163f.; 168)
[9] (Kauko & Palmroos 2014, 314)
[10] (Turoff 2002, 96)
[11] (Niederberger & Renn 2018, 29)
[12] (Gerhold 2019, 103)

4.1.3 Policy Delphi Process

Delphi's can be conducted as qualitative or mixed-method research on long-term unfolding issues (Tapio et al. 2017, 31; Zolingen & Klaassen 2003, 326). The forecasting technique is based on a panel of experts whose individual assessments of future topics are queried and cumulated utilizing a questionnaire (Pätäri 2010, 97; Kastein et al. 1993, 315). The probability, possibility, or desirability of scenarios can be investigated (Gordon 2009, 5). The Delphi method is predominantly applied for data collection and/or analysis purposes (Tapio et al. 2017, 33; Pätäri 2010, 97).

Zolingen and Klaassen (2022, 321) defined eight steps in a policy Delphi process that were followed for this study.

1. Narrowing down and formulating the topic under investigation, based on a literature review (Loo 2002, 765)
2. Defining the expertise needed to approach the issue
3. Identification of experts who cover the required field of expertise with a selection as heterogeneous as possible
4. The creation of the first questionnaire and the individual responses by the experts, where they got the chance to revise their answers in exchange with the perspectives of the other panelists (Zolingen & Klaassen 2003, 327)
5. Analysis of the answers through cluster and qualitative analysis
6. Incorporation of the first round's results in the second round's questionnaire
7. Analysis of the second round's outcomes through qualitative and statistical analysis
8. Zolingen and Klaassen (2022, 321) suggest holding an in-person meeting or workshop, after the analysis of the second round's data

Another approach to the eighth step is suggested by Tapio (2002, 98) to supplement the second round of a questionnaire with an interview. The idea is to challenge the panelists' arguments and gain deeper insight, as the engagement in the anonymous discussion among panelists tends to be lower than it would be needed. Due to the high time commitment for the panelists to participate in the questionnaire and the resulting drop-out rate, however, a further participation unit was omitted in this study.

Concerning the number of iterations, a minimum of two up to five rounds are suggested (ibid., 85). Within this study, an iteration of two rounds was conducted. The rounds were open for up to three weeks with the answers being made visible anonymously for the whole panel after the first half of the opening time. In a classic Delphi, the panel is closed once a consensus is reached, however, in a policy Delphi, reaching an agreement is optional, and dissensus in the form of diversity of opinions is equally desired. The outcome of the panel's discussions can be formulated as policy recommendations (Loo 2002, 766; 763; 767; Zolingen & Klaassen 2003, 321). The basic idea in a Delphi study

is to combine the expertise of several individuals in a group process without distorting the results by group effects. That is, others should only be convinced by good arguments. For this reason, a classic Delphi is conducted anonymously (ibid., 320). In a Policy Delphi, anonymity is maintained in the first rounds, but there is the possibility to conclude the study with a face-to-face group session (ibid., 321).

4.1.4 Policy Delphi Expert Panel

Experts can be defined by their knowledge, profession, or social status (Niederberger & Renn 2018, 46). Further, experts are conceptualized as the opposite of a layperson (ibid.). The expertise is obtained during several years of educational formation and working experience, intelligence and other characteristics should be disregarded at this point for the expert status (ibid.). Additionally, the expertise should be restricted to a certain field, whereby Niederberger and Renn (2018, 46) suggest that roughly ten years of experience in a field are needed to become an expert in something. Experts in a field for a Delphi study can be identified via expert presentations, scanning publications, institutions, public databases, and recommendations but with the risk of missing out on experts who are not publicly featured (ibid., 47; Tapio 2002, 86; Gordon 2009, 7). Organizations may also be asked to provide a suitable person. The advantage here lies in the expert's sense of responsibility to represent his or her own institution and thus increases the individual's commitment (Tapio 2002, 87). An interdisciplinary selection of experts secures the coverage of different fields and addresses the complexity of the question (Gordon 2009, 5; Loo 2002, 765). But also, the ratio of gender, age, and professional background should be balanced (Tapio 2002, 86). Policy Delphi's can be performed with ten up to fifty people (Turoff 2002, 82). Most importantly, participants must be carefully selected because such a small sample requires individuals with the potential to make meaningful contributions and compensate for the lack of quantitative data (Gordon 2009, 7). Biases can arise when participants are only identified by referrals or are self-selected (Tapio 2002, 86). To show that the subject under investigation is sufficiently covered, an expert matrix will be created. The matrix should span the categories of the topic, as well as relevant professions as dimensions (Kuusi et al. 2006, 114). The idea is to fit all the different expertise together to cover the entire issue as far as possible. Therefore, every category lacking coverage through experts can be viewed as a bias. Further, a bias occurs when experts are asked to draw socio-political conclusions through their thematic expertise, which might have been the case for the second Delphi round in this study (Niederberger & Renn 2018, 47).

For the present study, the panelists were searched through a literature review of relevant publications or white papers on mortality research in Germany. Research

institutes, registered associations, federal agencies, university hospitals, and insurance companies that deal with the topic under surveillance were scanned for experts and then contacted. A few experts were recommended by public health experts who were not themselves eligible for the study. In total 121 individuals and organizations were contacted through a personalized invitation letter sent by email. There were 39 responses to the 121 invitations sent out, of these, 16 agreed to participate in the study. Public Health, Environmental Health, Lifestyle Medicine, Climate Change and Health, Demography, Epidemiology, and Healthcare policy were identified as fields relevant to answering the questionnaire. Experts were identified having expertise in at least one of the relevant fields, had research experience, and had published on the topic. They should also have knowledge and understanding of lifestyle trends and/or climate change impacts on health. Medical background and experience with forecasting were seen as an advantage. In the first round, 10 experts participated, whereby two participants dropped out after the first half of the questionnaire. The gender ratio was equally divided between the two sexes. The age structure was less evenly distributed and strongly centered in the 30-39 age group. A few experts were also 50-59, or between 20-29 years old. The experts were employed in equal proportions in NGOs, universities, and research institutes. No representatives from the private sector, such as insurance companies, agreed to participate in the study (see Figure 1 Demographic Distribution of the Panel).

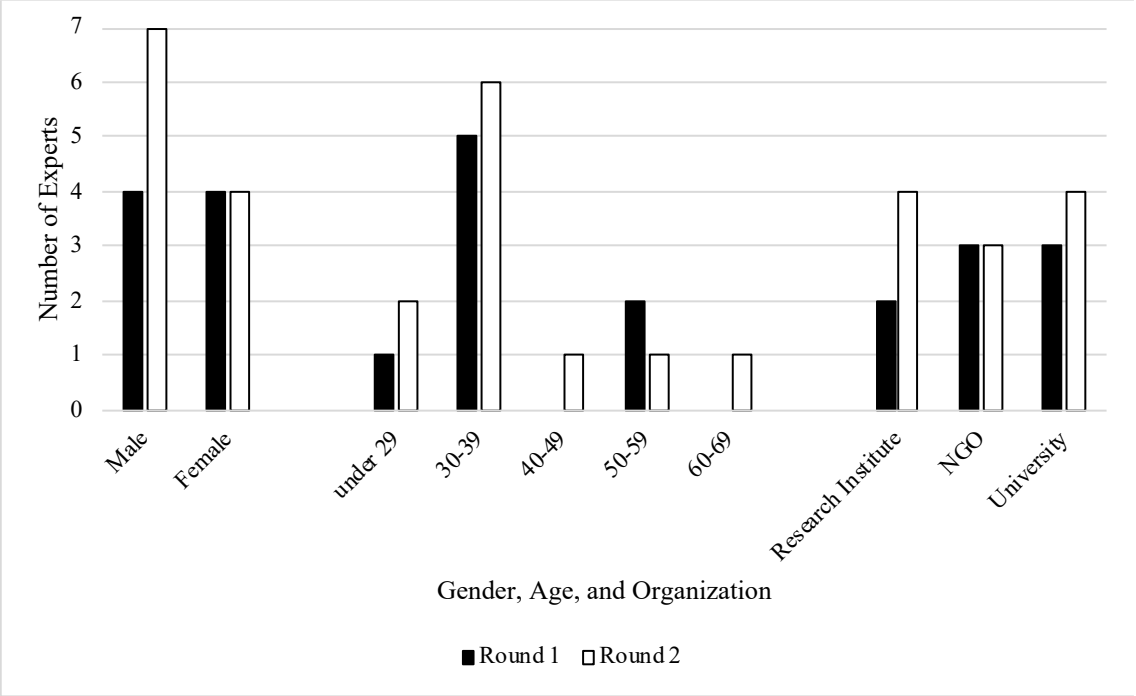

Figure 1 Demographic Distribution of the Panel

The expert matrix for the first policy Delphi round (see Table 2 Expertise Matrix from the First Delphi Round) reveals that all topics and profession fields needed for this study are covered. However, the strongest representation is among the public health profession,

with the thematic expertise in climate change and lifestyle change, where the first intersection was presented by five and the second intersection by six experts (see Table 3 Expertise Matrix from the Second Delphi Round). This could indicate a stronger emphasis on public health during the study. On the contrary, environmental and demography research are barely represented and could thus experience a shortcoming of this study. Further, the two people who dropped out after the first half did not indicate their expertise.

Table 2 Expertise Matrix from the First Delphi Round

Topics \ Professions	Medicine	Mortality research	Demography research	Social sciences	Public Health	Social medicine	Environmental research	Other
Causes-of Death	3	2	1		3	1		
Climate change and health	3			1	5	1	1	
Lifestyle and health	4			1	6	1		
Life expectancy	4	3	1		3	2		
Other								1

In the second round, 11 experts participated and completed the questionnaire. With seven versus four participants, male experts dominated this round. The most common age cohort represented was six participants aged 30–39. The decades 40, 50, and 60 each had one person represented, as well as two people between the ages of 20–29. Interestingly, all female experts belonged to the lowest age cohorts. The ratio between the organizations that the experts are employed at was equally distributed between research institutes, NGOs, and universities (see Figure 1 Demographic Distribution of the Panel). Again, no representative of the private sector was represented. Regarding the expertise matrix of the second policy Delphi round (see Table 3 Expertise Matrix from the Second Delphi Round) displays the coverage gap for mortality, demography, and environmental research. All other topics and professions are sufficiently covered. Additionally, to the unchanged grand coverage of public health experts with the topics of climate change and lifestyle and health, the highest amount of expertise is cumulated with public health professionals holding expertise with health promotion, respectively disease prevention.

Table 3 Expertise Matrix from the Second Delphi Round

Professions / Topics	Medicine	Mortality research	Demography research	Social sciences	Public Health	Social medicine	Environmental research	Other
Causes-of Death	3			1	4			1
Climate change and health	4			1	6	1		
Lifestyle and health	5			1	6	2		1
Life expectancy	3				4	1		1
Health Care System	3				5			
Health promotion/ Diseases prevention	4			1	7	2		1
Other								1

4.1.5 Operationalization

In order to answer the research questions by means of an empirical survey, theoretical concepts have been discussed in Chapter 3. Theoretical Concepts need to be operationalized to be able to translate them into meaningful questions for a questionnaire. The first question is 'How will mortality patterns transform under the influence of climate change and lifestyle change in Germany in 2060?'. Mortality patterns in this study are mainly approached through causes of death and life expectancy as indicators to research what the population predominantly dies off and when. Here, the growth rate of the categories is to indicate the change in mortality. The statistical term mortality indicates the mortality rate and the absolute number of deaths, which can be determined by the growth rates. Life expectancy is described as the average attainable age under constant life circumstances in a population (Destatis 2023e). The concept of life expectancy describes the age a person can be expected to reach if he or she were to live a lifetime under the same life circumstances as at the time of his or her birth.

To control the expected influence of lifestyle and climate change on mortality patterns, risk factors of those two categories, as well as life-prolonging factors are deployed.

Lifestyle is operationalized through the aspects of diet, sports, physical activity, body weight, smoking, and alcohol consumption, as the most relevant behaviors affecting health (Rapp & Klein 2020, 194). Climate change is operationalized as human-induced climate change, which causes a warming of global mean surface temperature, changes in air and water quality, precipitation patterns, an increase in natural disasters, and other related phenomena.

The second research question is 'Which measures could be suitable for reacting to the transformations under investigation?'. The policy implications are operationalized as measures or interventions to prevent certain developments from unfolding or to foster the occurrence of certain events, thus health promotion or disease prevention. Krajic et al. (2020, 138) propose that health promotion can be reached through education or training, economic incentives, and disease prevention via social restrictions, such as laws and prohibitions. So, measures in the questionnaire should be operationalized through these categories. In the realm of disease prevention, the distinction into primary, secondary, and tertiary prevention is made, as discussed in the previous chapter (ibid., 141). Further, to approach policy implications, the measures, and interventions, they are defined to tackle an issue, are performed by actors, carried out on the micro, meso, or macro layer in the society, and focus on a target group concerned with the issue (ibid.).

4.1.6 Policy Delphi Questionnaire

The Delphi method usually involves a written questionnaire with numerical questions and comment sections (Kauko & Palmroos 2014, 313). There is disagreement regarding the appropriate number of questions, but a maximum of 20 to 25 is recommended by Zolingen & Klaassen (2003, 326). The exact number varies depending on the complexity of the problem and the assumed commitment of the panelists. Quantitative questions might hold the advantage of being quicker to answer and evaluate. However, qualitative answers, despite being more time-consuming in the analysis, offer the possibility to express more notions and opinions (Gordon 2009, 9). The questionnaire of the first round (see Appendix 1 Questionnaire of the First Round) for the present study consisted of 34 questions, excluding questions regarding demography. Out of those, 26 questions were quantitative, asking for the growth rate of causes of death or the development of life expectancy.

Tapio (2002, 89) recommends encouraging the panelists throughout the questionnaire to state the explanation behind their answers in order to stay consistent in their notions. This recommendation was implemented in every question of the questionnaire. Eight questions were qualitative, open questions about stating 10 risk and life-prolonging factors for both, lifestyle and climate change on health. The questionnaire was divided by

gender, thus the 17 questions focused on female mortality patterns were identical for male mortality, as well.

Dividing the questions by gender was considered necessary because of the gender-specific differences in health behavior and risk factors. Nevertheless, the questionnaire thus exceeded the recommended number of questions, perhaps explaining some of the dropouts and the discussion might have been more vivid with a shorter questionnaire.

Twelve questions, each for male and female mortality, asked about the growth rate of categories of causes of death in 2060 compared to 2020. The questions were asked in a 21-step Likert scale reaching from minus 100 to plus 100 percentage points in increments of ten. Positive numbers indicate a growth, while negative numbers stand for a decrease, and zero displayed a *status quo*. The categories were formed from the clustering of Zhang et al. (2019, 17-18) of the ICD-10 codes from the World Health Organization. Thirteen categories of diseases were the outcome of Zhang et al.'s (2019, 17-18) work. For this study, their clustering was combined with the causes of death statistics provided by Gesundheitsberichterstattung des Bundes (2022) based on the data of the Federal Statistical Office (see Appendix 3 List of Causes of Death Categorized into 12 Groups according to the ICD-10 Standards). The grouping of diseases used here overlapped for the most part with the suggestion from Zhang et al. (2019), however, more ICD-10 codes were involved, and eighteen categories were formed in total. For the question of life expectancy, a curve of the development of females and males from 1980 to 2020 was displayed. The participants were asked to indicate the life expectancy they project for the years 2030, 2040, 2050, and 2060 under the consideration of all their previously given answers.

The questions must be formulated concisely and understandably, without oversimplifying the topic, to enhance creative thinking. In general, they should be answerable by the respondents (Gordon 2009, 8; Tapio 2002, 88). The requirement of clear formulation had some issues, as some of the stated examples of diseases for each cause of death category belonged to several groups. For example, skin cancer belongs to the malignant neoplasm and the skin disease categories. This created confusion and made the questions somewhat ambiguous. For calculating the growth rate panelists raised the issue of missing reference numbers. The development of the causes of death categories had been shown in a graph without displaying the absolute numbers. Further, it was not formulated whether the growth rate refers to per 100,000 inhabitants, which is the usual unit in demographic research, or to the whole population of Germany. A panelist criticized the unclarity, as both options come with different information that the respondents would have needed. For example, estimating a growth rate referring to the whole population requires also an assumption about the population size in 2060. Further, causes of death cannot be seen separately from each other, if one category of causes rises, other categories would automatically decrease. In some scenarios, this issue led to an

unintended high increase or decrease in overall mortality. Lastly, panelists would have wished to indicate a higher growth rate than 100 percentage points for some diseases, which was not possible on the 21-step Likert scale.

Further, the futures under investigation should be explicitly stated as preferable and probable, which was applied to the second round of the policy Delphi (Tapio 2002, 89). The questionnaire for the first round consisted of relatively short questions that were pre-tested by experts beforehand (Gordon 2009, 8). The second round was held more in an essay format where the panelists had the chance to reconsider their replies based on the analyzed reasonings behind answers, stated by the panel members (ibid., 9). Within the second round's questionnaire (see Appendix 2 Questionnaire of the Second Round), three questions about the demographic information of the panelist and the matrix of expertise were put at the beginning of the questionnaire, to avoid missing values from dropouts. This was followed by the descriptions of the five scenarios derived from the first round. After each scenario story, the panelists were asked through an open-ended question which policy implication arises from the scenario. Here, the creativity of the panel should not be restricted. However, it was stated as an orientation that a problem and a goal could be defined by the respondent. In addition, further aspects were listed for the respondent to reflect upon, such as the target group for policy implications, which were already described in Chapter 4.1.5 Operationalization. The panelists had the chance to discuss the answers through the anonymous comment section. At the end of the questionnaire, one question about the probability and desirability of each scenario was asked on a five-point Likert scale from very probable to very improbable with the option of neutrality. And then the same scale with desirability. Overall, the second questionnaire consisted of eleven questions which was a more reasonable amount than in the first questionnaire. Issues raised by the panel about the second questionnaire were mostly about the extensive length of the scenario descriptions.

4.2 Data Analysis

4.2.1 Data Analysis through Cluster Analysis

Cluster analysis is conducted to "[…] uncover groups in data" (Everitt et al. 2011, 5). Thus, if possible, the goal is to group the individual data into groups, to recognize patterns within the dataset, and calculate the proximity, thus the distance relation, between values (ibid.). A common issue with cluster analysis is that statistical clusters will always be detected, but the dataset structure does not necessarily reveal a real-life structure. The structure can be artificially constructed (ibid., 9). Within this study, this issue was

counteracted by qualitative data analysis, which related to the quantitative data. The structure discovered by cluster analysis could be verified and complemented by the outcome of the qualitative analysis.

The data retrieved from the first round had eleven cases from which one had so many missing values that it had to be excluded. Ten cases completed the first half of the questionnaire, which was about female mortality, and of those two dropped out about the corresponding questions about male mortality. Each gender part consists of questions about twelve causes of death grouped according to the ICD-10-codes standard, as well as four variables on the estimated life expectancies for the years 2030, 2040, 2050, and 2060 as quantitative data. The qualitative data resembles the explanations for each disease category, as well as one variable on the reasoning behind the life expectancy. Further, risk and life-prolonging factors of lifestyle and climate change were listed by the panel. The qualitative data was collected within a visible but anonymous discussion box. As not every panelist stated their reasoning behind estimations, the qualitative data has the most missing values.

To prepare the dataset for the hierarchical cluster analysis performance in the statistical program SPSS, the quantitative data from the first Delphi round was standardized, first, the data was converted to positive digits by adding 100 to each value. Afterward, the distance from each value to the lowest estimate was calculated. The outcome was maximized so that the lowest response had the value of zero and the highest response for each variable was given the value of 200. This procedure makes the variables more comparable. In this standardization, the outcome for life expectancy was weighted, as the data only consisted of four values, for each decade between 2030 and 2060, it was multiplied by three to be equal to the 12 values of the 12 categories of causes of death for each case. This was intended to prevent the causes of death from playing a greater role than life expectancy in cluster formation. However, this step turned out to lead to large deviations caused by life expectancy data, which will be discussed more in-depth later. Everitt et al. (2011, 69) suggest intuitively choosing a measurement, as some distance measurements are more suitable for certain data than others, but the perfect fit has not been detected yet. Therefore, several attempts were made to include the two quantitative measures of 12 variables of causes of death and estimated life expectancy from 2030 to 2060 with ten-year steps in the cluster analysis. Euclidean distance is well-suited because it can be applied, for example, to structured and relatively scaled data, such as growth rates of causes of death measured using a Likert scale (ibid., 57; Tapio 2002, 93). The Euclidean distance is used to measure the distance between values of a dataset in a multidimensional space. In the following step, the distance measure of values led to the first clusters, whereby the distance between those clusters needs to be measured. A few sensitivity analyses were performed whereby the furthest neighbor or complete linkage method was the best fit, as it identifies the maximum distance of values between different

clusters (Everitt et al. 2011, 61). The latter method is particularly suitable for creating homogenous clusters, that are distinct from each other (ibid., 79). Considering the elbow method on the dendrograms created for each clustering algorithm, seven to eight clusters were suggested, which seemed a lot for the ten cases, that could be considered, whereby each case represents all answers from one participant (ibid., 129). The elbow method indicates how many clusters are optimal by estimating the variation or the distance from each data point with every possible cluster. When showing the variation as a graph, the line will make a bend where the distance variance gets smaller. This point is called the elbow.

The variable on female life expectancy had missing values for two cases whereas for male life expectancy, one value was missing. The missing data were simulated by calculating the mean of the other cases, to be able to consider the underlying cases in the cluster analysis. After several trials with different combinations of measure methods, it became clear, that the life expectancy posed a bias to the cluster analysis. The variance was too large and thus the clusters were too fragmented. Also, the clusters should be about the health situation of Germany in 2060, thus the life expectancy is part of the narrative, but more a result of the causes of death than a causal basis of the scenarios. The bias of life expectancy could be seen in the resulting narratives of the scenarios. For instance, the anticipated level of life expectancy and the direction of growth of causes of death are not entirely logical. Some cases have the highest estimation of death rate; thus, mortality would increase in this scenario, but they also estimate the highest increase in life expectancy among all panelists. Normally, an increase in mortality would be expected to cause a decrease in overall life expectancy. This indicates an inconsistency in the perception of the respondents which is reflected in the data. This bias could have been counteracted by asking about the development of life expectancy in a second round based on the mortality rate. Which might have made the scenarios more concise.

Two connected measures were taken before deciding on excluding life expectancy from the cluster analysis. Firstly, the qualitative answers of the participants were translated into how they play out in the growth rate of diseases. It turned out, that partly contradicting storylines were put together in clusters through the analysis. For example, the composition of which causes of death categories were expected to increase or decrease among the panelists did not fit well together in the initial cluster analysis. Moreover, the missing values in life expectancies and their replacements would pose a high bias to the calculation. Thus, in the final version only the twelve variables of causes of death were used to perform the cluster analysis.

Secondly, considering the statistical outcome, as well as the qualitative analysis of the reasoning, the most meaningful clustering was reached with the furthest neighbor method and resulted in four clusters for the males and five clusters for females. Within the agglomeration schedule for female mortality, the biggest jump in coefficients can be seen

from steps five to six from 1418.685 to 2975.779 (see Figure 2 Agglomeration Schedule for Clustering Female Mortality).

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	5	7	622.837	0	0	5
2	2	6	692.042	0	0	3
3	2	10	1038.062	2	0	4
4	2	4	1314.879	3	0	5
5	2	5	1418.685	4	1	6
6	2	9	2975.779	5	0	8
7	1	3	5432.526	0	0	9
8	2	8	6678.201	6	0	9
9	1	2	9584.775	7	8	0

Figure 2 Agglomeration Schedule for Clustering Female Mortality

This can be seen graphically through the elbow method (Everitt et al. 2011, 129) in Figure 3 Elbow Method for Determining the Number of Clusters for Female Mortality. Until creating five clusters there is a meaningful proximity among the values within a cluster and a distance from other clusters. Thus, from both ways of figuring out the number of clusters, five clusters seem to fit the data on female mortality well. From the dendrogram (see Figure 4 Dendrogram on Cases Clustered Together for Female Mortality) cases five, seven, two, six, ten, and four are seen as one cluster, while nine, eight, one, and three are clusters of their own. Therefore, for the females, four clusters persisted in the answers of a single panelist, while one cluster persisted in six answers (n=10).

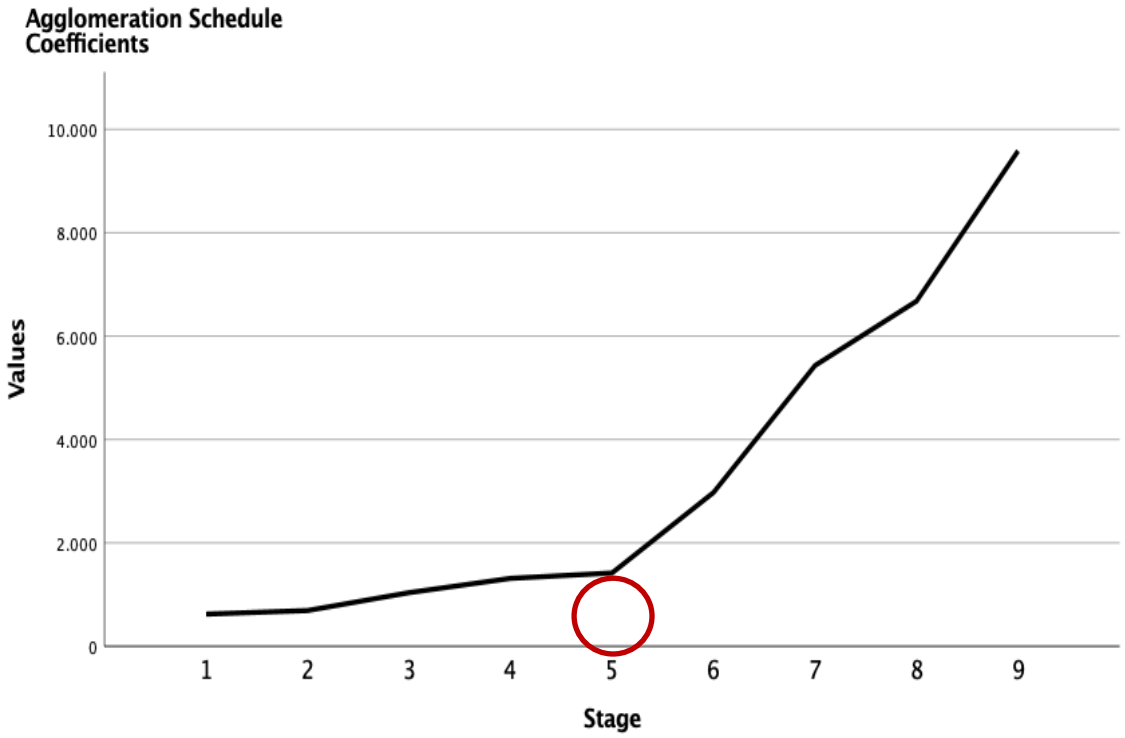

Figure 3 Elbow Method for Determining the Number of Clusters for Female Mortality

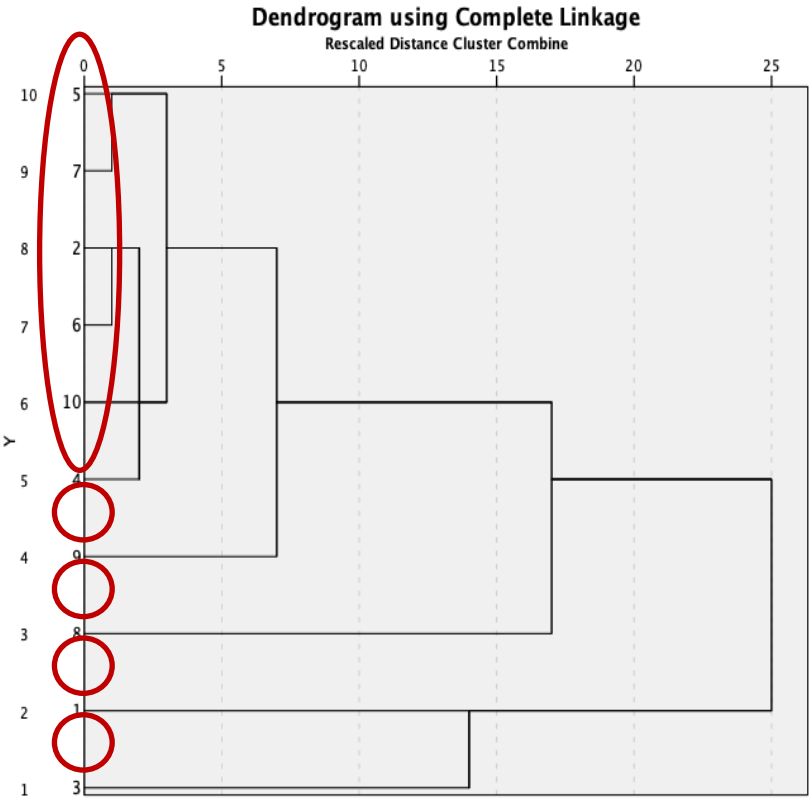

Figure 4 Dendrogram on Cases Clustered Together for Female Mortality

The jump in coefficients within the agglomeration schedule on male mortality is from step four to five with 4900 to 16000 (see Figure 5 Agglomeration Schedule for Clustering Male Mortality), as well as the elbow method shows a decreasing benefit of further clustering after four clusters (see Figure 6 Elbow Method for Determining the Number of Clusters for Male Mortality).

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	5	6	2200.000	0	0	3
2	7	10	3200.000	0	0	4
3	2	5	4400.000	0	1	4
4	2	7	4900.000	3	2	5
5	2	9	16000.000	4	0	6
6	2	8	23200.000	5	0	7
7	1	2	28600.000	0	6	0

Figure 5 Agglomeration Schedule for Clustering Male Mortality

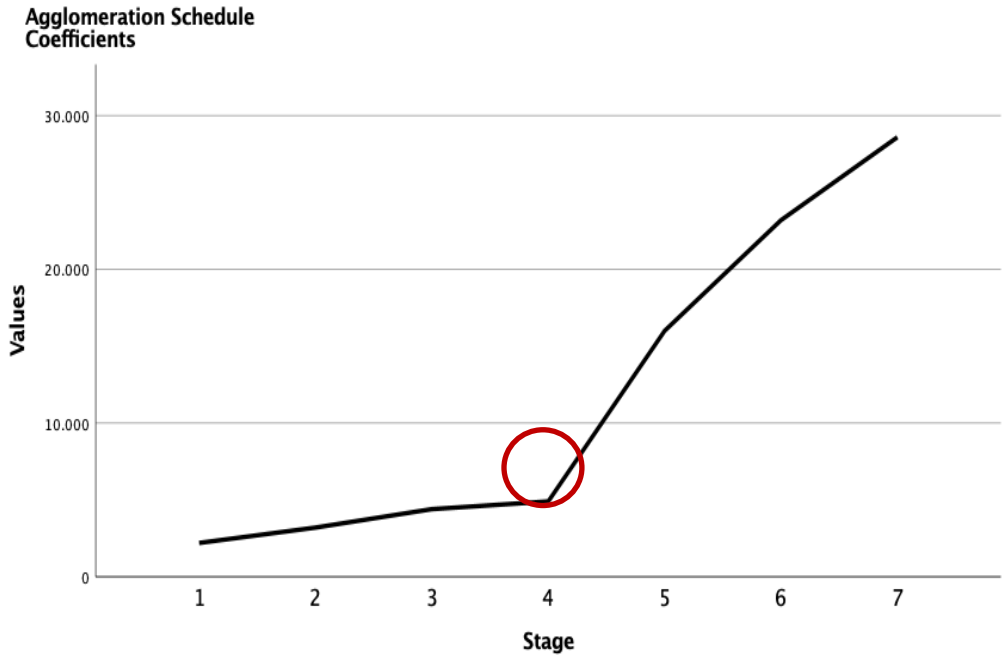

Figure 6 Elbow Method for Determining the Number of Clusters for Male Mortality

The dendrogram for male mortality shows the same cases brought together in clusters as for female mortality (see Figure 7 Dendrogram on Cases Clustered Together for Male Mortality).

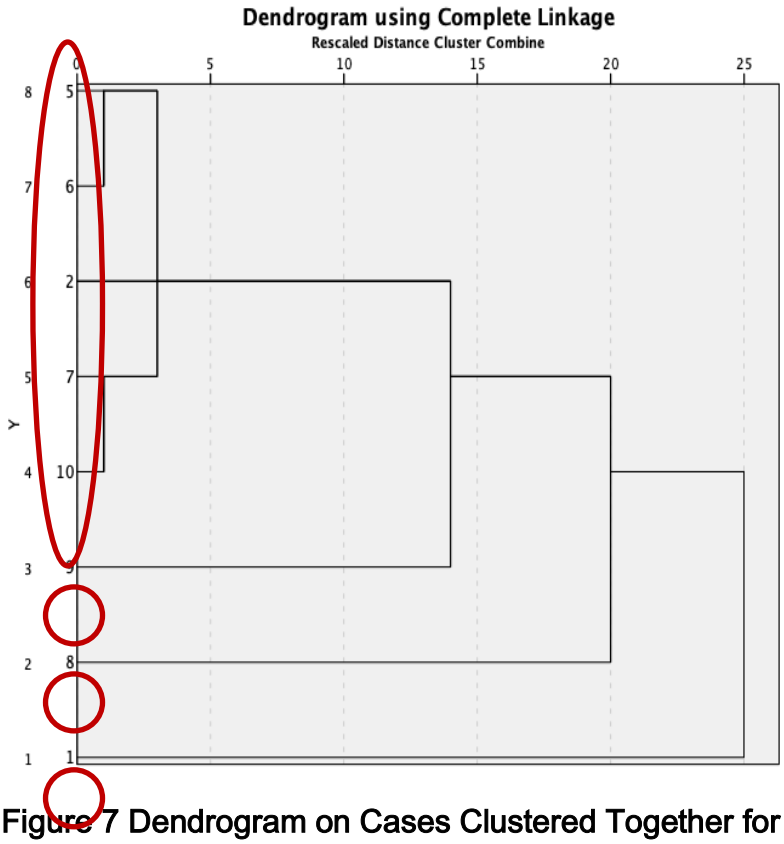

Figure 7 Dendrogram on Cases Clustered Together for Male Mortality

Therefore, for the males three clusters consist of the answers of one panelist each, and one cluster includes five answers. This is because two panelists answered the first half of the questionnaire about female mortality and only the other eight completed the whole questionnaire. The outcome shows that the cases, thus all the answers of one panelist together, for male and female are in the same clusters. Ergo, panelists estimated a very similar health outcome for both genders, which suggests creating scenarios for female and male mortality together. In one case, only one extra scenario for females is needed due to the missing values of male mortality. The low number of cases (n=10) and the dropout rate after the first half of the questionnaire made it more difficult to create significant clusters. As a last step, the centroids of the clusters were calculated through the arithmetic mean as suggested by Tapio (2002, 96). For instance, the centroid in cluster one for males in the category of certain infectious and parasitic diseases is 18 percentage points (see Figure 8 Cluster Centroid Through Arithmetic Mean). Indicating a moderate growth in this category.

Cluster Centroid through Arithmetic Mean												
	Certain infectious and parasitic diseases (A00-B99)	Malignant neoplasms (C00-D48)	Blood and blood-forming organs and certain disorders of the immune system (ICD-10 D50-	Digestive system, nutritional and metabolic diseases (ICD-10 E00-E90; K00-K93)	Mental and behavioral disorders (ICD-10 F00-F99)	Diseases of the nervous system and sensory organs (ICD-10 G00-H95)	Diseases of the circulatory system (ICD-10 I00-I99)	Diseases of the respiratory system (ICD-10 J00-J99)	Diseases of the skin and subcutaneous tissue (ICD-10 L00-L99)	Disease of the joints and connective tissue (ICD-10 M00-M99)	Urogenital system (ICD-10 N00-N99)	External causes, such as injuries and poisoning (ICD-10 S00-T98; U129, V01-Y98)
Cluster 1 - Male	18	0	2.5	26	32	26	-2	8	-10	2	2	16
Cluster 1 - Female	20	-10	0	20	20	20	-10	20	-20	-10	-10	-10
Cluster 2 - Male	30	20	10	50	20	10	-20	10	50	-30	20	-50
Cluster 2 - Female	30	30	10	20	20	10	-20	-20	10	-30	-10	-30
Cluster 3 - Male	100	-10	0	-20	50	10	0	-50	-20	0	10	-10
Cluster 3 - Female	100	-10	0	-10	50	10	0	-70	-10	0	-10	0
Cluster 4 - Male	30	-30	-10	50	80	100	-70	-10	-10	20	10	20
Cluster 4 - Female	30	-30	10	50	80	100	-70	-10	-10	20	10	20
Cluster 5 - Female	60	40	20	50	20	80	-30	0	50	20	0	40

Figure 8 Cluster Centroid Through Arithmetic Mean

4.2.2 Data analysis through Conventional Qualitative Content Analysis

To this thesis, conventional content analysis with some minor features of summative content analysis has been applied, as little theory and literature were available on the topic (Hsieh & Shannon 2005, 1277; 1279). With the aim to help cope with and capture complexity, qualitative content analysis also holds the advantage of flexibility while bearing the risk of being conducted in a non-thought-through manner (ibid., 1280; 1277). Thus, information could be selected from the panel without imposing categories and theories on them, with the risk, that important issues were missed (ibid., 1279-1280). The outcome of content analysis is typically models, with the ability to derive theory from the content analysis being limited (ibid., 1281).

The content analysis follows the following seven steps (ibid., 1287)

1. Formulate the research question
2. Select the sample to be analyzed
3. Define categories
4. Outline the coding process
5. Implement the coding process

6. Determine trustworthiness
7. Analyze the results of the coding process

Firstly, the study aimed to describe the phenomenon of reasoning for anticipated growth or de-growth in causes of death categories, as well as the estimated development of life expectancy (Hsieh & Shannon 2005, 1279). The qualitative data resulted from the open-ended questions in the survey on the eDelphi platform, to state the reasoning for numeric choices and the participants' vision for the future. The data consists of the written panelists' answers and was separately analyzed for female and male mortality patterns. In the first step, the data was gathered in two languages and thus translated from English into one common language, German. In the second step, color coding was used to eliminate redundant words, for instance, conjunctions, by marking them grey. Content analysis depends on good coding, which can be realized by dividing the huge amount of text into smaller pieces (Hsieh & Shannon 2005, 1287). Therefore, all the variables were analyzed individually. The broadest categories of the code system were the dimensions 'climate change' and 'lifestyle'. To generate the sub-categories inductively, summative content analysis was applied to code the words with a counting system. Initially, the answers of all participants were viewed together and then organized in the clusters that they were assigned to through cluster analysis. Identified similar words with the same meaning were coded into sub-categories in which the word count indicated the significance of the reasoning, due to its frequency, and the content for the scenario's storylines derived from this analysis (ibid., 1278; 1283). The number of codes varied between seven and 29 for each question asked, depending on the amount and diversity of the data (see Appendix 4 Codebook – First Delphi Round's Data). The trustworthiness of the data was tested by analyzing how much the qualitative data in each cluster had in common, which resulted in the confirmation of the cluster analysis. In the last step, the coded results were analyzed by summarizing them into coherent scenarios (see Section The Scenario's Storylines). By conducting the content analysis in a systematic manner and following a certain process and rules, quality characteristics of science can be ensured (ibid., 1287-1288).

Issues that occurred while analyzing the data for this study were firstly, that a single participant was assigned to most of the clusters, thus a comparison with qualitative data within a cluster was not always possible. That only allowed for an inter-comparison with other clusters, but not to compare intra-clusters in some cases. Secondly, even within the cluster with more participants, there are different answers that do not verify nor falsify each other. Lastly, the qualitative data had a lot of missing values due to the high effort in writing the reasoning.

In the second round, the question was formulated which policy implications arise from the scenarios derived from the first round, in particular, which concrete measures are needed with respect to the scenarios. The data analyzed consisted of the second-round

answers, as well as measures proposed within the first round. The qualitative data was organized in the NVivo 12 software. The qualitative analysis was performed for each of the five scenarios with the categories of problem, aim, intervention, kind of intervention, actors, impact of the intervention, target groups, and surroundings. With those codes measures could be identified, where firstly, the problem considered important from the scenario was formulated, resulting in an aim on how to avoid an event or how to foster a development (see Appendix 5 Codebook – Second Delphi Round's Data). Then the specific intervention was described which got categorized as the kind of intervention, thus the subcategories as education or training, economic incentives, and social restriction, as laws or prohibitions (Krajic et al. 2020, 138). The concrete intervention included the subcategories on which level, micro, meso, or macro, they are thought to be performed. Within the category of kind of intervention, preventive measures were further categorized as subcategories in primary, secondary, and tertiary prevention (Blüher & Kuhlmey 2016, 317). Actors are for example political institutions; thus, they were divided into communal, federal, or state levels. The impact of the intervention describes how the measure proposed is thought to tackle the problem defined. Target groups are the entities of people who are concerned by the issue defined and that the measure should aim at. Those were, for example, age groups, social layers, families, family caregivers, pupils, or students, working people, and so on. The category of surroundings included for example the workplace, educational institutions, canteen, neighborhood, etc., in which the measure was proposed to be carried out. Further subcategories were inductively derived while coding for the specific cases. To analyze the first scenario's implication, several interventions could be clustered under a larger category of social affairs, which included subcategories of fragmentation of the society and action regarding strengthening social coherence. The results of the coding were then systematically written according to the categories into brief policy recommendations, that stayed very closely with what had been initially stated.

Issues with trustworthiness might have occurred, as not every policy recommendation gave information for all the categories defined, which led to more detailed and less developed statements. However, the initial set of categories enhanced a systematic and traceable coding process.

4.3 Validity and Reliability

The quality criteria of validity, thus whether the instruments used to measure changes in mortality patterns and resulting policy implications were effective, shall briefly be discussed. Firstly, terms and concepts were defined through theory, as discussed above, in order to conceptualize measurement. Secondly, the questionnaires were pre-tested by

people with medical backgrounds to test the correctness of the questions asked and the content presented. But also, people with no medical expertise, but different academic backgrounds tested the questionnaire to ensure the understanding, functioning, and correctness of the questions asked. The questionnaire was approved by the pre-test participants and remarks made by them were included as changes in the questionnaire. However, the panelists provided feedback on ambiguities in the questionnaire, as addressed earlier, which certainly posed problems for the validity of the study. Thirdly, to cover the expertise needed to measure the topic under research, a careful selection of experts was made. The expert matrix (see Table 2 Expertise Matrix from the First Delphi Round and Table 3 Expertise Matrix from the Second Delphi Round) shows relatively good coverage for the first round and a slight deficit in the coverage for the second round, showing issues for validity in the latter. Fourthly, the validity of the study was aimed by having two rounds of Delphi in which discussions and making changes to the answers were constantly available to ensure high quality in the outcome. Lastly, the criterion of whether the outcomes could be adapted to other populations or situations is hard to tell as the study was restricted to Germany. However, panelists often referred to the public health situation in the U.S. or in other European Countries, for example drawing the comparison to the Nordic countries. Thus, the results of the Study could be partially applied to the context of other countries, similar to Germany.

Reliability as a quality criterion for consistency of measurements, whether they produce similar results when used in different contexts, is reviewed for this study based on four aspects. First of all, like for the purpose of validity, terms and concepts were defined through theory to conceptualize reliable questions in the questionnaire. Secondly, the qualitative data was analyzed by strictly following certain steps discussed below to ensure reliable outcomes. Thirdly, the internal reliability of the questionnaire was tested by Cronbach's Alpha for all quantitative data, with 0.868 as a result, which indicates high internal consistency among the quantitative measurements. Lastly, as discussed in the realm of validity, feedback from participants showed weak points in the questionnaire concerning clearness and preciseness. Feedback showed that respondents might have a different understanding of the questions, which could pose issues in the comparability of answers, for example, which diseases belong to certain causes of death categories.

Overall, limits in the validity and reliability of the study are detected through issues with the questionnaire and deficits in the expertise coverage, which must be considered in the interpretation of the results. Despite limitations, the criteria of systematic scientific work regarding validity and reliability were largely met.

4.4 Scenarios

"A scenario is a story with plausible cause and effect links that connects a future condition with the present, while illustrating key decisions, events, and consequences throughout the narrative" (Glenn 2009, 2).

After collecting the data through the Delphi method and applying qualitative analysis and cluster analysis, scenarios are used as a method to present the interim results and form the basis for the second round of data gathering. The second round consisted of a questionnaire displaying the derived scenarios from the first round and collecting policy implications arising from them.

The term scenario in the context of futures studies was used for the first time by Kahn in the 1950s, as the method, like Delphi, was developed by the RAND cooperation in the World War II period (ibid., 1; MacKay & Tambeau 2013, 674). Scenario planning is a widely used strategic planning method based on alternative future scenarios that identify key strategic decision points (ibid.). Scenarios are descriptive storylines about possible futures, including the trends and events leading there, based on discussions and data, developed in a scientific, but also creative manner (ibid., 674; Bijl 1992, 233; Glenn 2009, 2).

Initially, the distinction between business-as-usual, best-case, and worst-case scenarios was made (ibid., 1). Even though the first one was not intended to be a future prediction, it was criticized for bearing that risk. As scenarios are not used to predict the future but to identify critical uncertainties that may lead to significant changes and strategic surprises, current applications often exclude business-as-usual scenarios (MacKay & Tambeau 2013, 674; Glenn 2009, 1).

Scenarios can also be distinguished as exploratory and normative. The first one describes how certain drivers could unfold in the future, while the second one explores the desirability of future states (ibid., 3). While the first Delphi round was carried out in an exploratory manner, resulting in exploratory scenarios, the second round had a rather normative character. Scenarios can be carried out in an inductive or deductive manner. Thus, all variables are identified before scenario planning, deciding on the scenario manner, for instance, optimistic versus collapses. In an inductive way, which was applied in this study, scenarios are used to explore driving variables and the scenarios' manner (ibid., 5).

Any kind of scenario should be plausible and consistent, and provoke strategic response (ibid., 3). Scenarios can be carried out qualitatively or quantitatively, whereby most applications, as for this study, are performed as a mixed method (ibid., 4). The basis analysis should be qualitative, with subsequent refinement through quantitative analysis (ibid., 12). While statistical models should support the display of causality in scenarios

where it is beneficial, they themselves are projections and cannot be classified as scenarios (ibid., 2).

Scenario planning is a decision-making tool. The idea is to provide decision-makers with the required information and through the scenarios a set of decisions to choose from (Chermack 2005, 62). As a main purpose, scenarios provide a tool to organize a quantity of information in an easy and comprehensive way. Aiming for simplification and coping with uncertainty, by displaying future challenges and opportunities in an illustrative way (Glenn 2009, 18; 2). Instead of focusing on one possible future outcome, the goal is to consider a set of alternatives in decision-making due to the high uncertainty of the future (ibid., 3). The goal is to give a brief overview of driving forces and drivers in a scenario rather than exhausting in-depth descriptions (ibid., 5). Scenarios can be seen as a test world to explore different options and their outcome (ibid., 3). The aim of applying scenarios is to enhance long-term preparedness in policymaking in the present (ibid.). But they can also challenge predominant assumptions, for instance, in the present study, the prevailing conjecture of continuous growth in life expectancy was questioned (ibid.).

In organizations, scenario planning targets not only futures preparedness and decision-making but also organizational learning to increase the performance as a bottom line (Chermack 2005, 61). Thus, scenario planning tackles mental models, which are a person's knowledge, assumptions, and underlying perceptions about an issue (ibid., 62). Within this thesis, the focus is on scenario creation. Through the second round, altering mental models might have happened and it would be desirable if the scenarios could contribute to improving decision-making. However, there is no ambition to fulfill those criteria. MacKay and Tambeau (2013, 675) formulated ten steps to scenario planning:

1. Setting the focal issue, time horizon, relevant interest representatives
2. Preliminary work: evaluation of data and extensive review of existing research
3. Identification of key drivers and trends
4. Classification of drivers and trends as predetermined or uncertain
5. Definition of a sequence to make the scenario storylines coherent
6. Creation of a set of learning scenarios
7. Testing scenarios for internal consistency and plausibility
8. Modification of scenarios to create decision scenarios
9. Detection of warning signals from scenarios
10. Implication of the scenarios for strategic action

For the first step, mortality in Germany was set as the issue under investigation, as well as the time horizon of 2060, according to the projections made by the federal statistical office in Germany. Then the panel was selected, which is described more in-depth in Chapter 4.2.2 Policy Delphi Expert Panel. Lifestyle and climate change were identified as rough predetermined drivers. The sequence of the scenarios starts with the development of the growth rate of causes of death for 12 categories, described for men

and women, ordered from the biggest increases or decreases to the smallest changes. Then risk factors of the drivers of lifestyle and climate change are reviewed. Surprising events and underlying assumptions are described to frame the scenarios. Then, the development of life expectancy is described, followed by a summary of the key takeaways from the scenarios. To create meaningful storylines, an understandable writing style should be used, references to the past and present should be made, and diagrams should be used sparingly to illustrate the point. In addition, attention should be paid to quality criteria of consistency and plausibility so that the scenarios are coherent. Both the possible unfolding of the inevitable and foreshadowing of the unexpected must find their way into the stories (Chermack 2005, 61). The construction can be completed within a few hours in the course of participatory methods or up to a long-term observation and rather long process (Glenn 2009, 6). Within this thesis, the data collection through the Delphi method for the scenarios lasted for two weeks.

To conclude the general scenario construction section, two last remarks are made. Firstly, even though coherence is a key aspect of scenario creation, Glenn (2009, 12) encourages allowing for scenarios overdrawing the predefined line and prioritizing considering all valuable insights over perfect logical scenario storylines. Secondly, scenarios bear the risk of limiting peoples' perception by taking the created set of alternatives as mere possibilities and shutting down further future states (ibid., 18). For this reason, it must be clearly communicated that scenarios cannot be a prediction or complete coverage of all possibilities.

5 RESULTS

5.1 Panel Discussion

5.1.1 Discussion from the Policy Delphi Panel Round One

The first round of the Delphi study was conducted on the platform eDelphi through the questionnaire discussed in the previous chapter. The panel had the chance to answer the questionnaire within two weeks. In that period, given answers could constantly be revised. After the first week, the answers and comments stating the reasons behind numerical answers were made anonymously visible to the whole panel. In the second week, the panelists were therefore able to discuss with each other and revise their own statements based on the debate. Most of the panelists stated their reasonings, and a few discussed with each other leading to some changes in the answers after the debate. In the following, the points of discussion are recapitulated.

One expert stated that mental disorders can become the main causes of death, and another participant expressed their disagreement with this statement. The second person argued that the prevalence will starkly rise, but not the caused deaths. The initial expert insisted on their opinion by pointing out, that the diseases themselves will not kill people, but suicides could. As no other panelists participated in this discussion it is hard to say, which statement was supported more by the whole panel. However, all panelists agreed on a rise in the death rate through mental and behavioral disorders. The initial idea of mental illness as the main cause of death found its way into the Mental Health Inferno scenario that will be described later.

Further, an expert suggested that eye diseases such as ‘Cataracts’ and deafness are the most prevalent diseases for the category of diseases of the nervous system and sensory organs. Two other experts questioned whether the mentioned diseases are relevant for mortality. One argued that only through surgical accidents people might die in the context of these diseases.

One person described the increase in strokes due to rising life expectancy. Another person questioned whether life expectancy will actually rise, because of the assumption, that life expectancy peaked already and will therefore stagnate or decrease. The argument of the opponent of the statement was that infectious diseases and mental disorders will affect mostly young people which affects life expectancy patterns. With the consequence of less of an increase in disorders typical for the elderly. Again, no further opinions were expressed in that concern. However, the estimations of life expectancy showed a tendency towards a slowing down, remaining a status quo, or even a decline of life expectancy in

the future. With the direction of the life expectancy development most panelists apparently agreed, but if they share the same reasoning as the opponent in this case is not clear.

Concerning the diseases of the respiratory system, a person stated that allergic diseases are subject to rise in the future due to climate change. Another person argued that mortality through allergies is very low, two other people agreed on that. Furthermore, one person added that the prevalence of the disease will rise but not the actual number of deaths, and another person agreed. In this case, the agreement seemed evident.

Within diseases of the skin and subcutaneous tissue, an expert also argued that the prevalence will rise but not the actual death number, to which another person expressed agreement.

One person stated that the aging population is contributing to the increase in diseases of the joint and connective tissue. A person held against this, that joint and connective tissues are not among the main causes of death, not even in the older age cohorts. Another person agreed with the opponent's statement but argued further that if the prevalence of the disease rises and the treatment is not getting better, more people could die from it. Generally, a slight increase within this category was expected among all scenarios.

Another agreement among two of the participants occurred on the explicit differentiation between heat waves and a rise in the average temperature within the discussion about the effect of climate change on health. The reason for the differentiation was justified by the argument that a single heat wave can cause a high amount of mortality within a day and therefore poses a different risk. This argument was taken into account in the scenario descriptions.

For the category of malignant neoplasms in males, one panelist expected an increase in the course of an aging population. Another panelist questioned whether there will be an aging population or not in 2060. Thereupon, the first panelist defined an aging population as a certain amount of people above a certain age. Blümel et al. (2020, 3) assume that 9 to 10% of the population will be 80 or older in 2060, and the Federal statistical offices project that just under a third of the population will be over 65 (Destatis 2015, 6). For this reason, the argumentation of the first person can be agreed with, at least with regard to the aging population. Concerning the rise of the disease in question, at least for the growth rate of malignant neoplasms among men, all scenarios expected a decline.

A further agreement between two experts could be seen about a decrease in the category of blood and blood-forming organs and certain disorders of the immune system for males due to better healthcare. Interestingly, a very slight increase in this category was expected in all scenarios.

In the disease category of the digestive system, nutritional and metabolic diseases for males there was a statement about processed food and how it affects the digestive diseases. Another person counteracted, that there is a large increase in vegetarianism and

measurements for instance, the Nutri-Score to display nutrition, takes place, leading to a decrease in the digestive system, nutritional and metabolic diseases. One more person agreed with the initial statement, and the original expert argued that eating behavior nowadays already affects mortality in the year 2060, no matter the eating behavior of the upcoming years. Adding, that the obesity pandemic already started and will unfold further until 2060. Among all scenarios, a projected rise in death due to the category discussed could be witnessed.

For the category of diseases of the skin and subcutaneous tissue, one panelist stated that men are having more outdoor jobs, which is associated with an increased risk of cancer. Another participant questioned whether mortality could still be reduced due to screening. From other panelists' statements of reasoning, an agreement with the opponent may be assumed.

Lastly, a person argued for the category of urogenital system that men are likely to have prostate cancer, whereby the importance of the statement is challenged by another person saying that prostate cancer is not the main cause of death for men. From the reasoning of the panel, there was support for the prostate thesis, just as the expectations of improved screening and treatment.

The discussions were incorporated in the scenarios' descriptions as much as possible. Two aspects can be taken away from the debate. First, some arguments were about an increase in the prevalence of diseases versus an increase in the death rate. The increase in prevalence is not displayed within this study but of course, burdens the health. For further research it could be interesting to focus on the projection of disease burden, thus the prevalence. Second, some arguments include different age groups. Contrary to the gender dimension, it was not possible for the panel to distinguish the categories for the dimension of age. The qualitative data of this study suggests that there are significant differences. Further research could focus on projecting causes of death according to age cohorts. In the second round of the Delphi study, an attempt was made to encourage the panel to identify age groups that should be targeted for specific policy measures.

5.1.2 Discussion from the Policy Delphi Panel Round Two

The second round of the Delphi study was also conducted on the platform eDelphi with the second questionnaire discussed in the previous chapter. The panel was open for three weeks in order to give the experts more time to answer the questionnaire with the aim of reducing dropout rates. After the first half of that period, the policy implications stated as comments, as well as the rating in terms of probability and desirability for each scenario, were made anonymously visible to the whole panel. Again, the purpose was to give the experts the chance to engage in a debate to convince others and be convinced, and then

possibly revise their own answers. Overall, no discussion among the participants arose in the second round on the policy Delphi panel, but merely agreement with other statements was expressed often and ideas were added to other people's proposals. This kind of cooperation and attentive reading of other proposals is to be emphasized positively in the realm of a Delphi study. One issue in the second round was again the drop-out rate due to high time commitment or lengthy descriptions. Initially, eleven participants answered the demographic and expert-matrix part. For the first scenario, there were still six participants who submitted policy implications, while in the second one, it dropped to three. The third scenario was commented on by four experts and the remaining two scenarios were worked on by only two panelists. The probability and desirability of the scenarios were still answered by five people at the end of the questionnaire. Interestingly, the loss of participants in the second Delphi round was significantly higher than in the first round, although the questionnaire in the first round was considerably longer than in the second round. The constant decrease in answers throughout the questionnaire indicates that the time demand for the questionnaire was too high. Nevertheless, the Mental Health Inferno and Socioeconomic Mortality Pattern scenarios seem to have attracted the most interest. In the following, a few remarks raised by the experts shall be rendered.

A panelist challenged the assumption of improvement in the air quality stated in the first Delphi round and processed in the Disturbed Human-Environment Relationship scenario. The person argued that "In recent decades, the concentrations of many air pollutants have decreased significantly throughout Germany due to technical developments flanked by environmental policy measures. However, this only applies to a limited extent to ground-level, tropospheric, ozone. According to current forecasts, its concentration is likely to increase, as is the concentration of particulate matter" (Panelist 6). The development of air quality in the context of the growth rate of diseases of the respiratory system has been pondered on quite a lot. Thereby, two panelists assumed an improvement in air quality through measures, while three experts expected a worsening.

One participant noted that the probability of the five scenarios occurring differs in the individual German states. The person related the statement further to the international comparison and sums up that, if Germany is to be considered in its entirety, the scenario "Socioeconomic mortality pattern" appears to be the most likely. They further remarked that this also applies to the Nordic countries. Even if only one person actively agreed with this statement, it is reflected in the response behavior of the other participants in the evaluation of the scenarios. Four participants considered the occurrence of this scenario to be very likely and one person considered it to be rather likely. Thus, this scenario was rated as the most probable by the whole panel.

Another person expressed doubt about how realistic the Disturbed Human-Environment Relationship scenario is. They expected that human health would not be

dominated to the extent described in the scenario by climate change impact. Rather, "there are likely other factors that will play a bigger role" (Panelist 11). The panel varied on the probability of this scenario. Two people thought that the scenario was very likely, and one person thought it was rather likely, neutral, or very unlikely. Thus, except for panelist 11, everyone else in the panel seemed to think the scenario was at least somewhat realistic.

Panelist 8 concluded the discussion with the following statement "The challenge is a flexible and adaptive balance between the preferred options". The Socioeconomic Mortality Pattern and the Anticipatory Policy scenario were the most preferred, followed by the Gender-Specific Health scenario.

5.2 The Scenario's Storylines

The five scenarios derived from the study will be discussed more in-depth in the following, however, a brief comparison to get an overview shall be presented here. Regarding the main causes of death, female mortality in the Mental Health Inferno scenario is sticking out with mental and behavioral disorders (ICD-10 F00-F99) (see Table 4 Comparison of all Scenarios; Figure 9 Causes of Death for Males from 1980 to 2060 for all Scenarios; Figure 10 Causes of Death for Females from 1980 to 2060 for all Scenarios).

Table 4 Comparison of all Scenarios

Scenario elements / Scenarios		Mental Health Inferno	Socio-economic Mortality Patterns	Disturbed Human-Environment Relationship	Anticipatory Policy	Gender-Specific Health
Main Cause of Death		Mental and behavioral disorders (F) Malignant neoplasms(M)	Diseases of the circulatory system	Malignant neoplasms	Diseases of the circulatory system	Malignant neoplasms
Assumptions		Adiposity pandemic	Euthanasia	Insufficient medical progress in cancer treatment	Drug under-supply due to dependence from uncertain providers	Vulnerability of men to risky lifestyles.
Main risk factors		• Malnutrition • Violence and stress load	• Adiposity • Socio-economic difference	• Novel Entities • Climate change impact	Climate change impact	Socio-economic deprivation
Intervention		No Information (NI)	Adaptation measures • Infrastructure • Health care system	NI	• Prevention and treatment • Nutrition and tobacco usage	Severe tobacco control
Air quality		NI	Improvement	Improvement	Improvement	Deterioration
Life expectancy (2060)	F	84.0 ↑	83.4-85.7 →/ ↑	NI	82.2 ↓	81.4 ↓
	M	80.0 ↑	78.1-81.2 ↓/ ↑	NI	76.2 ↓	77.0 ↓
Mortality growth rate (2020-2060)	F	-19%	+9%	+10%	-2%	+1%
	M	-18%	-2%	NI	-4%	+1%

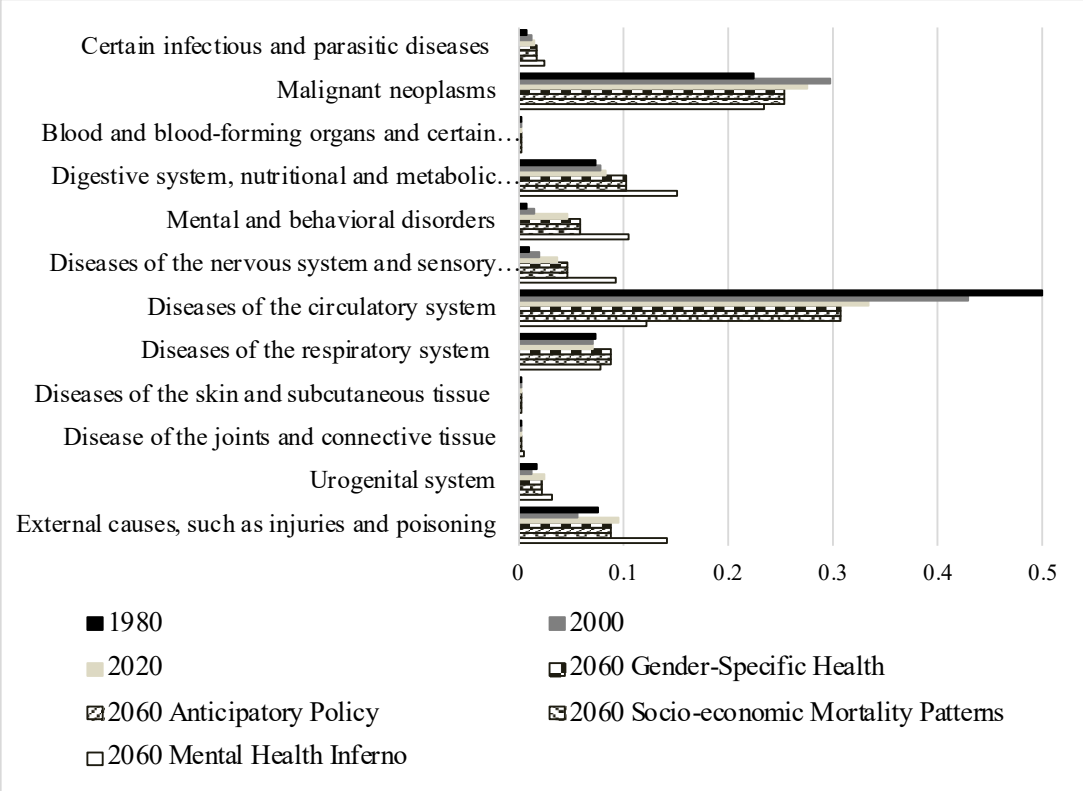

Figure 9 Causes of Death for Males from 1980 to 2060 for all Scenarios

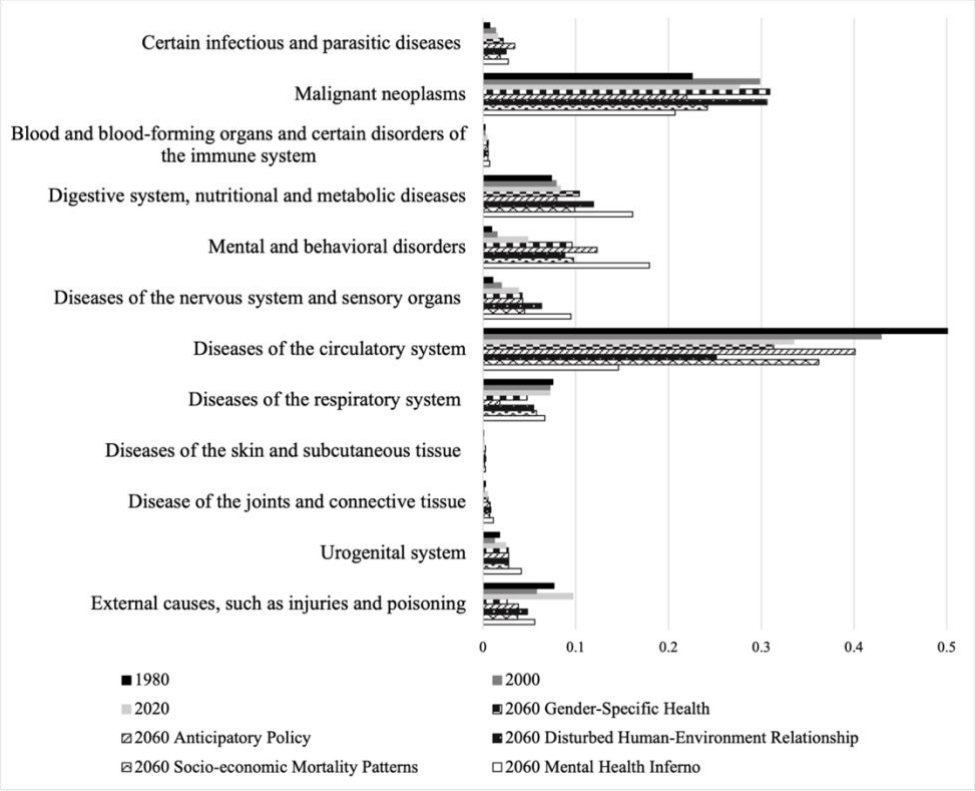

Figure 10 Causes of Death for Females from 1980 to 2060 for all Scenarios

The other scenarios and the male mortality in the Mental Health Inferno expect the main causes of the last decades, diseases of the circulatory system (ICD-10 I00-I99) and malignant neoplasms (ICD-10 C00-D48), to remain the predominant causes of death. The Socio-economic Mortality Patterns, Disturbed Human-Environment Relationship, and Anticipatory Policy scenarios all assume an improvement in air quality. On the contrary, the Gender-Specific Health scenario expects a deterioration. In Gender-Specific Health and Socio-economic Mortality Patterns are socio-economic differences the main risk factors to the population's health, especially paired with adiposity in Socio-economic Mortality Patterns along the social gradient. The Disturbed Human-Environment Relationship and Anticipatory Policy expect climate change impacts to pose the highest risk to health, in Disturbed Human-Environment Relationship additionally, the hazard of human-made novel entities is discussed. This makes those two scenarios the most climate change impact-driven ones, while the remaining three scenarios are driven more by lifestyle. In the Mental Health Inferno, malnutrition impacts physical health, while an anticipated increase in violence and stress load through multiple crises puts a strain on mental health. Through malnutrition, the Mental Health Inferno contains an adiposity pandemic that started already today. The Anticipatory Policy detects an early sign of a dependency on drug supply from uncertain partners today, which results in an undersupply. With widely applied Euthanasia, the Socio-economic Mortality Patterns projects an ethical and legal change in Germany. While the Gender-Specific Health foresees no change in the gender gap in health, rather a worsening in the situation for men, and the Disturbed Human-Environment Relationship anticipated no breakthroughs in cancer medicine. The Socio-economic Mortality Patterns, Anticipatory Policy, and Gender-Specific Health include interventions regarding preventive measures, tobacco, and nutrition control, and adaptative measures to the challenges of climate change impacts. Overall, the highest life expectancies in 2060 are expected in the Mental Health Inferno and Socio-economic Mortality Patterns with a slight increase and a decrease in the Anticipatory Policy and Gender-Specific Health. Across all scenarios, a female life expectancy of 81.4 up to 85.7 years, and a male life expectancy of 76.3 up to 81.2 years are estimated (see Figure 11 Life Expectancy Among all Scenarios Until 2060 for Both Genders).

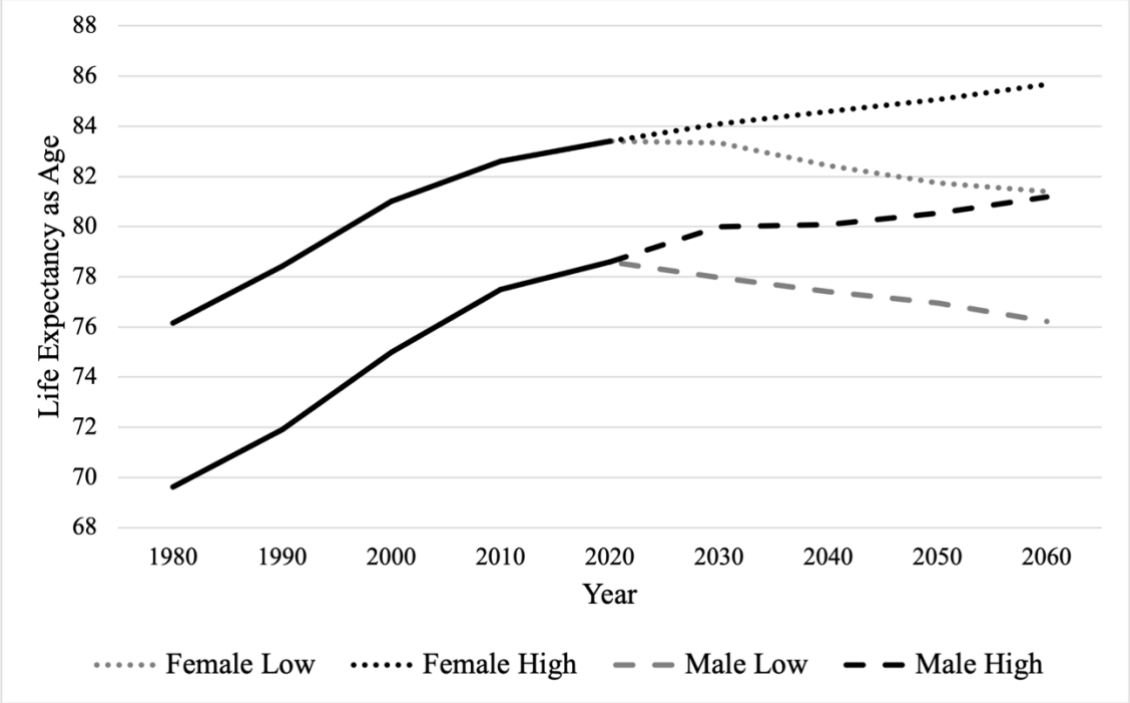

Figure 11 Life Expectancy Among all Scenarios Until 2060 for Both Genders

However, no big changes in life expectancy to the current levels are expected in any scenario. The results indicate a slowing down or stagnation of the life expectancy curve in the upcoming decades. In the case of mortality growth rate, the biggest change can be witnessed in the Mental Health Inferno with a decrease of circa 18-19% for the period 2020 to 2060.

Even though the scenario distinction made by Kahn has justified criticism, it gives a good idea of the scenarios' logic. So, if one would like to impose the scenario manners on the present scenarios, the Anticipatory Policy and Gender-Specific Health scenarios can be classified as a 'Business-as-usual' scenario, as the smallest changes occur among them. Then the Socio-Economic Mortality Pattern and Disturbed Human-Environment Relationship scenarios can be seen as the 'Worst-case' scenario, by having the highest increase in mortality. With a stark decrease in mortality and an increase in life expectancy, the Mental Health Inferno scenario could be classified as the 'Best-case' scenario.

5.2.1 Mental Health Inferno

The Mental Health Inferno scenario is based on cluster four. In particular, the uncertainty about the future in recent decades has led to a sharp rise in mental and behavioral disorders (ICD-10 F00-F99). Due to the complex treatment of these illnesses, mortality in the form of suicide in this disease category rose to become one of the main causes of death by the year 2060. This disease pattern also led to an increase in violence resulting in death and

slightly increased mortality attributed to the category of external causes, such as injuries and poisonings (ICD-10 S00-T98; U129; V01-Y98). Increased stress from the work environment, as well as a higher burden of family and elderly care paired with work, especially for women, due to the demographic change, further, more people being affected by loneliness, are posing the highest risk of developing mental illnesses in Germany in 2060.

Improvements in the treatment of diseases of the nervous system and sensory organs (ICD-10 G00-H95), as well as diseases of the joints and connective tissue (ICD-10 M00-M99), experienced a shortfall. Due to the aging population, the mortality caused by neurodegenerative diseases (belonging to ICD-10 G00-H95) has risen sharply, and joints and connective tissue (ICD-10 M00-M99) have increased slightly. The aging population describes the accumulation of the largest population group in the older age cohorts. On the contrary, it is largely possible nowadays to treat diseases of the circulatory system (ICD-10 I00-I99), which led to a strong decrease in the former main cause of death in this category, cardiovascular diseases. Although the incidence of malignant neoplasms (ICD-10 C00-D48) is rising due to the aging population, treatments could be improved and have a lowering effect on mortality. The same applies to diseases of the blood and blood-forming organs and certain disorders of the immune system (ICD-10 D50-D90), through improvements in health care.

Unhealthy eating habits with highly processed food resulted in an obesity pandemic, triggering a medium-strong increase in the digestive system, nutritional and metabolic diseases (ICD-10 E00-E90; K00-K93), and the prevalence of diseases of the urogenital system (ICD-10 N00-N99). In the case of the latter, prevention and enhanced treatment methods caused only a slight increase in mortality. Changing environmental conditions, such as pollution, lead to a slight increase in diseases of the respiratory system (ICD-10 J00-J99), but the relative incidence of deaths decreased, as it did for diseases of the skin and subcutaneous tissue (ICD-10 L00-L99).

Climate change caused species migration leading to the global spread of parasites and viruses, increasing the risk of infection. As a result, death through certain infectious and parasitic diseases (ICD-10 A00-B99), such as zoonotic diseases (e.g., avian influenza) moderately rose. Climate change triggered flooding, an increase in the average temperature, extreme heat, and cold events, which pose great risks for both female and male health. In particular, extreme heat can cause many deaths in a single day. Nevertheless, the relative increase in deaths from extreme weather conditions, belonging to external causes, such as injuries and poising (ICD-10 S00-T98; U129, V01-Y98) category, remained small due to the sharp increase in other categories (e.g., diseases of the nervous system and sensory organs).

Other risk factors that promote the development of diseases in this scenario are the increasing socioeconomic disparities as the main risk factors, unhealthy consumption

patterns, smoking, excessive alcohol consumption, physical inactivity, and the increase in unhealthy sleep patterns.

Life expectancy within this scenario for women is expected to stay around the 2020 level of 83.4 years in 2030 and establish a plateau there until 2060. For men, the plateau is reached at the age of approximately 80 between 2030 and 2060, where it rose to starting from 78.6 years in 2020 (see Figure 12 Life Expectancy in the Mental Health Inferno Scenario). Thus, the gender gap in life expectancy is assumed to decrease. Overall, this scenario foresees the second-highest life expectancy among all scenarios.

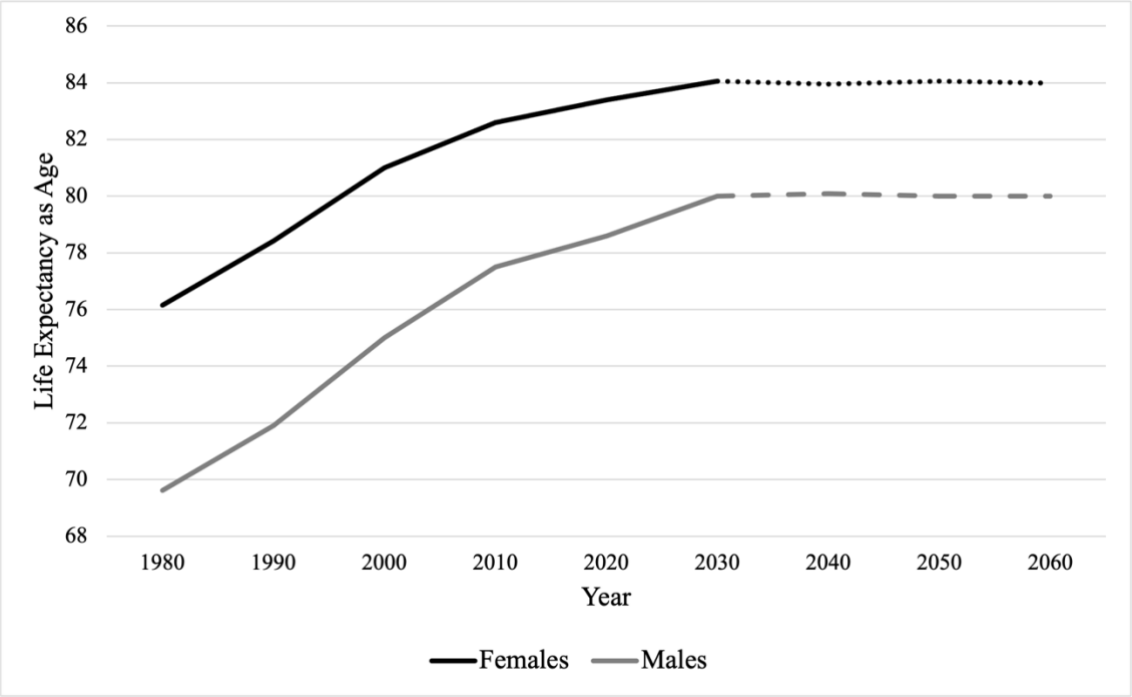

Figure 12 Life Expectancy in the Mental Health Inferno Scenario

In summary, this scenario assumes that treatment for most causes of death improves significantly and reduces mortality. Mental health remains difficult to treat and is compromised by various factors. Climate change strongly impacts the population in this scenario but without a pronounced effect on mortality. Whereas the lifestyle determinant Diet has led to an obesity pandemic due to unhealthy trends that favor mortality. Within this scenario, the growth in life expectancy slows down dramatically with the expected age of death staying constant for 40 years.

5.2.2 Socio-economic Mortality Patterns

This scenario stems from cluster one. Improvements in prevention, therapy, treatment, as well as adaptation measures, could decrease the mortality rate of causes of death in 2060 that were still prominent in 2020. Due to the rise in life expectancy and thus the aging

population, the mortality rate in general still rose as older age poses a higher risk of certain diseases. Mortality increased especially in diseases with age as a risk factor. Due to increased life expectancy from 2020 to 2060 and demographic change, a large proportion of the population is in the risk cohorts for certain diseases. Thus, despite lowering measures, the overall mortality rate increased. Among those age-related increases is malignant neoplasms (ICD-10 C00-D48) for women, as men are profiting more from the improvements. For all genders, the age-related prevalence and mortality of diseases of the blood and blood-forming organs and certain disorders of the immune system (ICD-10 D50-D90), mental and behavioral disorders (ICD-10 F00-F99), diseases of the nervous system and sensory organs (ICD-10 F00-F99) increased moderately. Diseases of the nervous system and sensory organs (ICD-10 G00-H95) and diseases of the joints and connective tissues (ICD-10 M00-M99) only rise in prevalence but can be addressed better through measures. All these categories increased primarily in prevalence, and mortality increased only slightly due to improved interventions. Men are the main beneficiaries of improved treatment options, as they have been particularly affected by diseases of the circulatory system in the past; this may partially offset their riskier lifestyles, such as engaging in riskier sports and poorer diets. Extreme weather events, such as heat waves, as well as increases in risk factors such as obesity and hypertension (elevated blood pressure) and increase the prevalence of circulatory diseases.

Mortality from diseases of the skin and subcutaneous tissue (ICD-10 L00-L99) decreased slightly despite increased ultraviolet exposure, due to improved screening and increased population awareness.

In terms of nutrition, there have been opposing trends in recent decades. On the one hand, the supply situation deteriorated due to environmental changes, while a predominantly plant-based diet spread and influenced the prevalence of malignant neoplasms (ICD-10 C00-D48). Across the population, increasing malnutrition and an increase in obesity, diabetes, and secondary diseases could also be observed due to inactivity because of increasing digitalization. At the same time, renal failure due to hypertension and excess mortality due to exsiccosis, thus low water content in the body, increases during heat waves. An epidemiological transition of diet in large parts of the world and the poor changes of this, increased people with a migration background are affected by adiposity. These trends together have led to a moderate increase in mortality from digestive, nutritional, and metabolic diseases.

Men are less likely to take advantage of preventive offers and thus benefit less. This is shown, for example, by the increase in prostate cancer and renal insufficiency in the course of the aging population in diseases of the urogenital system (ICD-10 N00-N99). Mortality from diseases of the respiratory system (ICD-10 J00-J99) and malignant neoplasms (ICD-10 C00-D48), for example, triggered by climate change-related air pollution and altered pollen, or chronic obstructive pulmonary disease (COPD) also

increased more in men than in women. This may be due, among other things, to a lower decrease in nicotine abuse among the latter. At the same time, air pollution and environmental hazards were reduced in terms of their carcinogenic effect through measures. This success could not be recorded for exposure to endocrine disruptors, thus synthetic substances that act like the body's own hormones, which led overall to a slight increase in mortality from malignant neoplasms (ICD-10 C00-D48) and diseases of the blood and blood-forming organs and certain disorders of the immune system (ICD-10 D50-D90).

Biodiversity loss and extreme weather events also led to a slight increase in mortality from certain infectious and parasitic diseases (A00-B99). With increased pandemics, the spread of zoonotic diseases, and diseases, such as tuberculosis and malaria, introduced through increased migration with increasing resistance to tuberculosis antibiotics as a result. However, increased migration also brought increased gastrointestinal and other infections to Germany. Extreme weather events repeatedly paralyzed infrastructure, such as sewage or wastewater treatment plants, favoring the spread of pathogens, as well as losses of healthcare infrastructure with the corresponding undersupply of chronic diseases. However, adaptation measures in the construction of infrastructure and medical adaptation to new pathogens were able to mitigate the increase.

The greatest increase in mortality was experienced by women in the case of mental and behavioral disorders (ICD-10 F00-F99), with multiple crises (burnout, existential anxiety, eco-anxiety, solastalgia, thus a sense of loss due to the destruction of one's home), traumatic experiences through migration and extreme weather events being the triggers for all genders. Particularly among women, the psychological and physical stress caused by the aging population and the resulting increase in care work is on the rise. But also, the excessive expectation and demand on the own person increased strongly in the last decades. The sharp increase in the prevalence of mental and behavioral disorders (ICD-10 F00-F99) is due to the long-term trend of social openness and the resulting increase in diagnosis. Due to increasing life expectancy and air pollution, the rate of dementia is rising sharply, which is why active euthanasia is being used much more frequently. However, the suicide rate also increased moderately. The suicide rate of men has traditionally been higher than that of women, but destigmatization in recent decades has lowered this. The sharp rise in the prevalence of mental and behavioral disorders (ICD-10 F00-F99) led to increased alcohol, drug, and medication abuse.

But extreme weather events such as increasing temperature and heat waves also lead to higher psychological stress and increased potential for aggression, which can lead to more violence resulting in death. And while this has had an increasing effect on the mortality rate from external causes, such as injuries and poisoning (ICD-10 S00-T98; U129; V01-Y98) in all genders, women are more vulnerable. Reduced social peace, increasing social inequality and distributional crises, exclusion, and stigmatization also

amplified this effect, leading to increased mortality among populations of lower socioeconomic status. For example, due to overrepresentation in unhealthy living environments with high exposure to noise, air pollution, and confinement. In contrast, people of higher socioeconomic status have been able to increase their life expectancy, through a predominantly plant-based diet, more equitable gender relations (e.g., care work and gender pay gap; Changing norms especially among men), reduced workweek, access to green space and water, and a good living environment. Rising inequality in access to health care due to increasing privatization also reinforces the trend in socioeconomic mortality patterns.

The increase in extreme weather events such as storms and floods, acute heat waves, and a general increase in temperature and water scarcity also leads to increased mortality in the category of external causes, such as injuries and poisoning (ICD-10 S00-T98; U129; V01-Y98). Externalized, the European Union's strong migration restriction measures led to increased mortality among people fleeing the consequences of the climate crisis.

Life expectancy is expected to slightly increase over the amount of approximately two years up until 2060, thus a drastic slowdown of the increase in life expectancy is assumed. Hereby, the gender difference in life expectancy decreases drastically in comparison to 2020 (see Figure 13 Life Expectancy in the Socioeconomic Mortality Pattern Scenario). Life expectancy is the highest in this scenario among all five.

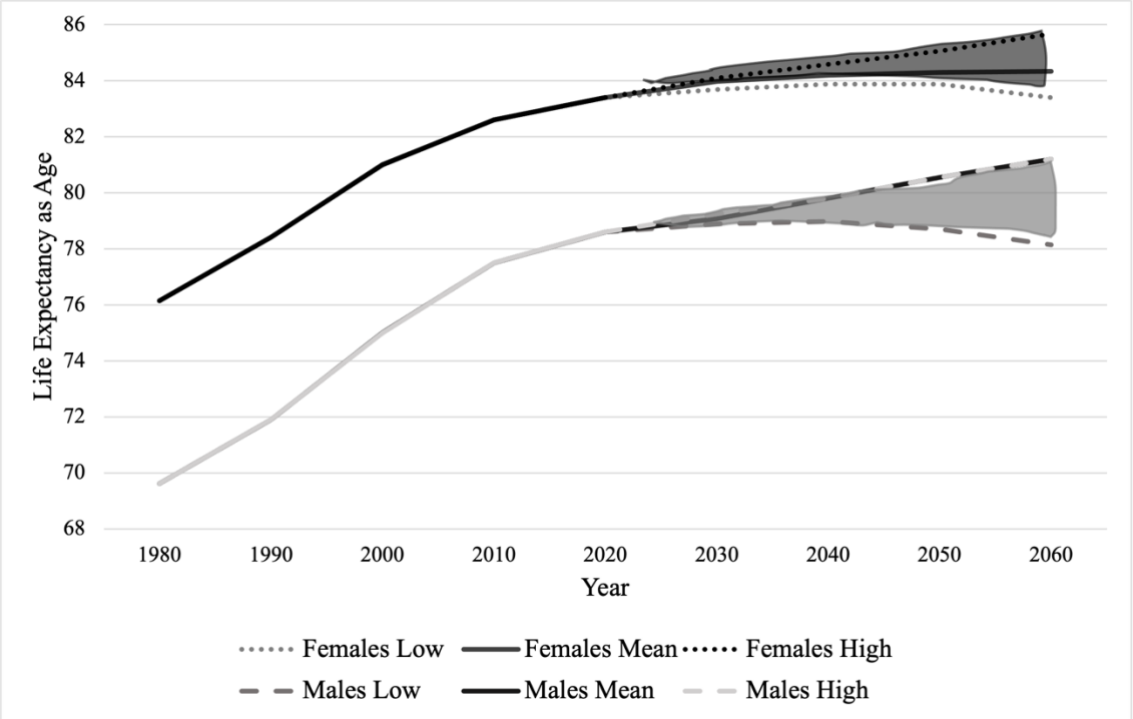

Figure 13 Life Expectancy in the Socioeconomic Mortality Pattern Scenario

In this scenario, the following aspects should be stressed as particularly interesting. First of all, the assumption of the implementation and wide application of legalized assisted suicide underlies the scenario. Secondly, health and life expectancy are mostly affected by socioeconomic status and thus differ greatly among the populations' layers and groups. This difference is expressed in the high prevalence of obesity, especially for people with a migration background or lower socioeconomic status. Fourthly, it is assumed, that mortality from most diseases has been successfully reduced in recent decades through improved prevention, therapy, and treatment methods. Fifthly, improved air quality through measures for the reduction of pollution is presumed. Lastly, the scenario builds upon adaption strategies for infrastructure and treatment of diseases regarding changed requirements. Thus, the scenario is characterized by state intervention.

5.2.3 Disturbed Human-Environment Relationship

This scenario is based on cluster five. So-called Novel Entities, thus chemical pollution by humans, caused some diseases to increase moderately to severely. Through these, malignant neoplasms (ICD-10 C00-D48) grew to become the leading cause of death in women, which medical progress could not keep up with, and diseases of the nervous system and sensory organs (ICD-10 G00-H95) also experienced a sharp increase due to novel entities and the disruption of the human-environment relationship in general. However, the slight increase in Blood and blood-forming organs and certain disorders of the immune system (ICD-10 D50-D90) can also be attributed to Novel Entities.

Climate warming was identified as another major cause of the increase in diseases. It caused a medium-strong increase in certain infectious and parasitic diseases (ICD-10 A00-B99), as it enabled the spread of vector- and waterborne infectious diseases to new areas (for vectors e.g., mosquitoes or ticks; for waterborne transmission e.g., by bacteria, viruses, and parasites). As well as a medium-strong increase in diseases of the skin and subcutaneous tissue (ICD-10 L00-L99) due to increased ultraviolet exposure in the wake of climate warming. In these categories, caused by Novel Entities, exposure to chemicals increased and with it the prevalence of inflammatory and allergic skin diseases. Climate change-triggered extreme weather events, such as floods, resulted in a moderate increase in external causes, such as injuries and poisonings (ICD-10 S00-T98; U129; V01-Y98).

In the area of lifestyle influence, an unhealthy diet led to a medium-strong increase in the digestive system, nutritional and metabolic diseases (ICD-10 E00-E90; K00-K93) due to the increase in obesity and its secondary diseases. The prevalence of diseases of the joints and connective tissue (ICD-10 M00-M99) experienced a slight increase due to the now predominantly sedentary lifestyle.

Due to the overload of global and societal developments, there has been a slight increase in mental and behavioral disorders (ICD-10 F00-F99) in recent decades.

However, air quality improved significantly, and in combination with better treatment methods, diseases of the circulatory system (ICD-10 I00-I99) were moderately reduced. Diseases of the respiratory system (ICD-10 J00-J99) also benefited from the cleaner air, but the longer pollen season due to global warming and the resulting higher prevalence of allergic asthma counteracted this negative factor.

Overall, diseases increased rather than decreased or remained the same because of the above developments.

5.2.4 Anticipatory Policy

Cluster three served as the base for this scenario. The strongest increase was experienced by certain infectious and parasitic diseases (A00-B99) by more than 100%. The reason for this was the destruction of natural wildlife habitats and associated proximity to humans. This resulted in a sharp increase in zoonotic infectious diseases that were more deadly than the COVID-19 virus that broke out in 2020. Changing living conditions due to climate change and measures to counteract it exerted pressure on the population and led to a medium-strong increase in mental and behavioral disorders (ICD-10 F00-F99). Women are particularly affected by this pressure, which increases the prevalence of these disorders, but men are more likely to commit suicide.

The aging population and the absolute decline in other diseases promoted a slight relative increase in diseases of the nervous system and sensory organs (ICD-10 G00-H95), in particular the age-related diseases Alzheimer's and Parkinson's disease.

Diseases of the respiratory system (ICD-10 J00-J99) recorded the strongest decline due to restrictions on internal combustion engines and individual transport, which resulted in improved air quality. Non-smoker protection in recent decades also contributed significantly to a decline in these diseases, although innovations by the tobacco industry have made this a constant process. Overall, women benefit significantly more than men from all these measures. In addition to nonsmoker protection, measures such as occupational health and safety and building regulations (e.g., asbestos regulation) led to a slight decline in malignant neoplasms (ICD-10 C00-D48) in the first two decades of the century. The trend toward a meat-free diet triggered by climate protection measures, coupled with improved early detection through screening and other preventive measures (e.g., HPV vaccination against cervical cancer), also contributed to this decline. Inflation-related poverty and overall increased stress levels in the population led to unhealthy diets. Poor population care due to climate change impacts (mainly droughts, water shortages,

floods, and plant pests) and poor diets attenuated the declining trend of malignant neoplasms (ICD-10 C00-D48).

Measures to promote healthier eating at work and educational institutions, as well as a ban on advertising unhealthy foods, slightly reduced digestive system, nutritional and metabolic diseases (ICD-10 E00-E90; K00-K93). As men have been able to bridge the gap to women's tendency toward healthier diets in recent decades, this effect had a particularly strong impact on them. Increased colorectal cancer screening and less meat consumption also reinforced the declining trend. Skin cancer screening likewise improved because of risk adaptation to climate change impacts and, together with more pronounced prevention (e.g., sun protection education for children), led to a slight decrease in diseases of the skin and subcutaneous tissue (ICD-10 L00-L99). This was particularly significant for men, as they were particularly affected by these diseases before the measures took effect. In contrast, men in the aging population experienced a slight increase in diseases of the urogenital system (ICD-10 N00-N99) due to the high risk of prostate cancer in old age. Among women, preventive measures (e.g., HPV vaccination against cervical cancer) and the long-term trend of societal openness to sexual health issues led to better education and thus a slight decrease in mortality in these diseases.

Enhanced attention to femicides and the visibility of women in safety development led to increased security for women overall. As a result, deaths through homicides and fatal traffic accidents decreased for women. In combination with rising deaths from natural disasters, triggered by climate change, external causes, such as injuries and poisonings (ICD-10 S00-T98; U129; V01-Y98), sum up to a status quo of these weak opposing trends. For men in this mortality category, despite the increased deaths from natural disasters, the diminishing effect of fewer traffic accidents predominated; this was mainly due to the overall decrease in personal transportation. Men had still been involved in traffic accidents significantly more frequently at the beginning of the decade. Further health risk factors for women included increased social pressure, which promoted eating disorders, among other things. In addition, the shortage of skilled labor led to an undersupply of maternity clinics and a shortage of midwives, which again made births riskier for women.

A major problem in 2060 is the supply of medicines. In the past, Germany had made itself dependent on insecure political partners, such as China, in this domain. For this reason, bottlenecks are occurring more and more frequently, which in some cases encourage toxic plagiarism of pharmaceuticals on the market.

Female life expectancy in the Anticipatory Policy scenario is expected to slightly decrease after 2020 to a level of approximately 82.1 years in 2060. The same development applies to males, where a life expectancy of 76.2 is expected for 2060 (see Figure 14 Life Expectancy in the Anticipatory Policy Scenario). Within this scenario with the second-lowest life expectancy among all, the gender gap increases.

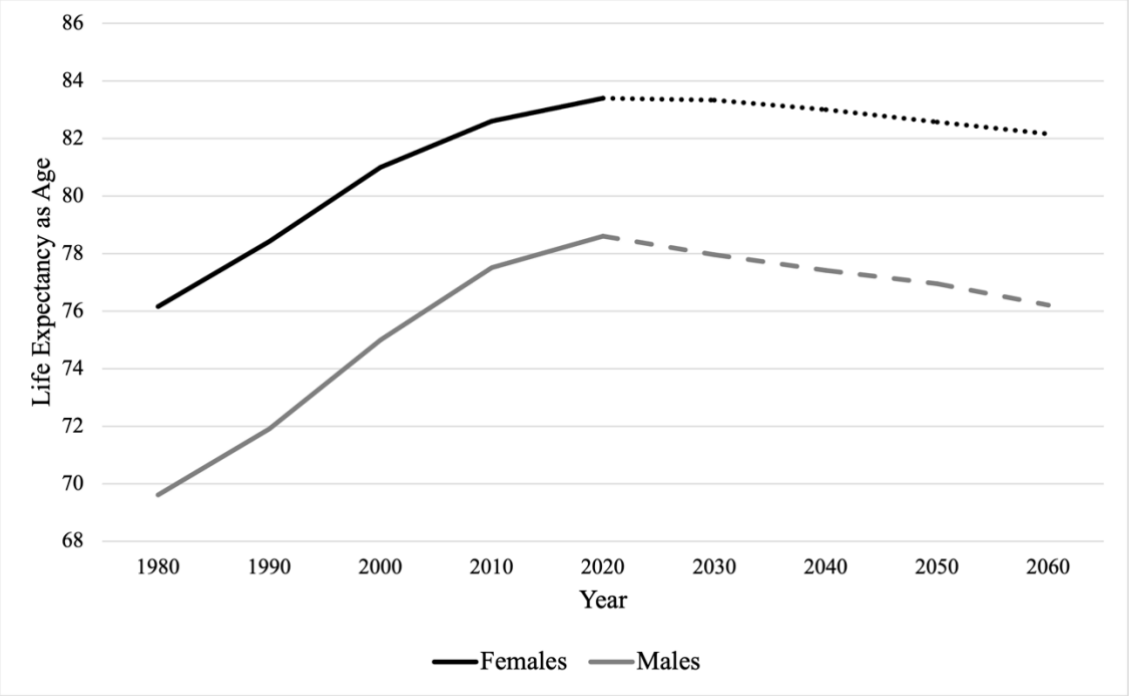

Figure 14 Life Expectancy in the Anticipatory Policy Scenario

Overall, the Anticipatory Policy scenario is very optimistic, with policy measures on transport, construction, nutrition, and smoking, better prevention, and technology reducing many diseases slightly to moderately and leading to a healthier society overall. Only climate change and habitat destruction posed an increased threat to public health. This was evidenced by the increase in infectious diseases, poorer drinking water quality after floods, inadequate treatment of drinking water due to global material shortages, and declining clean groundwater. Heat- and cold-associated deaths and other natural disasters were also among them. At the societal level, the uncertain outlook for the future led to stress and poverty, which can be seen as one of the main risk factors for the development of fatal diseases.

5.2.5 Gender-Specific Health

This scenario is based on cluster two. Men experienced the highest relative increase in this scenario for the digestive system, nutritional and metabolic diseases (ICD-10 E00-E90; K00-K93) due to an unhealthy diet and the associated higher risk of obesity, diabetes, and chronic intestinal diseases. The female population is merely affected by the increase in this category because of their tendency to eat healthier, the lack of exercise contributes more to a rise in diseases for women. Men experienced, in comparison to women, also a higher relative increase for diseases of the skin and subcutaneous tissue (ICD-10 L00-L99). Here, melanomas and forms of white skin cancer were particularly

significant for all genders. Since men work outdoors more often and take advantage of preventive services less frequently than women, they are significantly more affected by these diseases. Gender differences were also observed in diseases of the respiratory system. In women, lung cancer and chronic obstructive pulmonary disease (COPD), for instance, lung damage and airway constriction, which are often attributable to smoking, decreased slightly as a result of strong tobacco control policies. In contrast, these diseases tend to increase in men. Another burden on the respiratory tract is allergenic exposure to neophytes, invasive plant species, and more aggressive pollens.

There was also a slight increase in deaths from diseases of the urogenital system (ICD-10 N00-N99) among men, while deaths in this category decreased slightly among women, which is partly due to the gender-specific difference in the frequency with which preventive measures are perceived.

In both sexes, certain infectious and parasitic diseases (ICD-10 A00-B99) increased moderately due to the global spread of infectious diseases favored by climate change, for example by the tiger mosquito. However, viruses (e.g., hantaviruses) transmitted by rodents also trigger severe forms of disease. Malignant neoplasms (ICD-10 C00-D48) increased moderately mainly due to the relative decrease in other diseases. This effect was somewhat weaker in men since many diseases increased rather than decreased in them, and thus malignant neoplasms (ICD-10 C00-D48) increased only slightly. Similarly, mental and behavioral disorders (ICD-10 F00-F99) increased partly due to the relative decrease in other diseases. However, the prevalence of these diseases independently increased the most (especially among women) and contributed to the slight increase in mortality. One trigger for this was the psychological burden of climate change. Higher societal awareness increased the likelihood of diagnosis and thus survival. Also, climate change induced better vitamin D supply and the reduction of stress levels and winter depression by spending more time outdoors had a lowering effect on mortality.

Among diseases of the nervous system and sensory organs (ICD-10 G00-H95), the prevalence of eye diseases such as cataracts and hearing loss increased. Since these diseases rarely lead to death, mortality in this category increased only very slightly. Mortality in the category of blood and blood-forming organs and certain disorders of the immune system (ICD-10 D50-D90) increased slightly.

In contrast, mortality from diseases of the joints and connective tissue (ICD-10 M00-M99) decreased moderately, as did external causes, such as injuries and poisoning (ICD-10 S00-T98; U129, V01-Y98), with the effect on the latter being particularly strong for men. This is due to successful occupational health and safety measures, the decline in physical labor, and better prevention in leisure activities by using helmets and protectors, as well as improved safety systems in the motor vehicle industry. Due to the shortened winter caused by climate change, slippery road accidents resulting in fatalities occurred

less frequently. Deaths from diseases of the circulatory system (ICD-10 I00-I99) decreased slightly for both sexes due to better diagnostics and medical progress.

Female life expectancy is expected to slightly decrease after 2020 to a level of approximately 81.4 years in 2060. The same development applies to males, where a life expectancy of 77 is expected for 2060 (see Figure 15 Life Expectancy in the Gender-Specific Health Scenario). Within this scenario, the gap in life expectancy among the genders experiences a slight decrease, while it ranks as the scenario with the lowest life expectancy.

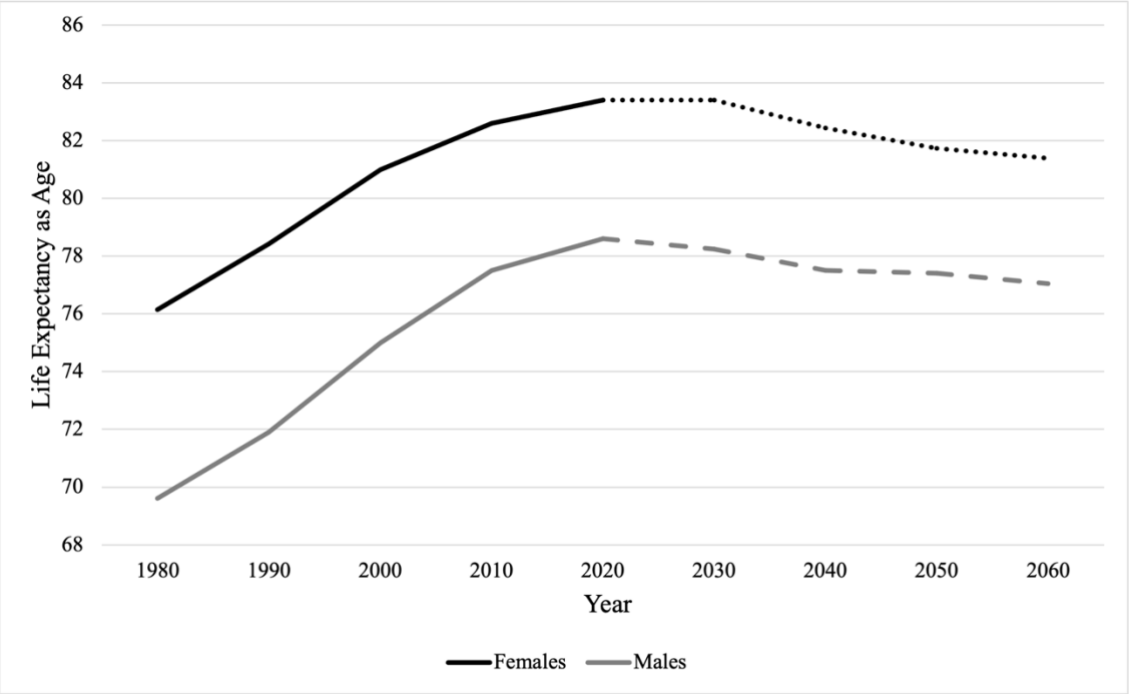

Figure 15 Life Expectancy in the Gender-Specific Health Scenario

Of particular interest in this scenario is the strong vulnerability of men due to riskier lifestyles, such as more frequent smoking, career choices, unhealthier diets, and lower use of preventive services. This scenario is based on the assumption of stronger tobacco control, but unlike other scenarios, it does not assume greater restriction of personal transportation, as poorer air quality due to particulate matter pollution, as well as accidents, is anticipated to remain a high risk for men. In addition, socioeconomic deprivation is considered one of the highest risk factors for health in the future.

5.3 Policy Formulation

Scenarios are a meaningful method for deriving long-term policy implications for certain issues. Further, policies can be vetted by being applied to all scenarios and testing whether they produce a sufficient outcome (Glenn 2009, 10). For this reason, the study's aim is to

detect policy implications based on the first Delphi round outcome in the format of scenarios on the cause of death situation in Germany in 2060. As Collins (2005, 194) remarks, the spectrum of health policy measures ranges from reforming the healthcare system to protecting vulnerable groups. For that reason, the panelists in this study were not restricted on which level they were suggesting the need for policy interventions. Nevertheless, the goal of policy implication detection is restricted by several limits, first of all, the panel only had the five scenarios as a starting point. As a result, the policy implications are restricted only to the potential futures detected and exclude the multitude of other possibilities. Secondly, expecting a complete set of well-developed policy measures exceeds the professional competencies of the relatively small group of experts participating in this study and the reasonable scope of this study.

To evaluate policy interventions Collins (2005, 195) proposes the following five criteria:

1. "Relevance: does the intervention contribute to the health needs of the target population? Is it consistent with policies and priorities?
2. Progress: how do actual results compare with projected or scheduled results?
3. Efficiency: what are the results in relation to resource expenditure of the intervention?
4. Effectiveness: to what degree does this particular intervention attain its objectives?
5. Impact: what is the effect of the activity on overall health and related socio-economic development?".

The aspects of relevance, efficiency, and impact were often picked up in the statements. However, it is beyond the scope of this thesis and its underlying research method to evaluate these proposals and to define a proper set of concrete policy actions. Rather, the purpose of this chapter is to give full transparency of all proposals in a systematic overview and to test the Delphi method to stir up creativity in deriving policy implications. All policy recommendations reflect the opinions of the panelists only. The suggestions put forward already indicate the broad spectrum of measures needed to address future challenges in health policy. Further research could take these statements as a starting point for a more detailed investigation in line with Collins's (2005, 195) approach.

In the following, a brief summary of cross-scenario implications shall be drawn, and a few comments will be made about them. Some measures were repeatedly mentioned during all scenarios, thus they were not always explained in depth again. The expansion of the public health field and its competencies as advisory actors in health policy, as well as the mitigation of the harmful influence of artificial intelligence, was mentioned in almost all scenarios (see Table 5 Policy Implication for Each Scenario). This was due to the fact, that the proposals stemmed from the same person, who expressed the need for those interventions for all scenarios. Other interventions that were mentioned several

times are the expansion of health literacy, investment in preventive measures, mitigation of climate change, and investments in infrastructural changes. Other very specific interventions like domestic drug development were only mentioned for one scenario, as the issue was only described in one scenario. The wide spectrum of recommendations suggests that there will not be a quick fix, but a balanced approach of targeted measures will be needed instead. The eclectic character of the policy recommendations clearly shows the limitations of the research method used. In the framework of this thesis, it is not possible to identify the relevant actions and evaluate them in terms of effectiveness, efficiency, political enforceability, technical implementation, and so on. This is the subject of further research.

Table 5 Policy Implication for Each Scenario

Policy interventions proposed by panelists	Scenarios				
	Mental Health Inferno	Socio-economic Mortality Patterns	Disturbed Human-Environment Relationship	Anticipatory Policy	Gender-Specific Health
Expansion of public health field as advisory actor in health policy	X	X	X	X	
Mitigate harming influence of Artificial Intelligence (AI)	X	X	X	X	
Health Literacy Expansion	X	X	X		
Infrastructure change to foster healthier lifestyle and climate change impact adaption	X	X		X	
Investment in preventive measures, e.g. screenings or safety measures	X			X	X
Mitigate climate change		X	X	X	
Foster plant-based diet	X			X	
Restrict advertisment for unhealthy food		X		X	
Investment in research			X		X
Digitalization of healthcare	X				
Strengthening of social coherence	X				
Regulate tobacco usage				X	
Regulate assisted suicide		X			
Economic system change		X			
Investment in domestic drug development				X	

Within the policy implication Delphi round, panelists were asked to estimate the probability and desirability for the five scenarios derived from the first round. As a result, the Socio-Economic Mortality Patterns Scenario received the most approval for being probable, with 80% of the votes for ‘very probable’ (see Figure 16 Estimations of the Probability of Occurrence of Each Scenario). Followed by the Mental Health Inferno scenario, and then the Disturbed Human-Environment Relationship scenario. The

probability of the Gender-Specific Health and the Anticipatory Policy scenarios are voted predominantly neutral with 60% votes for ‘neutral’ each.

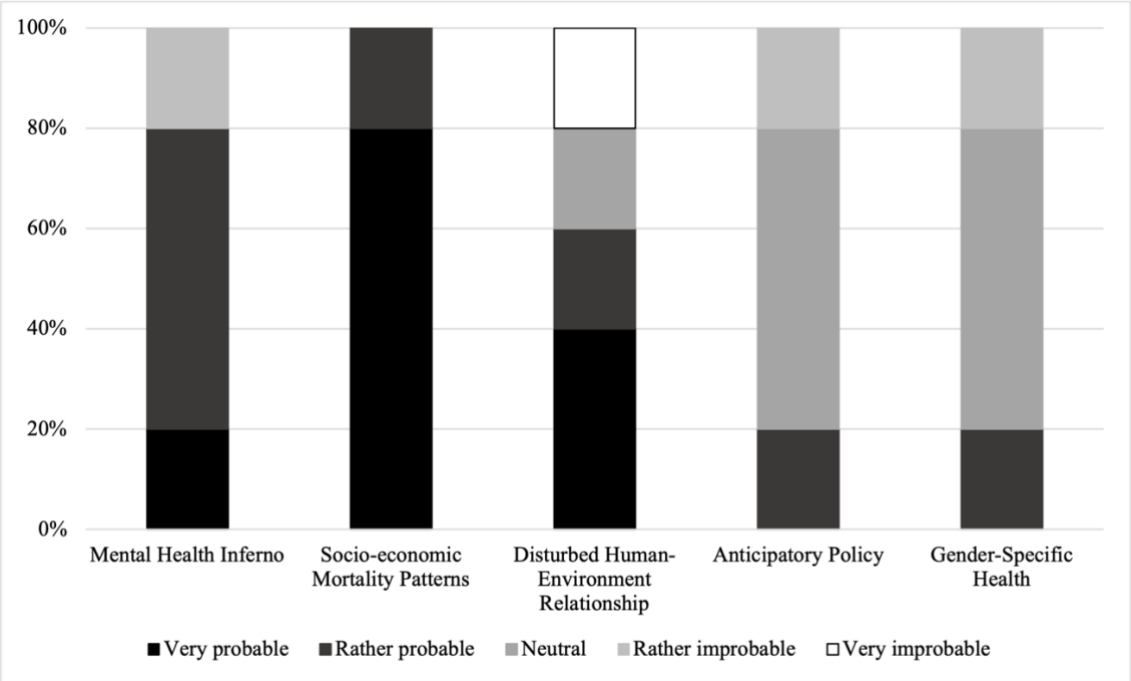

Figure 16 Estimations of the Probability of Occurrence of Each Scenario

Normativity plays a major role in the field of policymaking. It is not merely a matter of identifying different possible futures, but of considering which future is aspirational and, thus, desirable. For this reason, the experts were asked about the desirability of the five scenarios in their opinion. Concerning the desirability, the Anticipatory Policy scenario, with 60% of the votes for ‘very desirable’ and 40% of ‘rather desirable’, followed by the Socio-Economic Mortality Patterns scenario, seems to be the most desired one by the panel (see Figure 17 Estimations of Desirability of Occurrence of Each Scenario). While the Disturbed Human-Environment Relationship scenario and the Mental Health Inferno are less favored. The Gender-Specific Health scenario is somewhere in between with 60% of ‘rather desirable’ and in each case 20% for ‘rather undesirable’ and ‘very undesirable’. Within the desirability, no votes were cast for the option ‘neutral’.

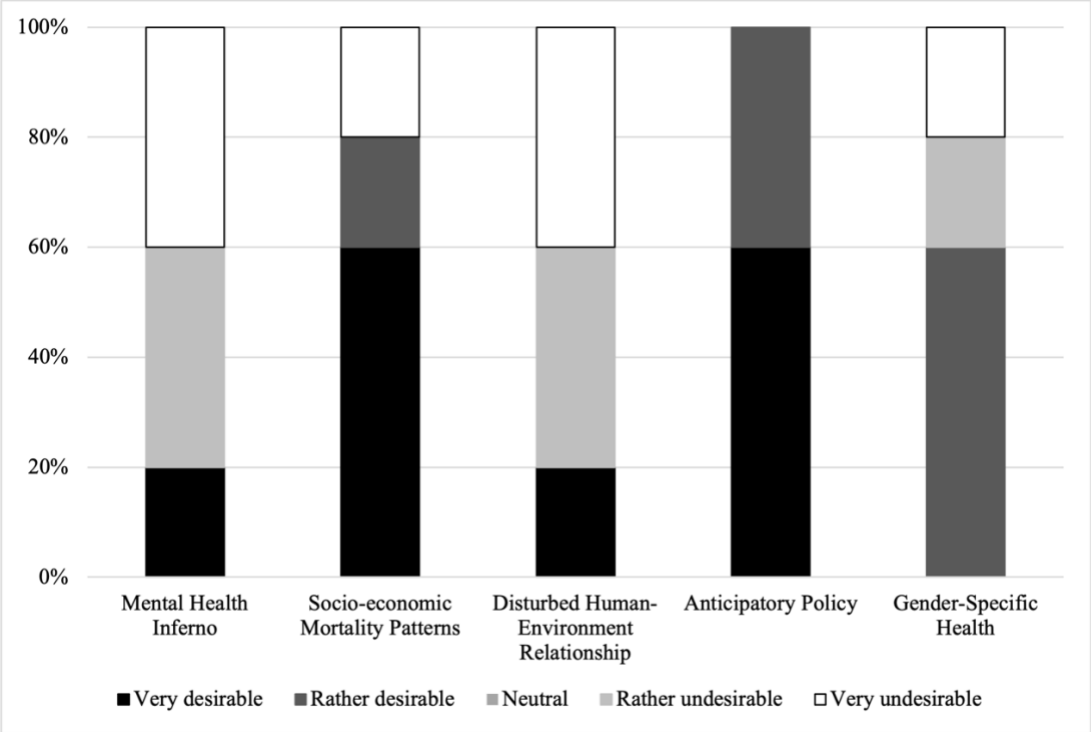

Figure 17 Estimations of Desirability of Occurrence of Each Scenario

5.3.1 Policy Implication for the Mental Health Inferno Scenario

"Policy bundles are needed, that is, bouquets of different measures that primarily address different groups and, above all, are designed in such a way that they do not exacerbate social inequalities but, at best, reduce them." (Panelist 10)

(Mental) Health Care System

The healthcare system is facing new challenges due to the population's heavy mental health burden. On the one hand, the complex treatment of mental and behavioral disorders presents itself as excessive demand for the health care system and thus exceeds the current capacities in the demand for psychiatrists and psychotherapists. For this reason, the panel suggests promoting mental health at the individual level in the population. At the same time, measures are aimed at building the health system's capacity to provide mental illness prevention, health promotion, and care at the structural level. This involves building a national system of prevention and early detection. In the following, some proposals of the panel are presented

Training of General Practitioners

The concepts of primary, secondary, and tertiary prevention and health promotion are discussed in 3.3. Concept of Lifestyle and its Impact on Health. In terms of all three

modes, the first measure proposed by the panel tackles the macro level, by increasing the capacity of the health system to cope with the increased disease burden of mental and behavioral disorders. For this, the competence of general practitioners in psychosomatic medicine to prevent, detect early, treat, or refer to mental illness could be trained through education and training to relieve psychiatrists and psychotherapists. The responsible actors here are medical associations, training centers for medical personnel, and ministries of health. This measure intends to relieve the burden on the health care system, especially on mental health workers.

Health Literacy, Mental Health Screening, and Recovery

The panel further advises deliberately bringing mental health-promoting measures into the population's working, educational, and training environments. Thus, it provides medical support to detect mental stress at transition points, such as school entry, graduation, the start of training, major exams, retirement, and every decade of a person's life. To strengthen mental health from an early age, life skills courses could be taught regularly in school. Concerning supporting family caretakers and parents, especially single parents, the suggestion arose from the panel to expand the existing short-term cure offering and make it available for the target group every few years to recover. This proposal tries to tackle the increased burden for the middle-aged group to take care of children, the elderly, and work, as those responsibilities are left to a relatively small group due to demographic change. These measures are aimed at both micro- and macro-level primary prevention through regular mental health screenings by trained personnel in the sense of early detection. As well as on the micro level through education and building of health literacy of pupils, students, and workers, as well as relief of workers and caretakers in the sense of incentives and health promotion. Legislators, educational institutions, and employers are key players in the implementation of these measures. The panel stresses that special attention needs to be paid to people with a migration background, as they belong to a more vulnerable group that is less likely to be reached by measures. This suggestion poses the challenge of reaching people who are not institutionally integrated through work and education.

Public Health Service (ÖGD)

The panel proposes to expand the Public Health Service, to maintain an overview of the development of mental health in the population, and to be able to react to it at an early stage. This includes employing more staff, holding higher university degrees, monitoring the mental health situation in Germany, and reporting regularly. The idea is to strengthen the Public Health Service’s competence as an advisory actor for German health policy, in contact with legislators, and executors of health measures at the highest levels of local,

state, and federal government. This measure thus starts at the structural level with economic means and laws.

Health Insurance and Digital Offers

Digitization in healthcare is becoming increasingly important, therefore the panel suggests the expansion of offers like telemedicine, thus online health consultations, to mitigate the burden of mental health in this scenario. This measure aims to make mental health care low-threshold and more easily accessible. The panel proposes that health insurance companies offer premiums for the regular use of these services to make primary and secondary prevention measures attractive. Focusing on the micro level through economic incentives.

Social Affairs

Various social developments also exert pressure on the mental health of the population. The tendencies toward individualization and fragmentation of society, not least due to social realities drifting apart and associated socioeconomic illnesses and regional differences in health care, disrupt social peace and have a detrimental effect on the mental health of the population. The influence of fake news and infodemics further amplifies these effects. Accordingly, the panels' mental health interventions aim to strengthen the community, strengthen social protection, and combat future anxiety caused by uncertainties. In addition, monitoring anti-democratic tendencies, promoting social discourse, and, where necessary, regulating activities on the web.

Fragmentation of Society and the Mental Health

These measures aim to promote more community activities at the workplace, in nursing homes, schools, and other educational institutions. This approach operates at the micro level in terms of primary and secondary prevention. Important actors are local governments and decision-makers in the health system. In addition to the entire population, the experts express the need to particularly consider people of lower socioeconomic status in the measures. In addition to promoting mental health through strengthened social cohesion, interventions could have climate co-benefits. A concrete example is shown below.

Community Gardens

Measures to support mental health in the form of primary prevention and health promotion can start at the micro level and make use of proximity to nature and community. An example presented by the panelists is the expansion of community gardens. Municipalities are seen as responsible for providing such initiatives and encouraging people through economic and social incentives. Further, the exchange

between generations is fostered through this measure. As a positive effect, community gardens contribute to environmental protection through local and ecological cultivation, and as a habitat for insects and small animals. The measure is mainly aimed at families, but the panel emphasizes the positive effect of community gardens on any group of people.

Stronger Regulations for the Internet

Further measures to promote social health in the sense of primary prevention via laws and regulations aim to amend laws on the use of artificial intelligence and automated chatbots when these are used for the targeted dissemination of disinformation. The panel expresses the need for standardized regulations at the state and federal levels by lawmakers as key actors. This measure would support mental health in the population by combating social division.

Climate Change Impact on Mental Health

Climate change and its consequences, or even the fear of these, harm mental health. Measures using the synergy of mental health promotion and environmental protection are therefore favored by the panel.

Urban Planning

At the macro level, suggestions to shift the focus of urban planning from a car-oriented infrastructure to non-motorized transport were discussed in the panel. This includes the expansion of public transportation and safe bicycle lanes. Increased mobility could contribute to a healthier lifestyle and thus also promote mental health, while infrastructural changes are expected to have positive effects on the climate. To protect vulnerable groups, it was proposed to promote electric mobility for people with disabilities, for instance. Additionally, to make public transport affordable for all social classes. The responsibility to carry out those measures is placed on the macro level by the municipal urban planning authorities and administration, whereby the entire population is seen as the target group. Further, political decision-makers and legislative bodies are called upon to create the legal framework and make resources available. A panelist also addressed the encouragement of companies and organizations to make climate-friendly investments due to attractive capital allocation criteria. Means of subsidy, tax relief, and higher taxation could also be used here to steer climate-friendly and mobility-enhancing infrastructural investments.

Planetary Health Diet

This aspect overlaps with the following paragraph. However, the panel promotes making the Planetary Health Diet, which is predominantly plant-based, more affordable

and attractive. A plant-based diet is suggested to have a positive impact on the climate, as well as on mental and physical health. On the one hand, incentives at the individual level are proposed to target higher taxation of non-plant-based food and reduce taxes on plant-based food. On the other hand, strengthening knowledge about nutrition through educational initiatives. Through legislative changes and attractive capital allocation criteria for companies, the panel expects a promotion of such a diet in the public food supply, thus canteens and cafeterias.

Increase in Certain Diseases

In the Mental Health Inferno scenario, in addition to the increase in mental health burden in the population, other diseases, especially typical diseases of old age and lifestyle-related diseases, have experienced growth. The first category includes, for example, diseases of the nervous system and sensory organs, while the second one means obesity and overweight, especially in younger people. The causes of obesity are explained by the panel among other reasons through malnutrition and the influence of advertisements for unhealthy food. Measures regarding these problems, suggested by the panelists, are aimed at improved primary, secondary, and tertiary prevention of age-related diseases, as well as creating incentives to enable healthy lifestyle changes. The trends toward overweight and obesity are proposed to be countered by economic incentives, such as higher taxation of unhealthy foods, tax relief for healthy foods, and advertising bans for unhealthy foods. The measures are aimed primarily at young people and socially disadvantaged people. The panel calls upon legislators at the federal level to act in this area, above all to exert greater control over the food industry and protect vulnerable groups. Since a healthier lifestyle is usually accompanied by co-benefits for environmental protection, positive effects on climate protection can be expected from these measures.

5.3.2 Policy Implication for the Socio-economic Mortality Patterns Scenario

“Economic change away from the competition- and growth-oriented system of market logic, which is based on and perpetuates inequalities, towards a sufficiency and cycle-oriented system. Everything else has a maximum socially compensatory effect” (Panelist 10).

Expansion

Health Literacy

The panel outlines the problem that health literacy, as a dimension of prevention and health promotion, is a competence that not all social groups in society have the same

opportunity to acquire. Therefore, the need was expressed to conceptualize measures, both with respect to the availability of and access to socially sensitive and responsive health literacy within wider programs. The proposals to expand health literacy are the same as for the mental health inferno but with a stronger emphasis on reaching people with migration backgrounds, different socioeconomic layers, ethnical groups, and families. Thus, besides educational institutions and employers, the communal administration is seen as the key player in reaching all people through neighborhood activities. The intervention can be classified as primary prevention in form of education or training to target the individual level.

Public Health Service (ÖGD)

The suggestion of the panel to expand the competencies of the Public Health Service has been discussed in the context of the Mental Health Inferno scenario. The measure is also proposed to tackle issues of the Socioeconomic Mortality Patterns scenario.

Assisted Suicide

A stark increase in the prevalence of mental and behavioral disorders, Alzheimer and Dementia resulted from the first Delphi round. The panelists thus mention the higher demand for assisted suicide. This intervention requires a clear legal situation resolved by the legislature at the state level.

Regulations

Stronger Regulations for the Internet

To foster social coherence the need for stronger regulations concerning artificial intelligence and automated chatbots was discussed for the implications of the first scenario. The panel discussed this measure again in the context of socioeconomic differences.

Regulation of Advertisement

Also, the regulation of unhealthy advertisements has been debated already. The experts emphasize the vulnerability of social groups towards this kind of advertisement with implications for their lifestyle choices. To protect those, the panel is demanding more legal intervention on the state and federal levels.

Adaption

Infrastructure

In the first round of data gathering, the panel described the impact of climate change-related extreme weather events on the infrastructure. Consequently, the spread of pathogens and damage to the healthcare infrastructure is fostered. Leading to a medical

care undersupply and sickening from pathogens. The panel thus demands government investments in adapting the infrastructure to extreme weather events. Further, promoting drug development to enable rapid action when new pathogens emerge.

Economic Change and Climate Change Mitigation

The panel outlines the problem of the competition and growth-oriented neoliberal market logic, which is driving climate change and perpetuating inequities in society. They draw the conclusion that economic change toward a sufficiency and cycle-oriented system is needed. This intervention can be located on the macro level, as a demand for system change. Climate change mitigation and the closing of the social gap are seen as expected outcomes of such. Generally, the need for environmental health within public health measures on the state and federal levels was mentioned to reduce the climate change hazards to health.

5.3.3 Policy Implication for the Disturbed Human-Environment Relationship Scenario

Climate Change Impact on Health

Environmental Protection and Health Promotion

The panel defines the alienation of humans from nature as a problem in the Disturbed Human-Environment Relationship scenario. This implies for all health policies to consider activities that join health and environmental aspects. As a concrete example, community gardens were mentioned previously. As another example, insect hotels are mentioned. The panel thereby admits that not the examples given are driving big change, but that they are seen as a template for a multitude of interventions that in sum have an impact. Those interventions are thought to be implemented in the population's environment, such as workplaces, schools, and so on.

Heat and Ultraviolet (UV) Exposure

A panelist outlines the problem of heat causing increasingly more deaths in 2060 in the course of climate change and argues, that the issue is even more severe than described in the Disturbed Human-Environment Relationship scenario. Further, the increase in death rate and prevalence of diseases through chronicle ultraviolet exposition is problematized here. The expert lists actinic keratoses, malignant melanomas, non-melanocytic skin cancer, basal cell carcinoma, squamous cell carcinoma, and so-called 'white skin cancer' as concrete examples of resulting diseases.

Several vulnerable groups are assigned to the described issue. Firstly, people who mainly work outside and thus experience a lot of heat exposition. Secondly, privately

spending longer time outside, for example in leisure time. Thirdly, small children's and older people's bodies are more vulnerable to heat. Lastly, people suffering from multimorbidity, thus having previous illnesses are highly vulnerable to extreme temperatures. Their previous illnesses might worsen from the extreme temperature events. Within the panel discussion, this aspect was brought up as it was not stressed enough in the scenario description. However, policy implications were not derived from the statement.

Research and Education

In order to mitigate climate change's impact on health, the panel describes the need for developing strategic health policies that are based on both, natural sciences and systematic public health research. Two strategies are proposed in this context. First, the 'Strategy of One Health', within this approach knowledge about the inextricable intertwining of human health, animal health, and ecosystem health is advocated by research. Second, the implementation of 'Health-in-all-policies' (HiaP) at all political levels. The panel proposes to strengthen the public health field in this regard by reinforcing special programs and providing funding for research at universities. Further, the build-up of prestigious schools of public health in all federal states in Germany, as cooperative research of primary research institutions with the Public Health Service at the communal level through Public Health Departments, state level through State Health Offices, and the federal level through Federal institutes of public health. And strengthening the Public Health Service at the European Union level through the European Centre for Disease Prevention and Control (ECDC) by building a stronger network with European public health schools. Further, on the international level, for example through strengthening United Nations Organizations and sub-organizations regarding public health. The focus of the proposed internationally well-connected research network is aimed to be on novel challenges and the mechanisms by which the novel entities affect health. Additionally, it provides a sustainable infrastructure for both, natural science, and systemic public health research. The intervention discussed can roughly be classified as research and education. In the view of the panel the preferred outcome is an interactive science policy practice network in the sense of 'Health-in-all-policies' (HiaP) rooted in a theoretically reflected and science-based One-Health, respectively Planetary-Health, framework.

Expansion

Public Health Service (ÖGD)

As discussed in the realm of the previous scenarios, an expansion of the competence of Public Health Service is proposed by the panel to monitor public health developments closely. Additionally, it is suggested to reinforce the Public Health Service through cooperation with graduate and postgraduate programs of high-ranking research

institutions, embedded in a network within the European Union and beyond. Also, the panelist is demanding for the Public Health Service to organize a national scientific meeting on novel challenges annually in cooperation with national or European organizations. The aim is to publish a health report out of that meeting, which is then presented to the respective legislative bodies at the state, national, or supranational level. This is an addition to the corresponding proposal to the previous scenarios. Basically, this measure aims to provide political actors with enough information on developments to enable timely action. It aims to improve and expand the generation and flow of information.

Regulations

Stronger Regulations for the Internet

As discussed previously, a panelist is demanding stronger regulation of artificial intelligence to counteract misinformation also in the case of the Disturbed Human-Environment Relationship scenario.

5.3.4 Policy Implication for the Anticipatory Policy Scenario

Expansion

Strategic Health Policies

An expert from the panel defines the Anticipatory Policy scenario as a major challenge for the public space. That person expresses the aim to develop novel strategic health policies that are based both on natural science and systemic public health research. The intervention consists of an ongoing feedback loop in policy development with the aid of the sciences mentioned, as a Public Health Action Cycle. The Public Health field is defined as the actor to focus the realization of the Public Health Action Cycle at all levels, communities, state level, federal level, European Union level, and international level, also by supporting a health-in-all-policies approach. Public Health Research provides information as ‘knowledge brokers’, especially in the evaluation of complex interventions. As discussed previously, the expansion of Public Health schools and educational institutions is proposed in the realm of this scenario. The panelist described the preferred outcome of this measure as an ongoing quality development by a Plan-Do-Check-Act Action Cycle, with an ongoing correction and adaption of health policy measures. The intervention is of research and government expenditure kind, to build the research network proposed.

Public Health Services (ÖGD)

The previous scenarios have discussed expanding the Public Health Services for monitoring and reporting purposes. However, for the Anticipatory Policy scenario, the role of the Public Health Service is discussed to publish regularly on the state of affairs as part of the Plan-Do-Check-Act Action Cycle (PDCA) discussed in the previous section. It is proposed to present the Health Report to the respective legislative bodies at the national, or supranational level.

Independence in Drug Supply

A problem detected by the panel is the dependence on drug supply on uncertain partners. As a solution, government expenditure as an invention is proposed which aims to invest largely in the domestic pharmaceutic industry.

Environmental Protection

The measure of mitigating climate change to reduce its impact on health has been discussed in the course of other scenarios already and is mentioned again within this scenario's implications.

Preventive Measures

Within the first Delphi round measures have already been discussed. One of those targets is the further expansion of preventive measures, such as the human papillomavirus (HPV) vaccination against cervical cancer or colorectal cancer screening, as examples. The aim of this intervention is to foster a decline in malignant neoplasms. This measure can be seen as a primary preventive intervention that requires an investment in the expansion of the prevention offer for the patient.

Restrictions

Transportation

Within the Anticipators Policy scenario, the current problem of polluted air is pointed out by the panel during the first round of data gathering. As a solution, restrictions on internal combustion engines and individual transportation are projected. The expected outcome is improved air quality, resulting in a decline in diseases of the respiratory system, more safety on the road, and a decline in traffic accidents. The intervention can be classified as laws and prohibitions.

Stronger Regulations for the Internet

To foster social coherence the need for stronger regulations concerning artificial intelligence and automated chatbots was discussed for the implications of the previous scenarios. The panel discussed this measure again in the context of anticipatory policy.

Tobacco Consumption

Also arising from the first round's discussion, stricter regulations for the tobacco industry and expansion of the non-smoker's protection are proposed to mitigate the impact of tobacco usage on health. The measure is expected to lead to a decline in diseases of the respiratory system. The intervention belongs to the category of laws and prohibitions.

Advertisement and Plant-Based Diet

Another intervention suggested in the first Delphi round targets the problem of malnutrition and harming diet patterns. The idea is to foster predominantly plant-based and healthier diets in the public space, to contribute to human and planetary health. Further, the ban on advertisements of unhealthy food is proposed. The measures target people in their private lives but predominantly at work and educational institutions where food is consumed in public spaces. The expected outcome described is a decline in malignant neoplasms and digestive system, nutritional, and metabolic diseases. Especially people who are more likely to follow an unhealthy diet, predominantly men or people of lower socioeconomic status, are suggested to profit from those measures.

5.3.5 Policy Implication for the Gender-Specific Health Scenario

Three remarks occur in the discussion of the policy implications for the Gender-Specific Health scenario. Firstly, the need is expressed for the government to invest more in gender medicine to tackle gender-specific health issues better. Secondly, the scientific community is invited to research increasingly under the consideration of sex as a dimension to provide information about gender-specific health. Thirdly, an agreement is expressed within the panel that this scenario could be incorporated in the four remaining scenarios, as this dimension is regarded as crucial for the others. Thus, all policy recommendations stated for the Gender-Specific Health scenario also apply to the other scenarios.

Within the first Delphi round, two measures were already mentioned as affecting factors on mortality. First, occupational health and safety measures were implemented strongly over the past decades, which led to the assumption in the first round, that those measures will get stronger, likely reducing mortality further in the category of external causes, such as injuries and poisoning. The same assumption is suggested for prevention through helmets and protectors, as well as an improved safety system in the motor vehicle industry. The main actors are employers and the production industry. Further, political actors can expand safety regulations and advertise using safety gadgets in their leisure time. However, other panelists who expected a rise in mortality in this category were assuming an increase because of climate change impacts, for example, flooding.

6 DISCUSSION

In what follows, the results of the study are discussed in the realm of the statements made in the chapter on the state of research, the results presented, and used to support or challenge the hypotheses derived from the theoretical chapter. In addition, the research questions shall be answered at this point.

Life expectancies forecasted for 2030-2060 derived from the present study are in any case the lowest values compared with estimations from the state of research (see Section Life Expectancy Forecasting for the Case of Germany; Table 6 Life Expectancy Forecasting Germany 2030-2060 - A Comparison), followed by the reference material of Destatis (2022b). All other presented models exceed Destatis (2022b) values. It can be observed that older publications tend to have higher life expectancy estimations. Apparently, younger publications were influenced by more recent trends slowing down the curve of life expectancy. The outcome of lower life expectancy forecasting values of this study is in line with the just-described decreasing trend of the past decades.

Table 6 Life Expectancy Forecasting Germany 2030-2060 - A Comparison

Year	Female			Male			Source
	Low	Average	High	Low	Average	High	
2030	83.3	83.8	84.4	78.0	79.0	80.0	Own results
	83.9	84.4	84.9	79.4	79.9	80.4	Destatis (2022b)
	.	.	85.8	.	.	81.3	Fuchs et al. (2018, 45)
2040	82.4	83.8	84.6	77.4	78.9	80.1	Own results
	84.5	85.4	86.3	80.3	81.2	82.0	Destatis (2022b)
	.	.	87.2	.	.	83.1	Fuchs et al. (2018, 45)
2050	81.7	83.7	85.1	77.0	78.9	80.5	Own results
	82.9	85.4	87.7	79.4	81.9	84.4	Vollset et al. (2020, Appendix 2, 21)
	85.0	86.4	87.6	81.1	82.4	83.6	Destatis (2022b)
	.	.	88.3	.	82.4		Babel et al. (2006, 547)
	.	.	88.48	.	.	84.67	Fuchs et al. (2018, 45)
2060	81.4	83.7	85.7	76.2	78.6	81.2	Own results
	85.6	87.3	88.9	81.9	83.5	85.0	Destatis (2022b)
	.	.	89.6	.	.	86.1	Fuchs et al. (2018, 45)
	~ 90	~ 92	~ 95	~85	~ 90	~ 94	Vanella (2017, 550)

To answer the research questions on ‘How mortality patterns transform under the influence of climate change and lifestyle change in Germany in 2060?’ and ‘Which measures could be suitable for reacting to the transformations under investigation?’ the five scenarios on the mortality in Germany in 2060 and their corresponding policy implications as results of a policy Delphi are briefly summarized. As the first, the *Mental Health Inferno* is the second most probable, but least desired scenario voted by the panel.

It is characterized by the sharp rise in death through mental and behavioral disorders in the aftermath of multiple crises that burden the population's mental health. Other diseases are mainly able to be cured causing the mortality to decrease for other causes of death. The biggest other risk factor to health is the adiposity pandemic, leading to a stark increase in digestive system, nutritional, and metabolic diseases. Other rising causes of death are correlated with the aging population and corresponding age-related diseases, such as diseases of the nervous system and sensory organs. The life expectancy rises, while the mortality rate decreases starkly. Policy implications for the *Mental Health Inferno* scenario formulated by the panel aim to strengthen mental health care, social coherence, public health services, digitalization of health care offerings, environmental protection, healthier diets, and better lifestyle choices. While regulating the influence of artificial intelligence on mental health and enabling infrastructural change with implications on individual mobility.

Within the *Socio-Economic Mortality Patterns*, which got voted as the most probable and second most desired scenario, digestive system, nutritional, and metabolic diseases are on the rise, as well as mental and behavioral disorders, and diseases of the nervous system and sensory organs. Even though circulatory system diseases slightly decrease, they remain the main cause of death. Risks to health are distributed unevenly along the socio-economic gradient, which makes social differences the biggest factor influencing health. One result of this is a stark increase in adiposity correlating with socio-economic status. Within this scenario, life expectancy for women varies between stagnation or an increase, while male life expectancy reaches from a decrease to an increase. Generally, mortality rates seem to either stagnate or increase. Policy measures proposed by the panel for this scenario are the strengthening of health literacy in the population, especially among socially more vulnerable groups. Further expanding the public health service and regulating how to establish assisted suicide. Stronger regulations are suggested for artificial intelligence usage, and unhealthy advertisement, especially when targeted to vulnerable groups. Further, adaptions of the infrastructure to climate change impacts and economic change for the purpose of environmental protection and social justice are demanded.

The *Disturbed Human-Environment-Relationship* was seen as medium probable by the panel, as some experts doubted the extent of environmental pollution and climate change impact on the health in Germany in 2060. However, the scenario was also voted as least desired. Through climate change impact, external causes, such as injuries and poisoning are projected to rise within this scenario due to extreme weather events. Further, the hazard from novel entities is seen to foster death through diseases of the nervous system and sensory organs, as well as leading in combination with other expositions to a stark rise in malignant neoplasms. These are considered the main causes of death, also through the assumption of insufficient medical progress in cancer treatment.

Again, unhealthy diets and a predominantly sedentary lifestyle are argued to cause more death through the digestive system, and nutritional and metabolic diseases. The scenario is predominantly characterized by the risk of novel entities and climate change impact. The mortality rate is suspected to increase. Particularly important to this scenario were environmental protection and protection from heat and ultraviolet exposure, as policy implications. In addition, an expansion of research and education on public health was proposed, to include the aspect of health in every policy decision.

As neutrally probable but highly desired, the *Anticipatory Policy* scenario was assessed by the panelists. It stands out for its forward-looking health policy, which is confronted with the strong impact of climate change on health, as well as uncertainty caused by missteps in the past, such as dependence on unreliable partners. On the other hand, improvements in treatment and prevention, as well as policy measures led to a decrease in deaths of for example malignant neoplasms and diseases of the respiratory system. The biggest increase is witnessed by certain infectious and parasitic diseases in the aftermath of the destruction of natural wildlife habitats. Due to the multitude of negative influences on health, a decrease in life expectancy is expected. While the mortality rate is stagnating or slightly decreasing. In response to the challenges implied by this scenario, the panel proposed to strengthen the strategic health policies to ensure that health interests receive more attention in policies. The expansion of public health services, preventive measures, and stronger environmental protections were also emphasized. Also, the importance of investing in the national drug supply. In the sense of anticipatory policy, stronger regulations for the internet, transportation, tobacco consumption, unhealthy advertisements, and unhealthy diets were included.

Since *Gender-Specific Health* was discussed by the panel as a component of other scenarios instead of a stand-alone scenario, it got voted neutrally probable and half desired, half undesired. The scenario is characterized by the vulnerability of men's health due to gender-specific lifestyle habits. For instance, the predominantly meat-based diet of a majority of men leads to a high increase in digestive system, nutritional, and metabolic diseases, such as obesity, diabetes, and chronic intestinal diseases. But also, the tendency of men to use prevention less often led to a gender-specific increase in for example death through diseases of the urogenital system. On the other hand, there was a stronger increase in women's mortality through mental and behavioral disorders. Within this scenario, a decrease in life expectancy is anticipated, while the mortality rate is thought to stagnate or slightly increase. The panel expressed the need for higher governmental investments in gender medicine in the realm of this scenario. Further, the benefits of safety regulations and measures at work and in leisure time were reflected in this scenario.

In the chapter on the state of research, projections were presented, and in the theory section, hypotheses on mortality development were formulated. In the following, the

findings of this study will be classified in the presented state of research and hypotheses will be compared. As in other mortality forecasts, this study suggests an increase in the mortality rate through its scenarios, which corresponds with the aging population in some scenarios. Diseases connected to the aging population were also emphasized in the scenarios of *Socio-Economic Mortality Patterns*, *Disturbed Human-Environment Relationships*, and *Gender-Specific Health*.

The policy implications of Pöttgen et al. (2011) to smoke less, be more active, enforce healthier diets, foster social inclusion, and provide more psychological support were also suggested by the experts of this panel. As tobacco regulation in the *Anticipatory Policy* scenario, more activity in the *Mental Health Inferno*, and *Socio-Economic Mortality Patterns* scenarios, healthier diets within the *Mental Health Inferno*, *Anticipatory Policy*, *Socio-Economic Mortality Patterns*, *Anticipatory Policy* scenarios. And lastly, social inclusion and psychological care in the *Mental Health Inferno* scenario. As well as the limitations of vehicles, environmental protection, and community gardens were found through a literature review and were later suggested by the panel. In the case of vehicle limitations in the *Mental Health Inferno*, *Anticipatory Policy*, and *Socio-Economic Mortality Patterns* scenarios. Environmental protection in the realm of the *Socio-Economic Mortality Patterns*, *Disturbed Human-Environment-Relationship*, and *Anticipatory Policy* scenarios. And lastly, community gardens are implied for the scenarios of *Mental Health Inferno* and *Disturbed Human-Environment-Relationship*.

Morbidity as described in Blüher and Kuhlmey (2016, 315-316) cannot be sufficiently substantiated with results on mortality, as these are two different concepts. However, evidence can be found from the scenario descriptions that the medicalization, or expansion, theory can be supported by the *Disturbed Human-Environment Relationship* scenario. As, the scenario storyline increasingly refers to the rise of diseases, without fatal consequences, because of lifestyle and climate change influences. This could support an expansion of morbidity, and thus a declining quality of life. Furthermore, the compression thesis could be supported by the *Mental Health Inferno*. In this scenario, most diseases decline sharply due to major medical advances. A decline in morbidity would thus be conceivable. In addition, the *Socioeconomic Mortality Patterns* scenario could support the mixed form of bi-modality, where morbidity differs strongly by factors such as socioeconomic status. Lastly, the *Anticipatory Policy* and the *Gender-Specific Health* scenarios might not support any of the theses. Since a basic assumption of morbidity theories is a steadily increasing life expectancy, the two scenarios just mentioned cannot support any of the theses due to their projected declining life expectancies.

Further, Rapp and Klein (2020, 194) stated obesity as the most prevalent health hazard of the future. This thesis was thus also advocated with varying intensity in all scenarios. As well as the recommendations of Rapp and Klein (2020, 206; 195) concerning targeting with a special focus on people of lower socio-economic status with public health measures

and fostering vegetarian and vegan diets were proposed by the panel for most scenarios. The need expressed by Rapp and Klein (2020, 196) to foster physical activity and sports was less addressed in the policy recommendations of this study. It was mentioned once in connection with infrastructural measures to change mobility behavior.

The study's life expectancy estimations are below other projections, such as for instance the Federal Statistical Office, which also has a higher Gender Gap in life expectancy. The gap, however, might be unintentional due to the indication through a cursor, not by stating an exact number. The life expectancy indication was rather focused on the direction of the curve than on the exact number. A slowing down of the life expectancy curve could be witnessed in Destatis (2019), Vollset et al. (2020) projections, and in this study. Within this study, some scenarios expected a decrease in life expectancy, but even the increasing life expectancy projections indicate a slowing down of the curve. As for the hypotheses, Ebeling et al. (2018, 377) assume a continuous rise in life expectancy and an increase in life expectancy equality due to improvements and measurements in the future. As lifestyle and climate change-related decreases in life expectancies were among the projections of the panelists, the continuous life expectancy hypothesis cannot be supported by this study. Similarly, Carlsson (1976, 387-388) assumes that the future will be a better version of today with implications for the development of mortality. As one of the main findings, the estimated trend of stagnating or decreasing life expectancy, together with an increase in mortality in some scenarios, this assumption gets challenged through the study's results.

To summarize, the study's results are in line with many findings of other studies in the available literature, however, a few statements were challenged, for instance, the assumption of a continuous growth in life expectancy or the perpetual improvement in mortality.

6.1 Conclusion

This chapter aims to conclude the thesis by highlighting its major findings and a critical assessment of its limitations regarding the research set-up. Overall, the research process proved itself and laid the foundation for the relevant results of this thesis. Key elements of the set-up will be discussed, such as expert matrix, panel selection, questionnaire, Delphi rounds, drop-out rates, and data analysis. Further, a wild card scenario and an early sign are mentioned, as well as suggestions for follow-up research.

First of all, some categories of the expert matrix were underrepresented, leading to biases in the outcome, for instance, there might have been an over-emphasize of the public health sector in the second Delphi round due to an overrepresentation of experts from that field. While other areas, such as environmental research, have been underrepresented in

both rounds. However, the gender ratio was equally distributed, and the panelists were carefully selected in the sense of Gordon (2009, 7) to compensate for the lack of quantitative data. In addition, ethical research standards were adhered to as the panelists were assured anonymity and this was maintained throughout the process.

Some participants were more active than others, which made them more influential on the study results, and few panelists dropped out during the process. However, the discourse among the panelists is likely to have intervened on this issue. As a further quality-ensuring aspect of the panel, it should be highlighted that no 'snowball' system, thus the referral of experts from other panelists has been applied to this study (Tapio 2002, 86). Another bias might have occurred by asking experts in a specific field to create general policy recommendations, thus exceeding their competencies (Niederberger & Renn 2018, 47). Again, the agreement that was expressed for other proposals in the panel discussion from experts of different fields can be regarded as a control body for the quality of the statements.

Concerning the questionnaire, issues with the length and unclear conceptions were raised by some panelists. Which was intended to be counteracted by pre-tests. A general issue Vanella and Deschermeier (2020, 516) mentioned regarding the 'translation' of experts' knowledge into statistical data might have also occurred in this study in the context of causes of death growth rate and life expectancy curve development estimations. Nevertheless, this study did not require the findings to be translated into exact parameters for forecast models. The aim was merely to identify the rough direction and intensity of developments as well as the reasons for them, which was also achieved.

Another issue was the composition of four of the five clusters based on the answers of a single participant each, representing one's notion about future mortality. However, it should be highlighted positively, that despite the relatively low number of participants, such distinct scenarios could be derived. The first round of Delphi generated meaningful scenarios.

The Delphi process applied turned out to not be the adequate format to produce sophisticated policy recommendations. To develop the policy suggestions further, an additional Delphi round to vote and rank those implications would have been needed. However, a third round of Delphi would have been too demanding for the effort of the expert panel. In hindsight, leaving policy implications out of the study and focusing on improving the five scenarios of the first round might have contributed more to the quality of the research. In the context of the panel discussion, it must be highlighted positively, that some experts actually revised their answers during the first round in the aftermath of exchanging opinions. This corresponds to the basic idea of the Delphi method. In the second round, attentive reading of other proposals could be witnessed through referrals and expressed agreement with other statements, which should be highlighted positively.

Within the cluster analysis, the risk of the artificial construction of clusters could be mitigated by verifying the discovered structure through qualitative analysis. In the second round, differences in the extent of policy recommendations development were aimed to be tackled through a systematic and traceable coding process.

Scenarios cannot be seen as an exhausted coverage of all possible future states (Glenn 2009, 18). Thus, even though meaningful scenarios on the mortality in Germany in 2060 could be derived from the study, a variety of scenarios could of course not be covered. For instance, a wild card scenario would be the participation of Germany in war, which would cause high mortality from external factors, such as violence, killing, famine, hygiene issues, and so on. This case would come with a drastic lowering of life expectancy and a corresponding increase in the mortality rate. Bell (2004, 236-237) further discussed the influence of unexpected events such as natural disasters, the spread of new diseases, mass killings, such as genocide, and the destruction of the environment as unforeseen drivers of mortality in forecasting. Due to the importance of climate change impact in this study, natural disasters, such as flooding, and the destruction of the environment have been discussed. Also, the possibility of rising deaths through violence was mentioned. However, the possibility of mass killings is not part of the study's results.

In the U.S., in addition to alcohol and nicotine usage, drug and medication abuse poses a serious risk to public health. With a steadily sharp rise in drug-related deaths, accounting for 106,699 deaths a year in 2021 (National Institute on Drug Abuse 2023). And is thus among the leading causes of death especially among those under 40 years of age (Centers for Disease Control and Prevention 2022). Destatis (2019, 37) even mentions the slowing down of the life expectancy curve partly due to drugs, in the context of the United States. This could also indicate an early sign of such a trend in Germany or other European countries. In this study, within the debate on lifestyle impacts on health, other drugs than alcohol and cigarettes have not been discussed by the experts. Only the *Socio-Economic Mortality Pattern* scenario picks up on the increasing medication and drug abuse in the aftermath of the increase in mental and behavioral disorders. Therefore, the factor of medication and drug abuse might have been overlooked in this study. Another submerged aspect might be cultural and technological innovations in the second round of Delphi (MacKay & Tambeau 2013, 677). As in the policy recommendations, little investment in medical innovation and generally no technical solutions have been presented.

As a follow-up it would be interesting to apply concepts to the study’s result, to measure to which extent death could be avoided, for example through the burden of disease or amenable death (see Hoffmann et al. 2013). Furthermore, the present study indicated significant socioeconomic- and age-related differences in mortality, that could be investigated further in follow-up research.

Within this study, the scope focused on what people will die off and when. If a scenario like the *Mental Health Inferno* comes true, in which most of the causes of death become

treatable, ethical questions on ‘what is desirable to die off and when?’ and ‘Is death becoming a choice?’ emerge. Those questions present themselves as a crucial debate in the sense of quantity versus quality of life discussed by Bell (2004, 252). Further, in the realm of the *Socio-Economic Mortality Patterns* scenario, the ethical issue of assisted suicide was touched upon. If death is becoming a choice through declining mortality, will assisted suicide become an important cause of death? This topic has been controversially discussed for decades and even more intensively in recent years. While other countries, such as Switzerland, have a clear legal case for euthanasia, the legal situation regarding assisted suicide remains diffuse after two recent draft laws regulating it were rejected by the German Bundestag (Deutscher Bundestag 2023). This study contributes to the research base by displaying the possible increasing need in the future for assisted suicide, and thus the urgent need for a legal situation.

The study showed the advantages of using the Delphi method in demography, a field in which it has been used less, with its outcome of five scenarios on possible mortality composition and a set of corresponding suggestions for policy making. In addition, as one of the most important findings, the study gives an indication of a slowing down of life expectancy or even a decreasing trend. Although nothing in life is certain but death, this study has helped to reduce uncertainty about mortality trends by providing five scenarios for mortality in Germany in 2060.

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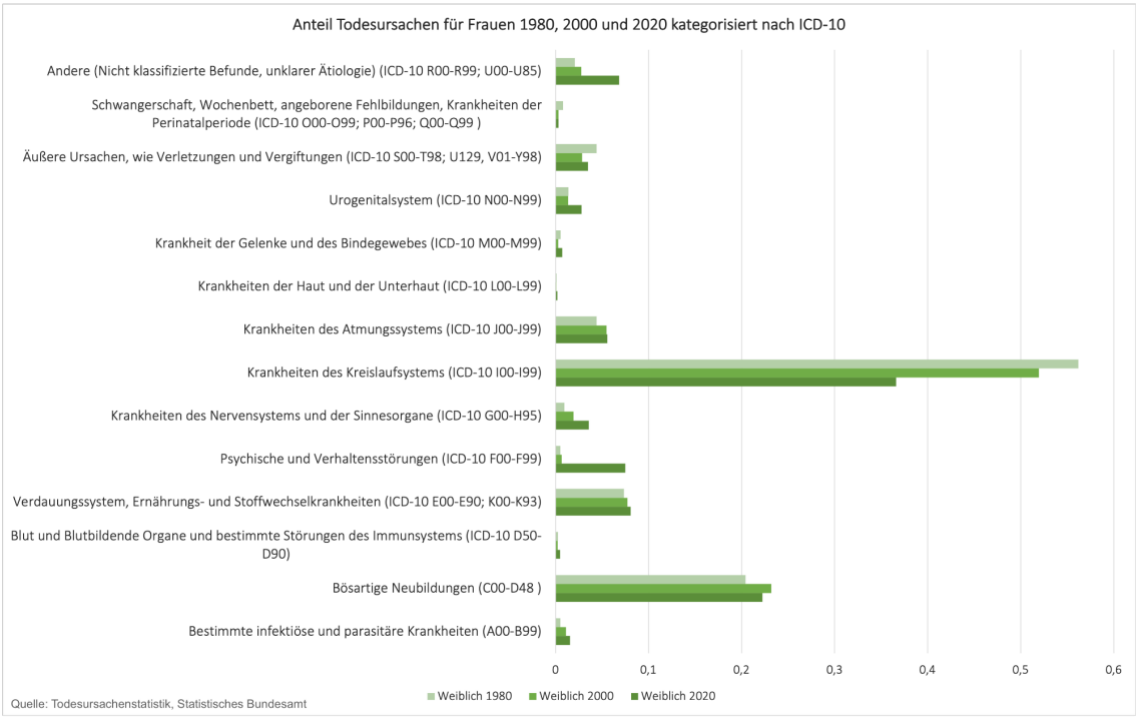
APPENDICES

Appendix 1 Questionnaire of the First Round

1. Mortalität von Frauen in Deutschland 2060

1.1. Entwicklung der Todesursachen von Frauen

Nehmen Sie sich bitte zunächst etwas Zeit, um an die aktuelle Public Health Situation von Frauen in Deutschland zu denken und wie sich diese in den letzten 40 Jahren verändert hat. Dieser Denkprozess soll durch den nachstehenden Graphen unterstützt werden, welcher den prozentualen Anteil von Todesursachen an allen Sterbefällen von Frauen in 1980, 2000 und 2020 zeigt. Die Todesursachen sind in 14 Kategorien nach ICD-10 Standard zusammengefasst. Ungefähr die Hälfte der Todesursachen blieb in den letzten 40 Jahren unverändert. Tod durch Krankheiten des Kreislaufsystems nahmen jedoch über die Zeit ab, während Mortalität im Zusammenhang mit psychischen Erkrankungen und Verhaltensstörungen anstieg. Auf den folgenden Seiten werden Sie die Wachstumsrate für 12 dieser Kategorien im Jahr 2060 schätzen.



K1: Bestimmte infektiöse und parasitäre Krankheiten bei Frauen

Bitte denken Sie einen Moment über die Entwicklung der Todesursachen in den letzten 40 Jahren nach, unter Einfluss von Lebensstil, Klimawandel, sowie technischen und medizinischen Innovationen. Überlegen Sie dann, was das für die nächsten 40 Jahre in Bezug auf Mortalität bedeutet. Richten Sie Ihren Fokus auf das Jahr 2060. Denken Sie an

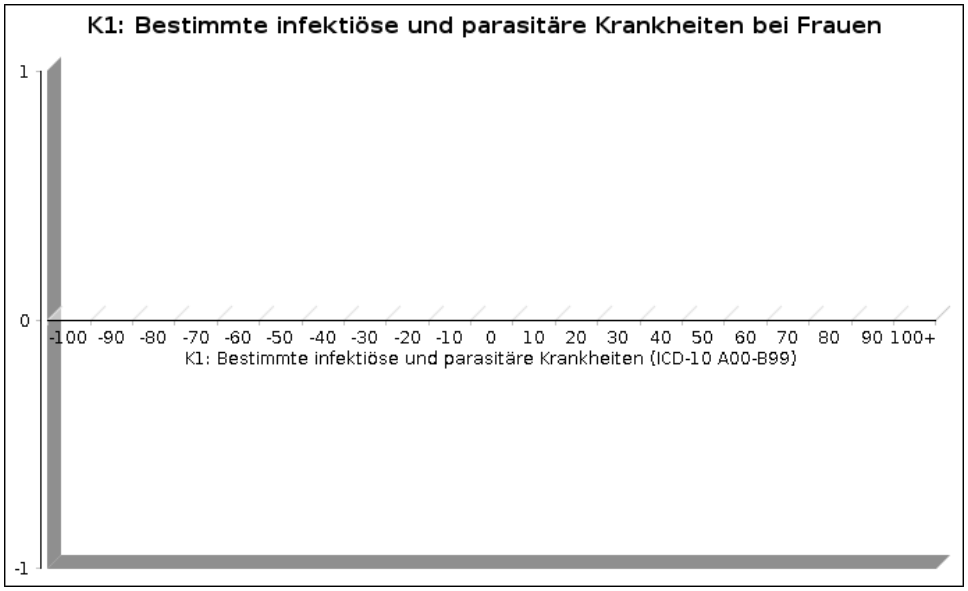
Innovationen, Klimawandelfolgen und Lebensstiländerungen, die Deutschland wahrscheinlich prägen werden.

Im Folgenden werden Sie den Großteil aller Todesursachen nach ICD-10 Standard in 12 Kategorien zusammengefasst sehen. Bitte schätzen Sie für jede Kategorie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch eine bestimmte Todesursache im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Erklärung: Angenommen, es gibt 100 Todesfälle durch eine bestimmte Todesursache im Jahr 2020. Wenn die Anzahl der Todesfälle bis zum Jahr 2060 um weitere 100 ansteigt, würde dies eine Zunahme um 100% bedeuten, da die Anzahl der Todesfälle verdoppelt würde. Wenn die Anzahl der Todesfälle um weitere 50 ansteigt, würde dies eine Zunahme um 50% bedeuten, da die Anzahl der Todesfälle um die Hälfte steigt. Ein Wert von -100 würde bedeuten, dass die Anzahl der Todesfälle um 100% zurückgehen wird, während ein Wert von 100+ bedeuten würde, dass die Anzahl der Todesfälle um 100% oder mehr ansteigen wird.

Unter K1: Bestimmte infektiöse und parasitäre Krankheiten (ICD-10 A00-B99) fallen Infektionskrankheiten, wie bspw. Lungenentzündung, sexuell übertragbare Krankheiten, Tuberkulose, Malaria oder Magen-Darm-Viren.

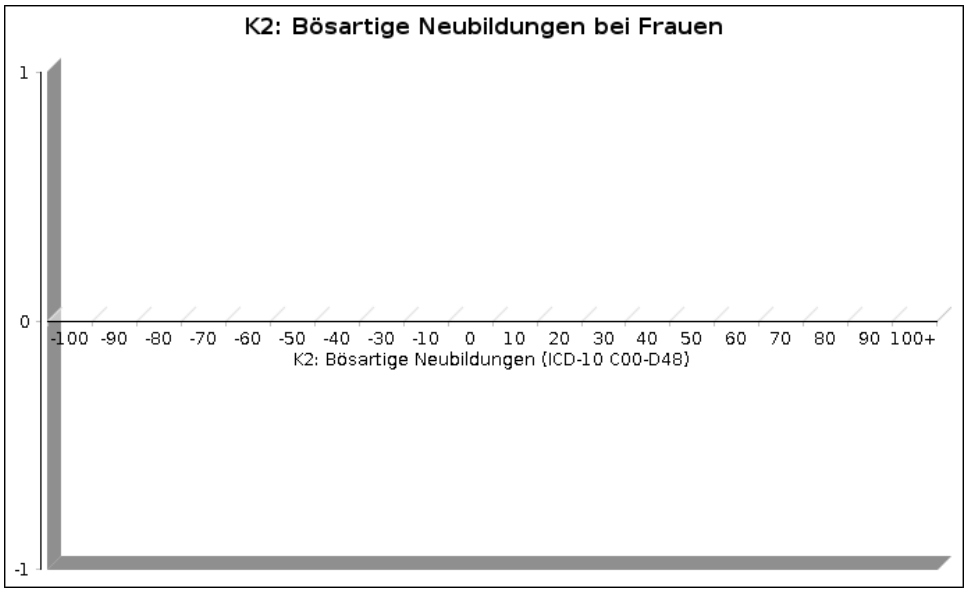
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



K2: Bösartige Neubildungen bei Frauen

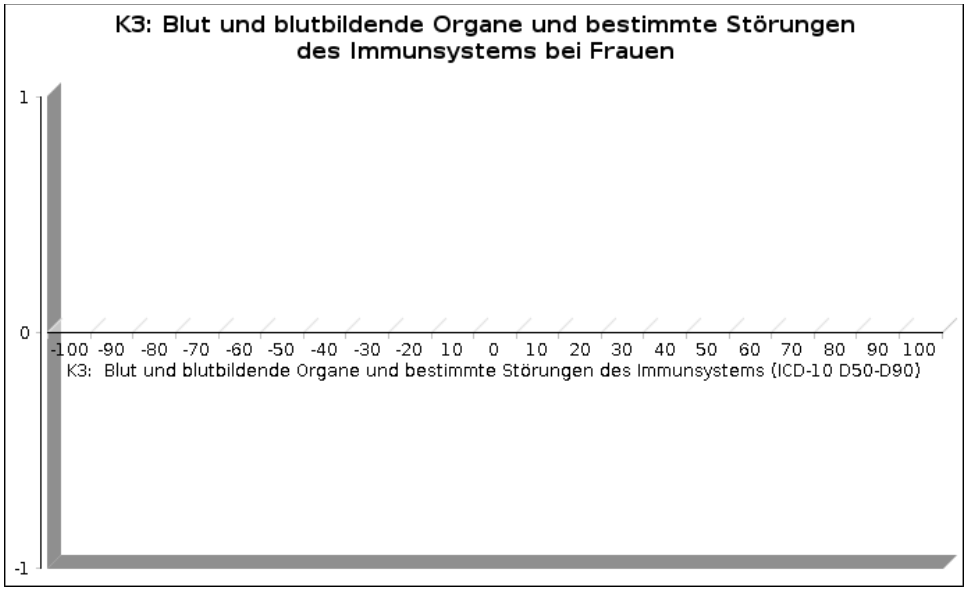
Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K2: Bösartige Neubildungen (ICD-10 C00-D48) im Jahr 2060 im Vergleich zum Jahr 2020

zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K2: Bösartige Neubildungen (ICD-10 C00-D48) fallen Krebserkrankungen, wie bspw. Lungen-, Brust-, Darm-, Prostata- und Bauchspeicheldrüsenkrebs.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



K3: Blut und blutbildende Organe und bestimmte Störungen des Immunsystems bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K3: Blut und blutbildende Organe und bestimmte Störungen des Immunsystems (ICD-10 D50-D90) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K3: Blut und blutbildende Organe und bestimmte Störungen des Immunsystems (ICD-10 D50-D90) fallen Blutkrankheiten, wie bspw. Leukämie und Lymphome, also eine bösartige Erkrankung des Lymphsystems. Aber auch Anämie, also die Abnahme der roten Blutkörperchenanzahl zählt zu diesen Krankheiten.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

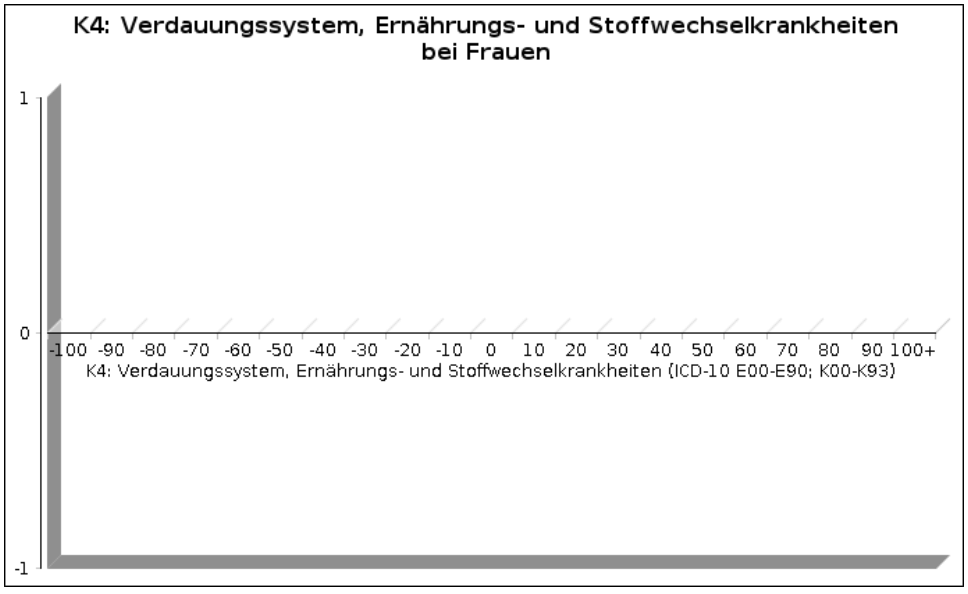


K4: Verdauungssystem, Ernährungs- und Stoffwechselkrankheiten bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K4: Verdauungssystem, Ernährungs- und Stoffwechselkrankheiten (ICD-10 E00-E90; K00-K93) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

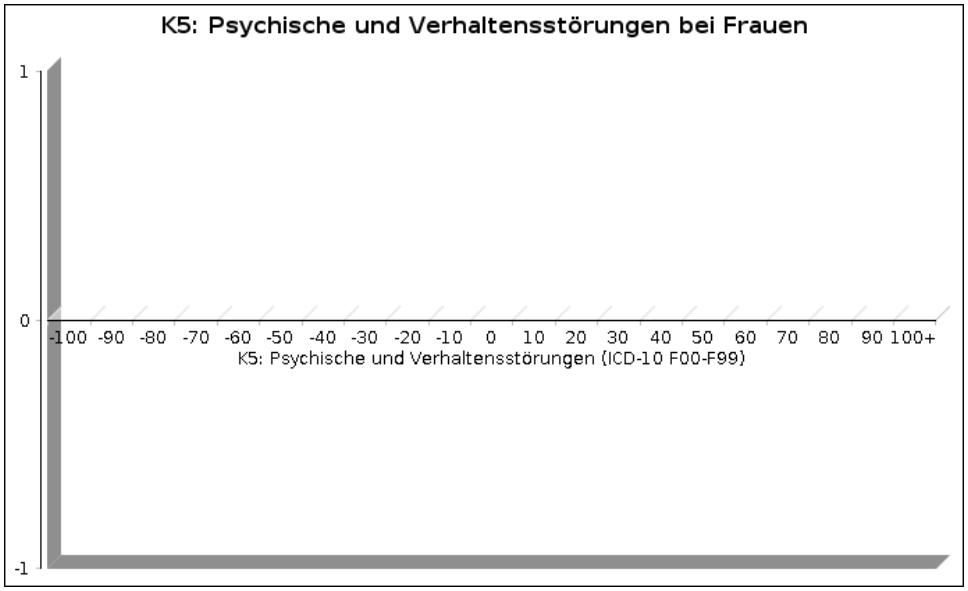
Unter K4: Verdauungssystem, Ernährungs- und Stoffwechselkrankheiten (ICD-10 E00-E90; K00-K93) fallen Krankheiten, wie bspw. Diabetes mellitus, Adipositas, Schilddrüsenerkrankungen, Lebererkrankungen und Darmkrebs.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



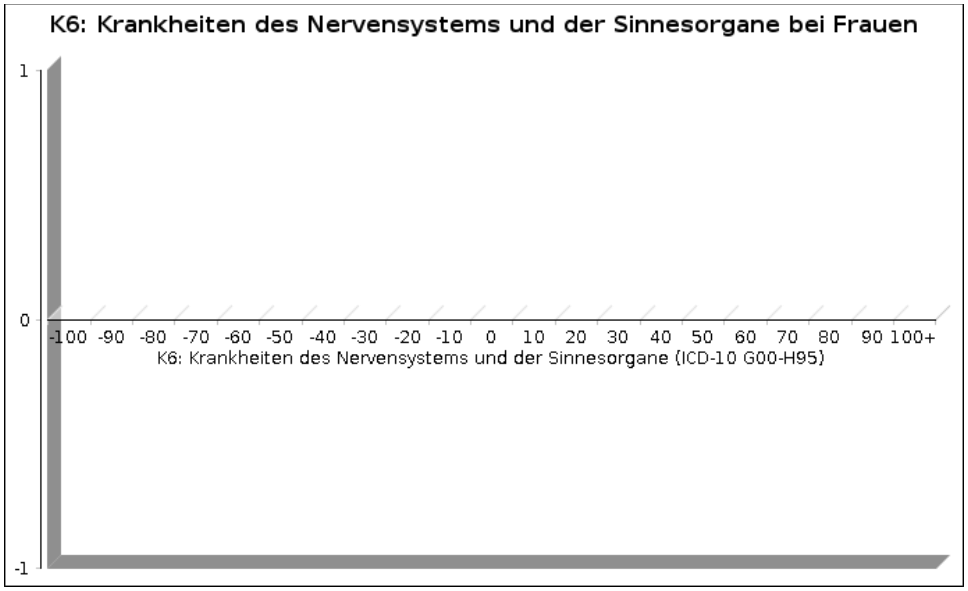
K5: Psychische und Verhaltensstörungen bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K5: Psychische und Verhaltensstörungen (ICD-10 F00-F99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K5: Psychische und Verhaltensstörungen (ICD-10 F00-F99) fallen Krankheiten, wie bspw. Depression, Schizophrenie, Angsstörungen und Demenz. Psychische Erkrankungen stehen erhöht im Zusammenhang mit Suizid und Drogenmissbrauch.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



K6: Krankheiten des Nervensystems und der Sinnesorgane bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K6: Krankheiten des Nervensystems und der Sinnesorgane (ICD-10 G00-H95) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K6: Krankheiten des Nervensystems und der Sinnesorgane (ICD-10 G00-H95) fallen neurologische Krankheiten, wie bspw. Alzheimer, Parkinson, Migräne und Epilepsie.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

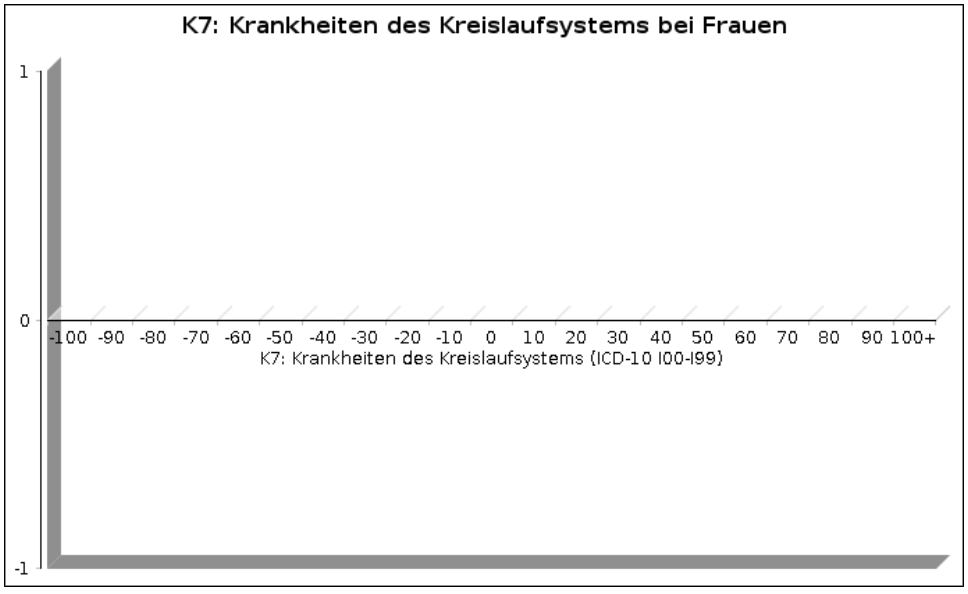


K7: Krankheiten des Kreislaufsystems bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K7: Krankheiten des Kreislaufsystems (ICD-10 I00-I99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

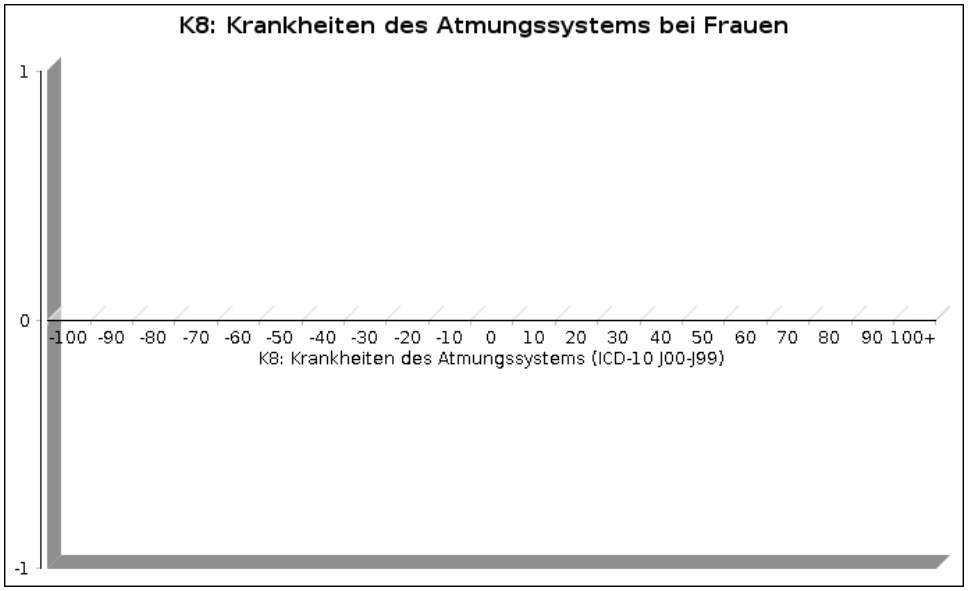
Unter K7: Krankheiten des Kreislaufsystems (ICD-10 I00-I99) fallen Krankheiten des Herzens und der Blutgefäße, wie bspw. Bluthochdruck, Herzinsuffizienz, Schlaganfall und koronare Herzkrankheiten, also Ablagerungen durch Fett und andere Substanzen auf der Arterie, die zu einer verringerten Durchblutung des Herzens führen kann.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



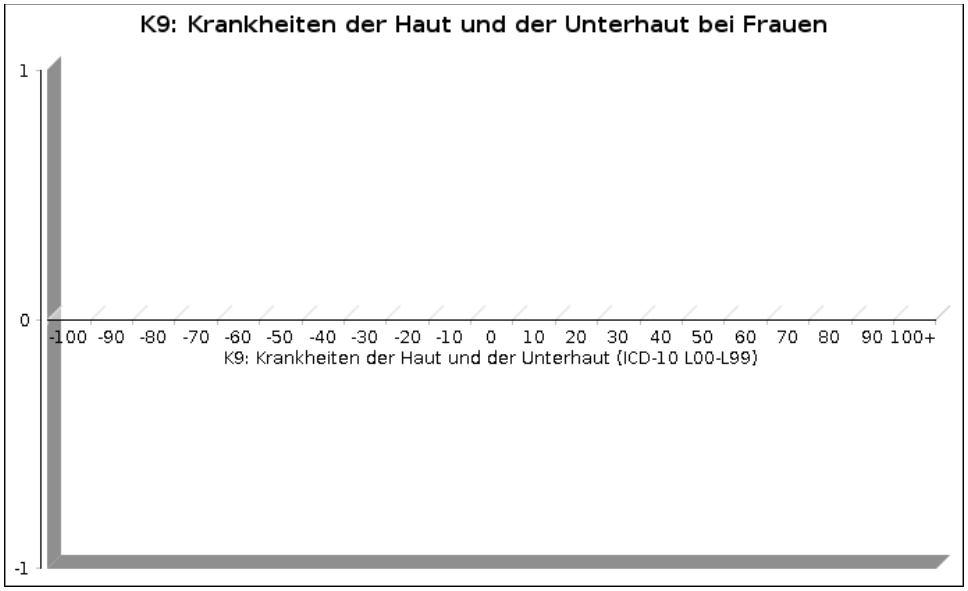
K8: Krankheiten des Atmungssystems bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K8: Krankheiten des Atmungssystems (ICD-10 J00-J99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K8: Krankheiten des Atmungssystems (ICD-10 J00-J99) fallen Lungen-, Atemwegs- und Nasenhöhlenkrankheiten, wie bspw. Asthma bronchiale, Lungenentzündungen, Lungenkrebs und chronische obstruktive Lungenerkrankungen, also eine Verrengung der Atemwege, die zu Atemnot und Husten führt.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



K9: Krankheiten der Haut und der Unterhaut bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K9: Krankheiten der Haut und der Unterhaut (ICD-10 L00-L99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K9: Krankheiten der Haut und der Unterhaut (ICD-10 L00-L99) fallen Krankheiten, wie bspw. Hautkrebs, Ekzeme und Dermatitis, sowie Psoriasis, eine chronische Hautentzündung.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

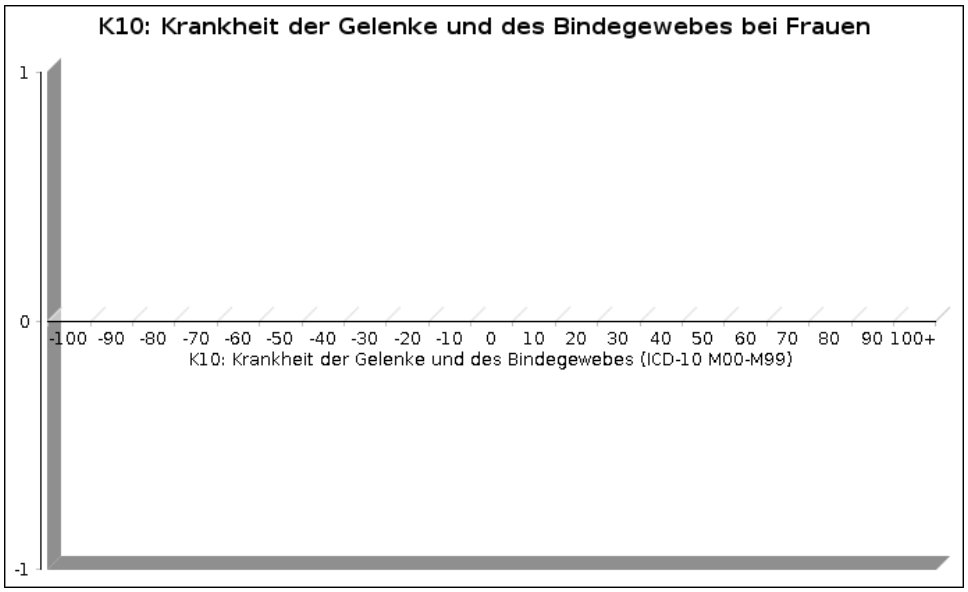


K10: Krankheit der Gelenke und des Bindegewebes bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K10: Krankheit der Gelenke und des Bindegewebes (ICD-10 M00-M99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Unter K10: Krankheit der Gelenke und des Bindegewebes (ICD-10 M00-M99) fallen Krankheiten, wie bspw. Arthrose, Rückenschmerzen, Osteoporose und Rheumatoide Arthritis. Diese Erkrankungen stehen in Zusammenhang mit einem erhöhten Verletzungssisiko.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

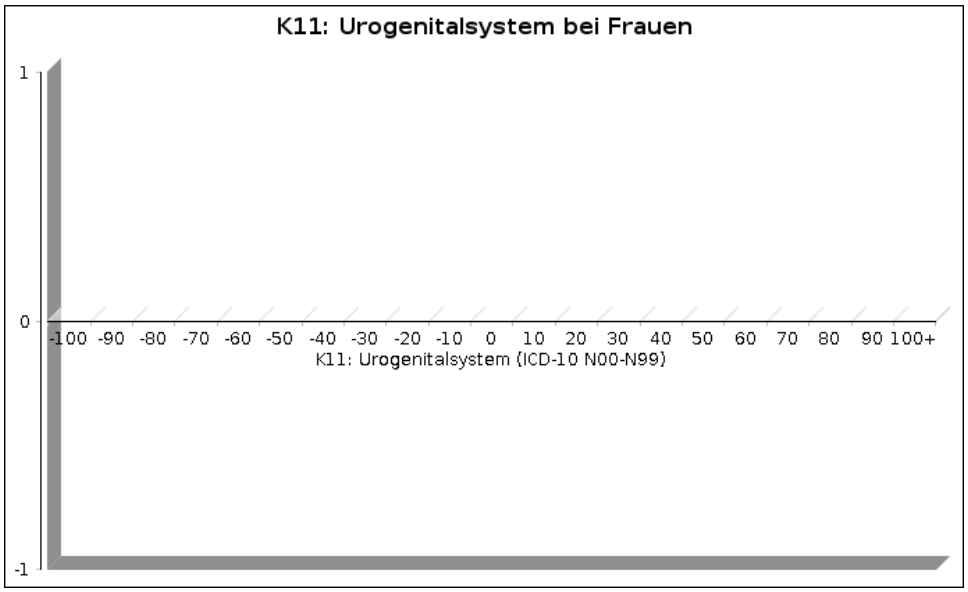


K11: Urogenitalsystem bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K11: Urogenitalsystem (ICD-10 N00-N99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Unter K11: Urogenitalsystem (ICD-10 N00-N99) fallen Krankheiten der Nieren, Harnleiter, Blase, Harnröhre, Prostata, Geschlechtsorgane und männliche Brustdrüse, wie bspw. Prostata-, Blasen-, Hoden-, und Gebärmutterhalskrebs. Aber auch Krankheiten der Hanrwegsinfekte, Nierensteine und Niereninsuffizienz gehören in diese Kategorie.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

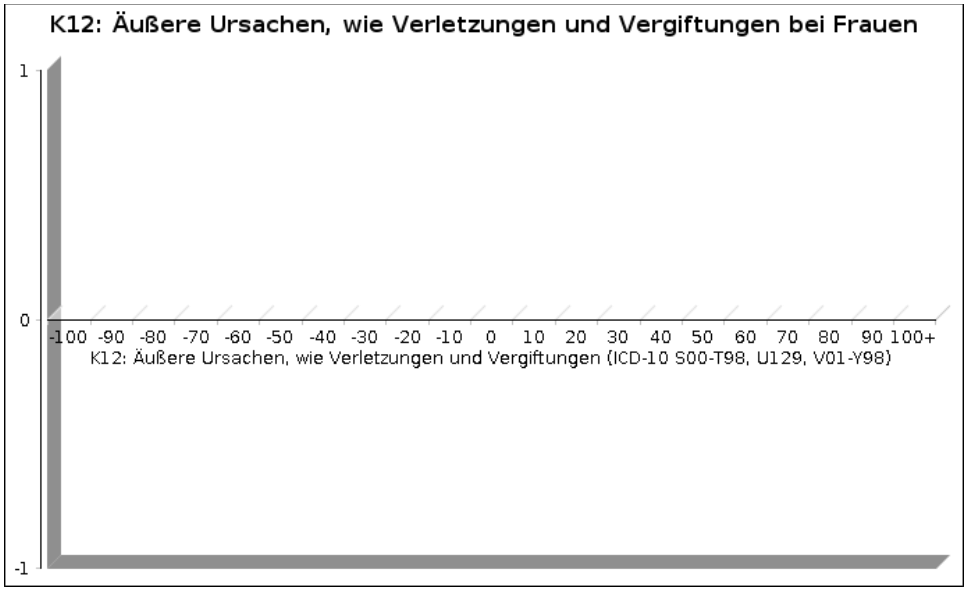


K12: Äußere Ursachen, wie Verletzungen und Vergiftungen bei Frauen

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K12: Äußere Ursachen, wie Verletzungen und Vergiftungen (ICD-10 S00-T98, U129, V01-Y98) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Unter K12: Äußere Ursachen, wie Verletzungen und Vergiftungen (ICD-10 S00-T98, U129, V01-Y98) fallen Verletzungen durch Unfälle, Gewalt, Selbstverletzung, Vergiftung durch Medikamente, Drogen oder Giftstoffe, und natürliche Katastrophen.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



1.2. Lebensstilbedingte Risikofaktoren für die Gesundheit von Frauen

Nehmen Sie sich bitte zunächst etwas Zeit, um darüber nachzudenken, wie sich die Risikofaktoren des Lebensstils für die Gesundheit seit 1980 verändert haben. Beispielsweise führte der Anstieg von Adipositas in den letzten Jahrzehnten zu vermehrten Diabetes Erkrankungen.

Definition: In dieser Studie wird Lebensstil als Lebensweise verstanden. Beziehen Sie in Ihre Überlegung die Bereiche Ernährung, körperliche Aktivität, Konsumverhalten, Arbeitsweisen, soziale Normen und Ideale, sowie sozioökonomische Unterschiede ein (Rapp & Klein 2020).

Reisen Sie gedanklich nun in das Jahr 2060. Welche Faktoren des Lebensstils werden in Deutschland das größte Risiko für die Gesundheit von Frauen darstellen und lebensbedrohliche Krankheiten begünstigen?

Bitte geben Sie im Kommentarfeld Ihre voraussichtliche Top-Ten-Liste der lebensstilbezogenen Risikofaktoren für Frauen an, die im Jahr 2060 in Deutschland zum Tod führen. Um Ihre Argumentation für andere Teilnehmende nachvollziehbar zu machen, führen Sie bitte dabei an, welche Überlegungen hinter Ihrer Liste von Faktoren stehen.

1.3. Lebensstilbedingte lebensverlängernde Faktoren für die Gesundheit von Frauen

Nehmen Sie sich bitte zunächst etwas Zeit, um darüber nachzudenken, wie sich die lebensverlängernden Faktoren des Lebensstils für die Gesundheit seit 1980 verändert haben. Beispielsweise trugen eine bessere Ernährung und Vorsorgemaßnahmen, sowie eine für den Körper weniger belastende Arbeitsweise in den letzten Jahrzehnten zu einer erhöhten Lebenserwartung bei.

Definition: In dieser Studie wird Lebensstil als Lebensweise verstanden. Beziehen Sie in Ihre Überlegung die Bereiche Ernährung, körperliche Aktivität, Konsumverhalten, Arbeitsweisen, soziale Normen und Ideale, sowie sozioökonomische Unterschiede ein (Rapp & Klein 2020).
Reisen Sie gedanklich nun in das Jahr 2060. Welche Faktoren des Lebensstils werden in Deutschland 2060 einen lebensverlängernden Effekt für die Gesundheit von Frauen darstellen?
Bitte geben Sie Ihre Antwort im Kommentarfeld an, Um Ihre Argumentation für andere Teilnehmende nachvollziehbar zu machen, führen Sie bitte dabei an, welche Überlegungen hinter Ihrer Liste von Faktoren stehen.

1.4. Klimabedingte Risikofaktoren für die Gesundheit von Frauen

Bitte denken Sie einen Moment darüber nach, wie sich die durch den Klimawandel bedingten Risikofaktoren für die Gesundheit seit 1980 bis heute entwickelt haben. So nahmen zum Beispiel allergische Beschwerden durch eine klimabedingte, verlängerte Pollensaison zu (RKI 2010). Ein weiteres Beispiel sind die Hitzesommer seit Anfang der 2000er Jahre, die das Herz-Kreislauf-System kranker, älterer oder vorbelasteter Menschen beanspruchen und sogar zu hitzebedingten Todesfällen geführt haben (Umweltbundesamt 2022). Versetzen Sie sich nun bitte in das Jahr 2060. Welche durch den Klimawandel verursachten Faktoren stellen im Jahr 2060 in Deutschland das größte Risiko für die Gesundheit von Frauen dar, die lebensbedrohliche Krankheiten begünstigen können?
Definition des Klimawandels: Der vom Menschen verursachte Klimawandel, der eine Erwärmung der globalen mittleren Oberflächentemperatur, Veränderungen der Luft- und Wasserqualität, der Niederschlagsmuster, eine Zunahme von Naturkatastrophen und andere damit zusammenhängende Phänomene verursacht.
Bitte geben Sie im Kommentarfeld Ihre voraussichtliche Top-Ten-Liste der klimawandelbedingten Risikofaktoren für Frauen an, die im Jahr 2060 in Deutschland zum Tod führen. Um Ihre Argumentation für andere Teilnehmende nachvollziehbar zu machen, führen Sie bitte dabei an, welche Überlegungen hinter Ihrer Liste von Faktoren stehen.

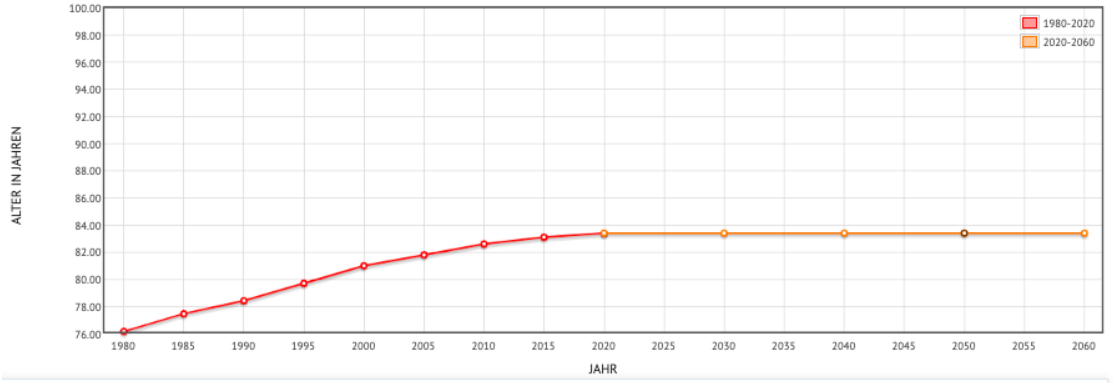
1.5. Klimabedingte lebensverlängernde Faktoren für die Gesundheit von Frauen

Nehmen Sie sich bitte zunächst etwas Zeit, um darüber nachzudenken, wie sich die lebensverlängernden Effekte des Klimas für die Gesundheit seit 1980 verändert haben. Beispielsweise geht das Unfallrisiko bei Glatteis und Schnee zurück.
Definition des Klimawandels: Der vom Menschen verursachte Klimawandel, der eine Erwärmung der globalen mittleren Oberflächentemperatur, Veränderungen der Luft- und

Wasserqualität, der Niederschlagsmuster, eine Zunahme von Naturkatastrophen und andere damit zusammenhängende Phänomene verursacht.
Reisen Sie gedanklich nun in das Jahr 2060. Welche Faktoren des Klimawandels werden in Deutschland 2060 einen lebensverlängernden Effekt für die Gesundheit von Frauen darstellen?
Bitte geben Sie Ihre Antwort im Kommentarfeld an, Um Ihre Argumentation für andere Teilnehmende nachvollziehbar zu machen, führen Sie bitte dabei an, welche Überlegungen hinter Ihrer Liste von Faktoren stehen.

1.6. Lebenserwartung (LE) für Frauen

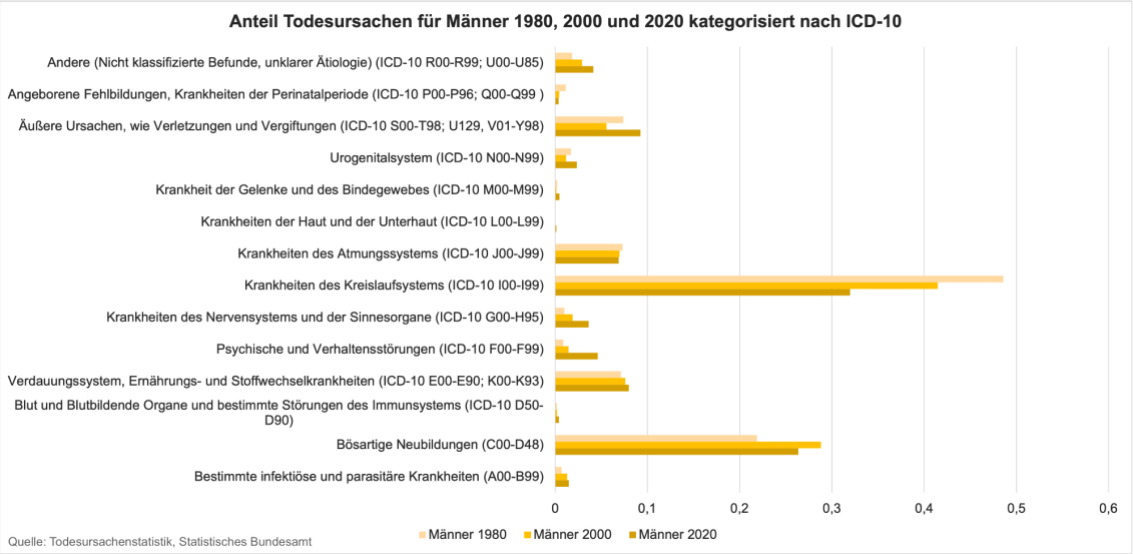
Im Folgenden sehen Sie die Entwicklung der Lebenserwartung für Frauen in Deutschland von 1980 bis 2020. Beziehen Sie all Ihre vorherigen Antworten und Ihr Zukunftsbild von Deutschland 2060 ein. Geben Sie dann Ihre Schätzung der voraussichtlichen Lebenserwartung als Alter in Jahren für das Jahr 2060 für Frauen in der gleichen Grafik an wie die vorhergehenden Lebenserwartungen.
Definition von Lebenserwartung: Lebenserwartung wird als durchschnittlich-erreichbares Alter beschrieben, unter konstanten Lebensumständen in einer Population (Destatis 2022). LE wird in dieser Delphi als erwartbares Alter zum Todeszeitpunkt eines weiblichen Säuglings verstanden, das 2060 geboren wurde und lebenslang unter den selben Lebensumständen wie im Jahr 2060 leben wird.
Erklärung: Der rote Graph zeigt die LE von Frauen von 1980 bis 2020 gemäß den Daten des World Development Indicators (2022). Der orange Graph bezeichnet den Teil, den Sie bitte schätzen sollen. Führen Sie Ihre Cursor jeweils auf die vertikale Linie (für 2030-2060), der orange Punkt wird sich nun schwarz verfärben. Bitte klicken Sie auf der vertikalen Linie auf Höhe Ihres geschätzen Wertes für das Alter als LE für Frauen.
Bitte beschreiben Sie anschließend kurz welche Überlegungen zu Ihrer Schätzung über die Lebenserwartungsentwicklung für Frauen von 2030-2060 führten.



2. Mortalität von Männern in Deutschland 2060

2.1. Entwicklung der Todesursachen von Männern

Nehmen Sie sich bitte zunächst etwas Zeit, um an die aktuelle Public Health Situation von Männern in Deutschland zu denken und wie sich diese in den letzten 40 Jahren verändert hat. Dieser Denkprozess soll durch den nachstehenden Graphen unterstützt werden, welcher den prozentualen Anteil von Todesursachen an allen Sterbefällen von Männern in 1980, 2000 und 2020 zeigt. Die Todesursachen sind in 14 Kategorien nach ICD-10 Standard zusammengefasst. Ungefähr die Hälfte der Haupttodesursachen blieb in den letzten 40 Jahren unverändert. Tod durch Krankheiten des Kreislaufsystems nahmen jedoch über die Zeit ab, während vor allem Mortalität im Zusammenhang mit Krebs-Erkrankungen anstieg. Auf den folgenden Seiten werden Sie die Wachstumsrate für 12 dieser Kategorien im Jahr 2060 schätzen.



K1: Bestimmte infektiöse und parasitäre Krankheiten bei Männern

Bitte denken Sie einen Moment über die Entwicklung der Todesursachen in den letzten 40 Jahren nach, unter Einfluss von Lebensstil, Klimawandel, sowie technischen und medizinischen Innovationen. Überlegen Sie dann, was das für die nächsten 40 Jahre in Bezug auf Mortalität bedeutet. Richten Sie Ihren Fokus auf das Jahr 2060. Denken Sie an Innovationen, Klimawandelfolgen und Lebensstiländerungen, die Deutschland wahrscheinlich prägen werden.

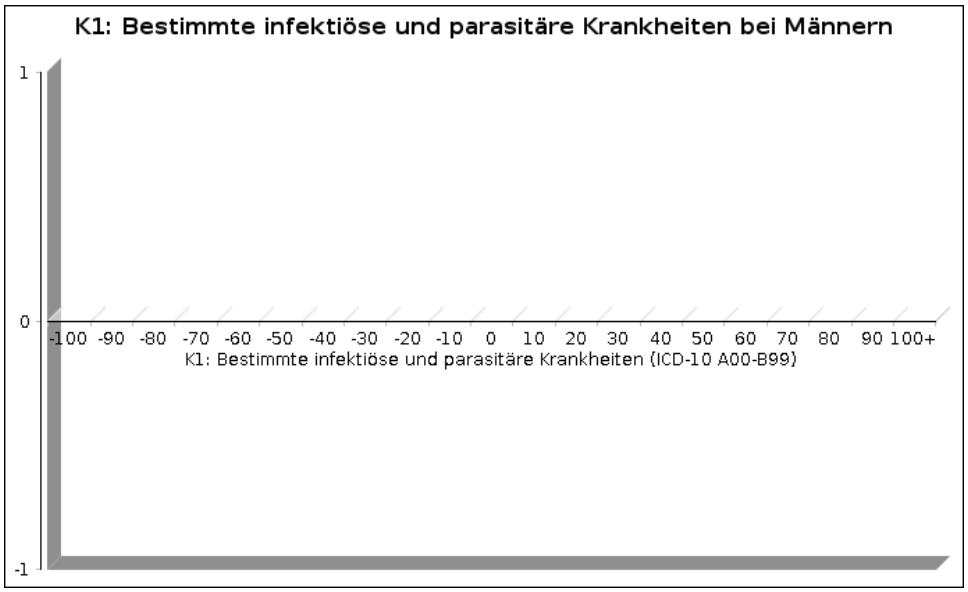
Im Folgenden werden Sie den Großteil aller Todesursachen nach ICD-10 Standard in 12 Kategorien zusammengefasst sehen. Bitte schätzen Sie für jede Kategorie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch eine bestimmte Todesursache im Jahr 2060 im Vergleich zum Jahr 2020 zunehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Erklärung: Angenommen, es gibt 100 Todesfälle durch eine bestimmte Todesursache im Jahr 2020. Wenn die Anzahl der Todesfälle bis zum Jahr 2060 um weitere 100 ansteigt,

würde dies eine Zunahme um 100% bedeuten, da die Anzahl der Todesfälle verdoppelt würde. Wenn die Anzahl der Todesfälle um weitere 50 ansteigt, würde dies eine Zunahme um 50% bedeuten, da die Anzahl der Todesfälle um die Hälfte steigt. Ein Wert von -100 würde bedeuten, dass die Anzahl der Todesfälle um 100% zurückgehen wird, während ein Wert von 100+ bedeuten würde, dass die Anzahl der Todesfälle um 100% oder mehr ansteigen wird.

Unter K1: Bestimmte infektiöse und parasitäre Krankheiten (ICD-10 A00-B99) fallen Infektionskrankheiten, wie bspw. Lungenentzündung, sexuell übertragbare Krankheiten, Tuberkulose, Malaria oder Magen-Darm-Viren.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

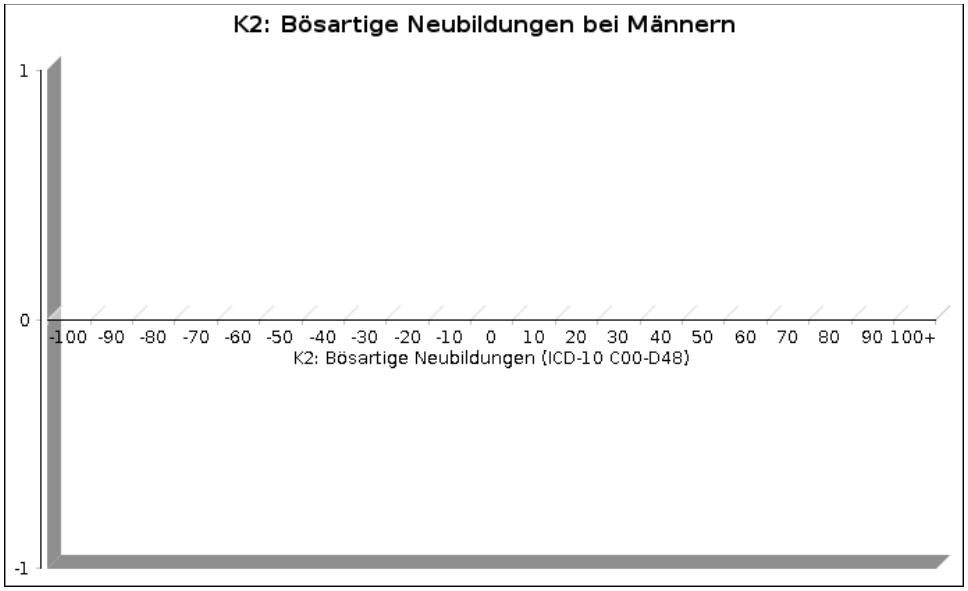


K2: Bösartige Neubildungen bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K2: Bösartige Neubildungen (ICD-10 C00-D48) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Unter K2: Bösartige Neubildungen (ICD-10 C00-D48) fallen Krebserkrankungen, wie bspw. Lungen-, Brust-, Darm-, Prostata- und Bauchspeicheldrüsenkrebs.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

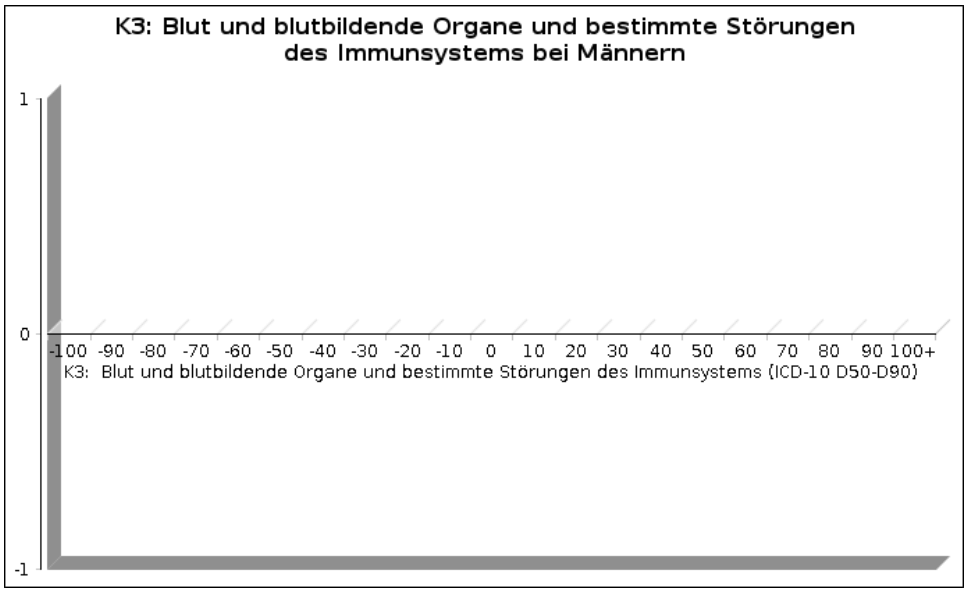


K3: Blut und blutbildende Organe und bestimmte Störungen des Immunsystems bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K3: Blut und blutbildende Organe und bestimmte Störungen des Immunsystems (ICD-10 D50-D90) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Unter K3: Blut und blutbildende Organe und bestimmte Störungen des Immunsystems (ICD-10 D50-D90) fallen Blutkrankheiten, wie bspw. Leukämie und Lymphome, also eine bösartige Erkrankung des Lymphsystems. Aber auch Anämie, also die Abnahme der roten Blutkörperchenanzahl zählt zu diesen Krankheiten.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

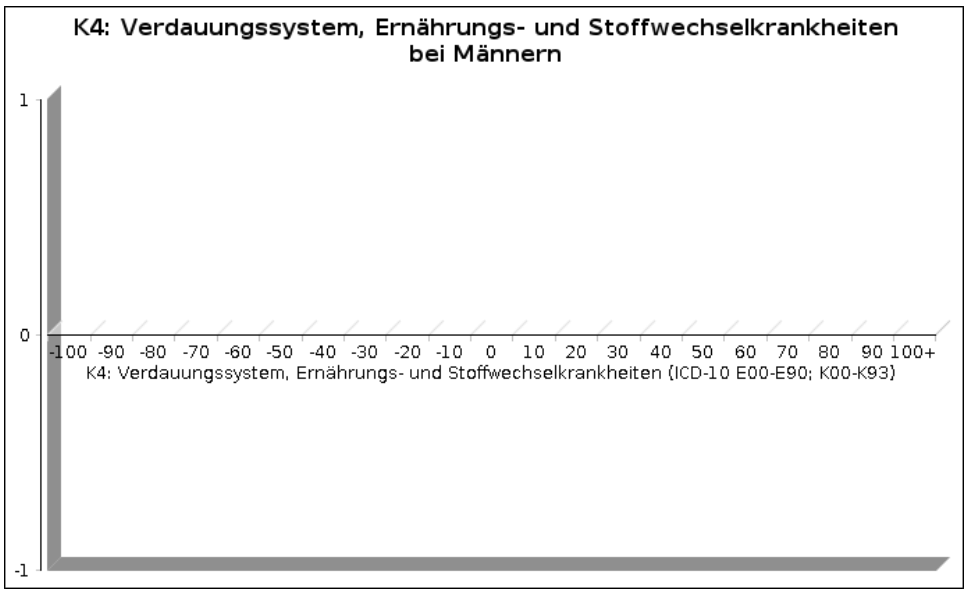


K4: Verdauungssystem, Ernährungs- und Stoffwechselkrankheiten bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K4: Verdauungssystem, Ernährungs- und Stoffwechselkrankheiten (ICD-10 E00-E90; K00-K93) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Unter K4: Verdauungssystem, Ernährungs- und Stoffwechselkrankheiten (ICD-10 E00-E90; K00-K93) fallen Krankheiten, wie bspw. Diabetes mellitus, Adipositas, Schilddrüsenerkrankungen, Lebererkrankungen und Darmkrebs.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

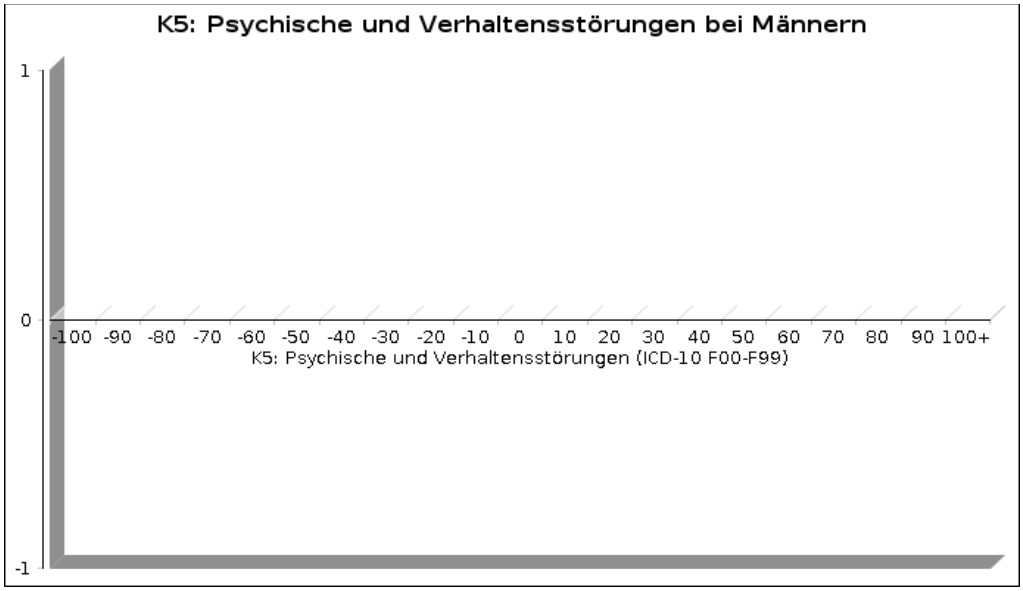


K5: Psychische und Verhaltensstörungen bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K5: Psychische und Verhaltensstörungen (ICD-10 F00-F99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Unter K5: Psychische und Verhaltensstörungen (ICD-10 F00-F99) fallen Krankheiten, wie bspw. Depression, Schizophrenie, Angsstörungen und Demenz. Psychische Erkrankungen stehen erhöht im Zusammenhang mit Suizid und Drogenmissbrauch.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

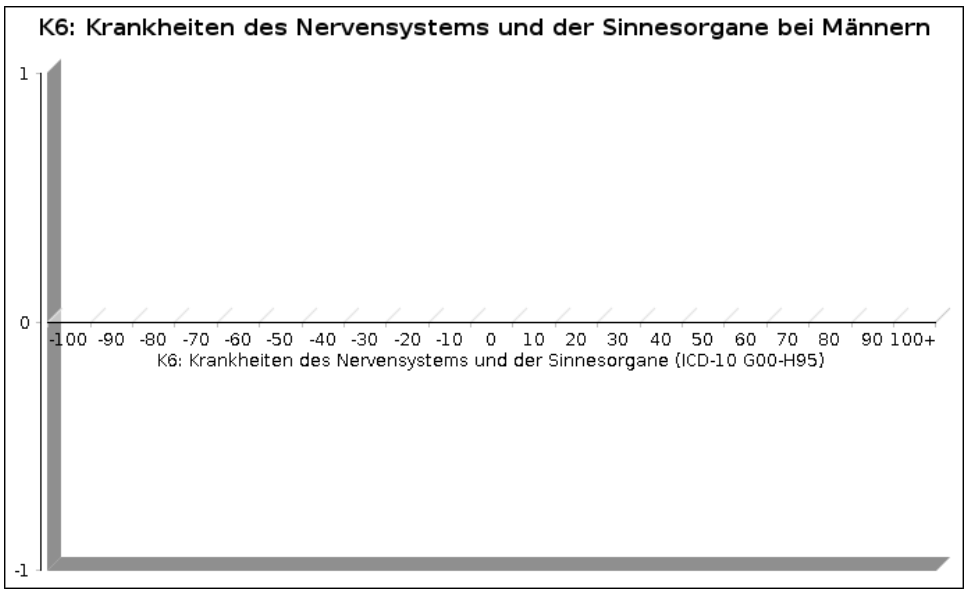


K6: Krankheiten des Nervensystems und der Sinnesorgane bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K6: Krankheiten des Nervensystems und der Sinnesorgane (ICD-10 G00-H95) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

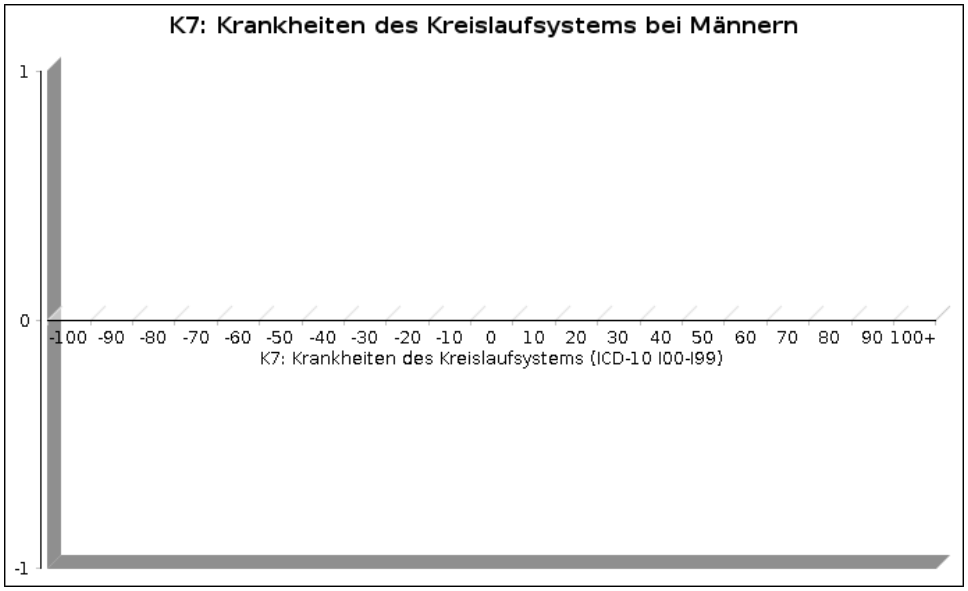
Unter K6: Krankheiten des Nervensystems und der Sinnesorgane (ICD-10 G00-H95) fallen neurologische Krankheiten, wie bspw. Alzheimer, Parkinson, Migräne und Epilepsie.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



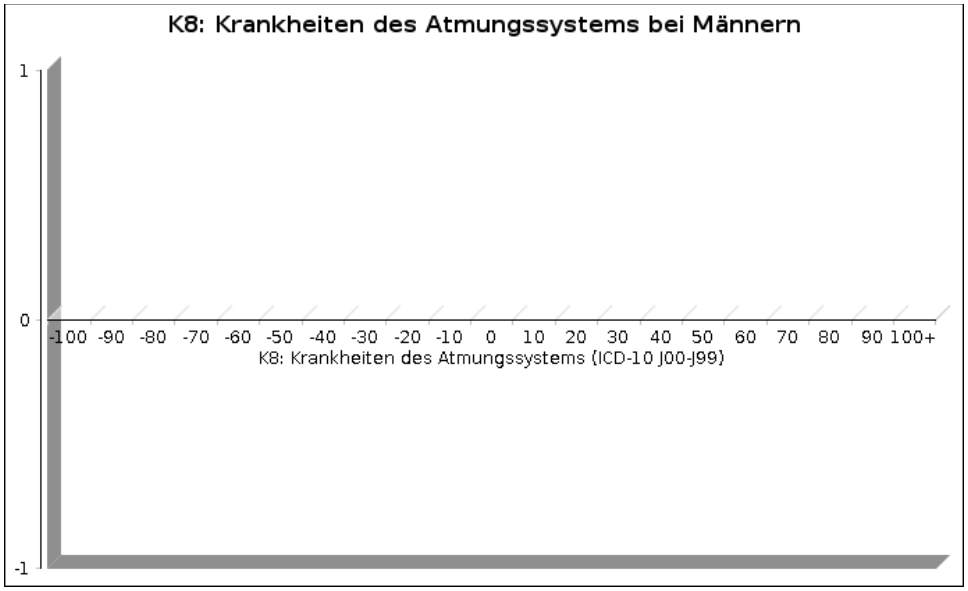
K7: Krankheiten des Kreislaufsystems bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K7: Krankheiten des Kreislaufsystems (ICD-10 I00-I99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K7: Krankheiten des Kreislaufsystems (ICD-10 I00-I99) fallen Krankheiten des Herzens und der Blutgefäße, wie bspw. Bluthochdruck, Herzinsuffizienz, Schlaganfall und koronare Herzkrankheiten, also Ablagerungen durch Fett und andere Substanzen auf der Arterie, die zu einer verringerten Durchblutung des Herzens führen kann.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



K8: Krankheiten des Atmungssystems bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K8: Krankheiten des Atmungssystems (ICD-10 J00-J99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K8: Krankheiten des Atmungssystems (ICD-10 J00-J99) fallen Lungen-, Atemwegs- und Nasenhöhlenkrankheiten, wie bspw. Asthma bronchiale, Lungenentzündungen, Lungenkrebs und chronische obstruktive Lungenerkrankungen, also eine Verrengung der Atemwege, die zu Atemnot und Husten führt.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

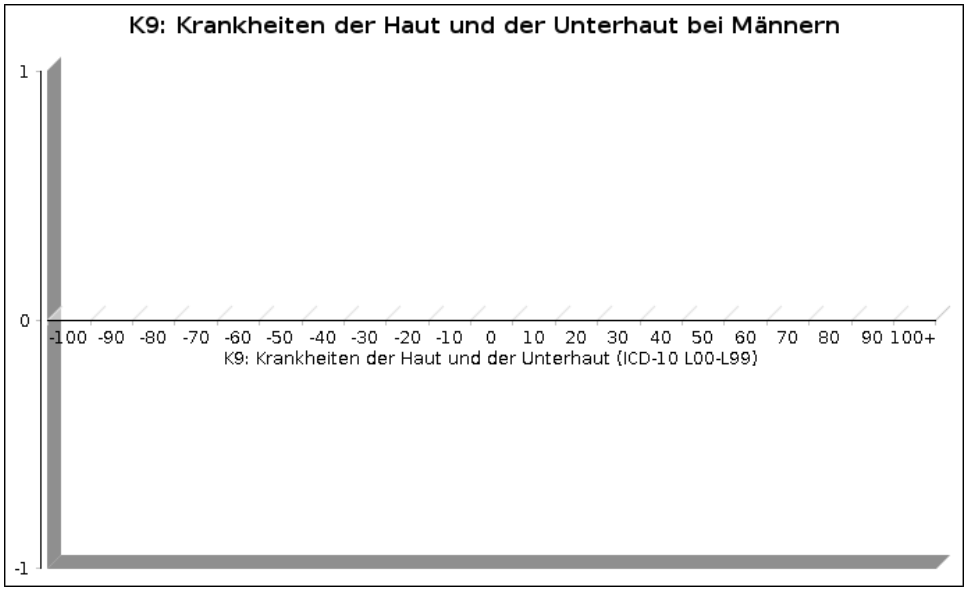


K9: Krankheiten der Haut und der Unterhaut bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K9: Krankheiten der Haut und der Unterhaut (ICD-10 L00-L99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

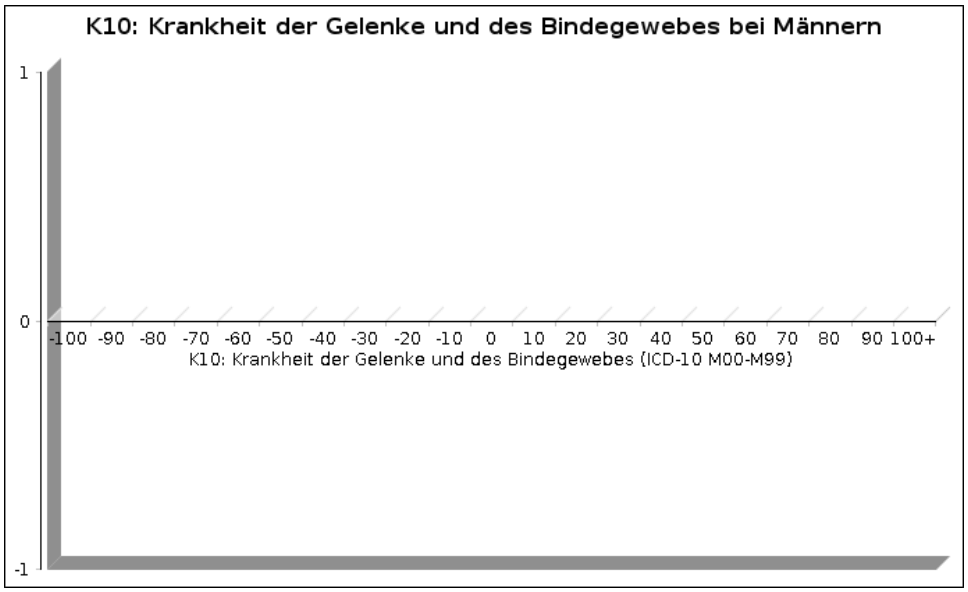
Unter K9: Krankheiten der Haut und der Unterhaut (ICD-10 L00-L99) fallen Krankheiten, wie bspw. Hautkrebs, Ekzeme und Dermatitis, sowie Psoriasis, eine chronische Hautentzündung.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



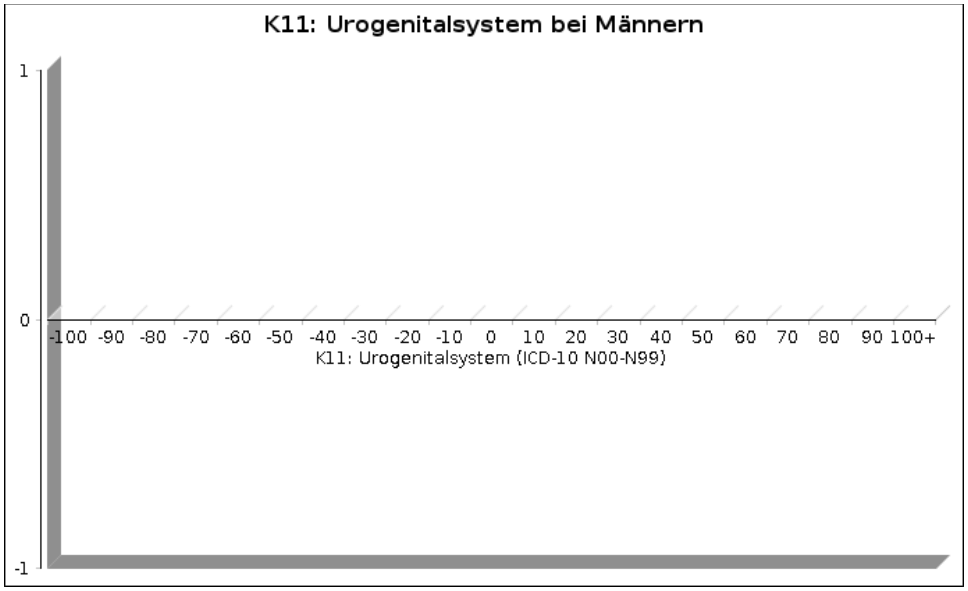
K10: Krankheit der Gelenke und des Bindegewebes bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K10: Krankheit der Gelenke und des Bindegewebes (ICD-10 M00-M99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K10: Krankheit der Gelenke und des Bindegewebes (ICD-10 M00-M99) fallen Krankheiten, wie bspw. Arthrose, Rückenschmerzen, Osteoporose und Rheumatoide Arthritis. Diese Erkrankungen stehen in Zusammenhang mit einem erhöhten Verletzungssisiko.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



K11: Urogenitalsystem bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K11: Urogenitalsystem (ICD-10 N00-N99) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.
Unter K11: Urogenitalsystem (ICD-10 N00-N99) fallen Krankheiten der Nieren, Harnleiter, Blase, Harnröhre, Prostata, Geschlechtsorgane und männliche Brustdrüse, wie bspw. Prostata-, Blasen-, Hoden-, und Gebärmutterhalskrebs. Aber auch Krankheiten der Hanrwegsinfekte, Nierensteine und Niereninsuffizienz gehören in diese Kategorie.
Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.

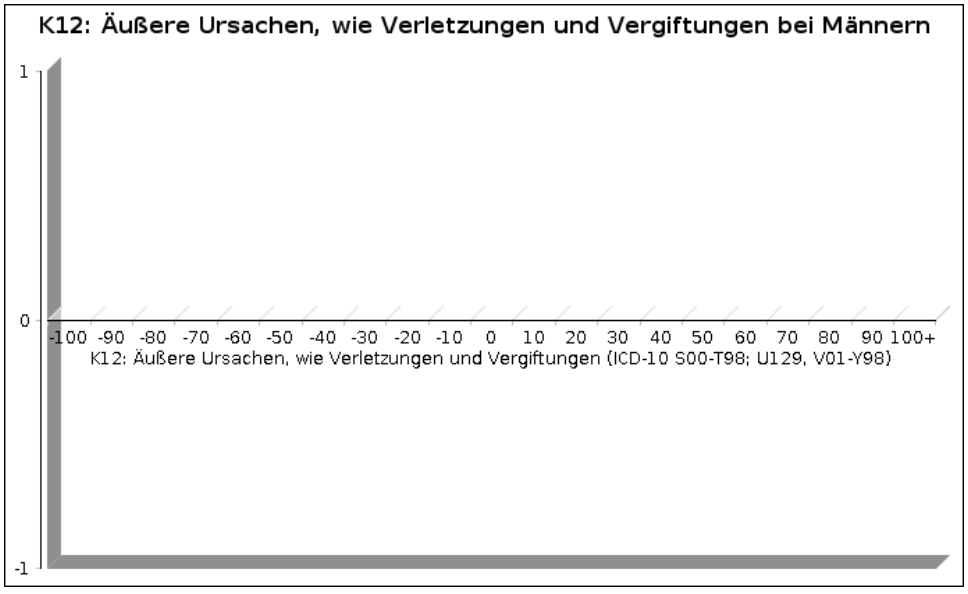


K12: Äußere Ursachen, wie Verletzungen und Vergiftungen bei Männern

Bitte schätzen Sie, um wie viele Prozentpunkte die Anzahl der Todesfälle durch K12: Äußere Ursachen, wie Verletzungen und Vergiftungen (ICD-10 S00-T98, U129, V01-Y98) im Jahr 2060 im Vergleich zum Jahr 2020 zu- oder abnehmen wird. Sie müssen keine Veränderungen berechnen, vielmehr geht es darum, ob Sie eine starke, mittlere oder schwache Zu- oder Abnahme erwarten.

Unter K12: Äußere Ursachen, wie Verletzungen und Vergiftungen (ICD-10 S00-T98, U129, V01-Y98) fallen Verletzungen durch Unfälle, Gewalt, Selbstverletzung, Vergiftung durch Medikamente, Drogen oder Giftstoffe, und natürliche Katastrophen.

Um den anderen Teilnehmenden Ihre Argumentation zu verdeutlichen, geben Sie bitte anschließend im Kommentarfeld an, welche Überlegungen zu Ihren Einschätzungen führten.



2.2. Lebensstilbedingte Risikofaktoren für die Gesundheit von Männern

Nehmen Sie sich bitte zunächst etwas Zeit, um darüber nachzudenken, wie sich die Risikofaktoren des Lebensstils für die Gesundheit seit 1980 verändert haben. Beispielsweise führte der Anstieg von Adipositas in den letzten Jahrzehnten zu vermehrten Diabetes Erkrankungen.
Definition: In dieser Studie wird Lebensstil als Lebensweise verstanden. Beziehen Sie in Ihre Überlegung die Bereiche Ernährung, körperliche Aktivität, Konsumverhalten, Arbeitsweisen, soziale Normen und Ideale, sowie sozioökonomische Unterschiede ein (Rapp & Klein 2020).
Reisen Sie gedanklich nun in das Jahr 2060. Welche Faktoren des Lebensstils werden in Deutschland das größte Risiko für die Gesundheit von Männern darstellen und lebensbedrohliche Krankheiten begünstigen?
Bitte geben Sie im Kommentarfeld Ihre voraussichtliche Top-Ten-Liste der lebensstilbezogenen Risikofaktoren für Männer an, die im Jahr 2060 in Deutschland zum Tod führen. Um Ihre Argumentation für andere Teilnehmende nachvollziehbar zu machen, führen Sie bitte dabei an, welche Überlegungen hinter Ihrer Liste von Faktoren stehen.

2.3. Lebensstilbedingte lebensverlängernde Faktoren für die Gesundheit von Männern

Nehmen Sie sich bitte zunächst etwas Zeit, um darüber nachzudenken, wie sich die lebensverlängernden Faktoren des Lebensstils für die Gesundheit seit 1980 verändert haben. Beispielsweise trugen eine bessere Ernährung und Vorsorgemaßnahmen, sowie eine für den Körper weniger belastende Arbeitsweise in den letzten Jahrzehnten zu einer erhöhten Lebenserwartung bei.
Definition: In dieser Studie wird Lebensstil als Lebensweise verstanden. Beziehen Sie in Ihre Überlegung die Bereiche Ernährung, körperliche Aktivität, Konsumverhalten, Arbeitsweisen, soziale Normen und Ideale, sowie sozioökonomische Unterschiede ein (Rapp & Klein 2020).
Reisen Sie gedanklich nun in das Jahr 2060. Welche Faktoren des Lebensstils werden in Deutschland 2060 einen lebensverlängernden Effekt für die Gesundheit von Männern darstellen?
Bitte geben Sie Ihre Antwort im Kommentarfeld an, Um Ihre Argumentation für andere Teilnehmende nachvollziehbar zu machen, führen Sie bitte dabei an, welche Überlegungen hinter Ihrer Liste von Faktoren stehen.

2.4. Klimabedingte Risikofaktoren für die Gesundheit von Männern

Bitte denken Sie einen Moment darüber nach, wie sich die durch den Klimawandel bedingten Risikofaktoren für die Gesundheit seit 1980 bis heute entwickelt haben. So zum Beispiel die Zunahme von allergischen Beschwerden durch eine klimabedingte,

verlängerte Pollensaison (RKI 2010). Ein weiteres Beispiel sind die Hitzesommer seit Anfang der 2000er Jahre, die das Herz-Kreislauf-System kranker, älterer oder vorbelasteter Menschen beanspruchen und sogar zu hitzebedingten Todesfällen geführt haben (Umweltbundesamt 2022). Versetzen Sie sich nun bitte in das Jahr 2060. Welche durch den Klimawandel verursachten Faktoren stellen im Jahr 2060 in Deutschland das größte Risiko für die Gesundheit von Männern dar, die lebensbedrohliche Krankheiten begünstigen können?
Definition des Klimawandels: Der vom Menschen verursachte Klimawandel, der eine Erwärmung der globalen mittleren Oberflächentemperatur, Veränderungen der Luft- und Wasserqualität, der Niederschlagsmuster, eine Zunahme von Naturkatastrophen und andere damit zusammenhängende Phänomene verursacht.
Bitte geben Sie im Kommentarfeld Ihre voraussichtliche Top-Ten-Liste der klimawandelbedingten Risikofaktoren für Männer an, die im Jahr 2060 in Deutschland zum Tod führen. Um Ihre Argumentation für andere Teilnehmende nachvollziehbar zu machen, führen Sie bitte dabei an, welche Überlegungen hinter Ihrer Liste von Faktoren stehen.

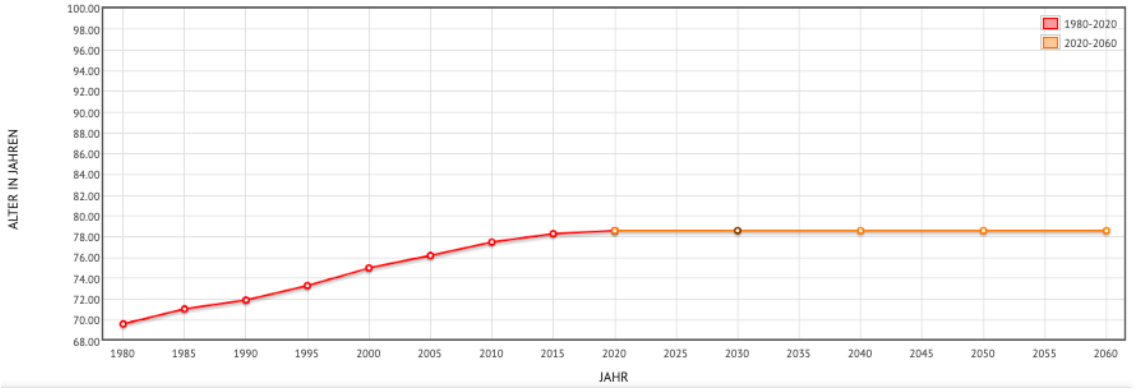
2.5. Klimabedingte lebensverlängernde Faktoren für die Gesundheit von Männern

Nehmen Sie sich bitte zunächst etwas Zeit, um darüber nachzudenken, wie sich die lebensverlängernden Faktoren des Klimas für die Gesundheit seit 1980 verändert haben. Beispielsweise geht das Unfallrisiko durch Glatteis und Schnee zurück.
Definition des Klimawandels: Der vom Menschen verursachte Klimawandel, der eine Erwärmung der globalen mittleren Oberflächentemperatur, Veränderungen der Luft- und Wasserqualität, der Niederschlagsmuster, eine Zunahme von Naturkatastrophen und andere damit zusammenhängende Phänomene verursacht.
Reisen Sie gedanklich nun in das Jahr 2060. Welche Faktoren des Klimawandels werden in Deutschland 2060 einen lebensverlängernden Effekt für die Gesundheit von Männern darstellen?
Bitte geben Sie Ihre Antwort im Kommentarfeld an, Um Ihre Argumentation für andere Teilnehmende nachvollziehbar zu machen, führen Sie bitte dabei an, welche Überlegungen hinter Ihrer Liste von Faktoren stehen.

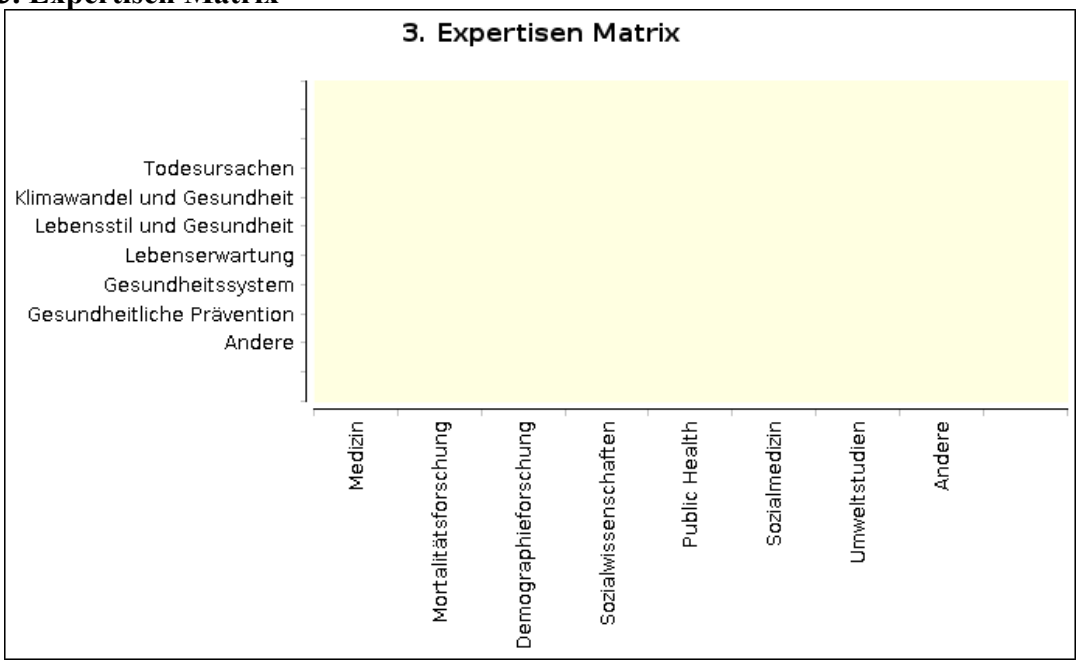
2.6. Lebenserwartung (LE) für Männer

Im Folgenden sehen Sie die Entwicklung der Lebenserwartung für Männer in Deutschland von 1980 bis 2020. Beziehen Sie all Ihre vorherigen Antworten und Ihr Zukunftsbild von Deutschland 2060 ein. Geben Sie dann Ihre Schätzung der voraussichtlichen Lebenserwartung als Alter in Jahren für das Jahr 2060 für Männer in der gleichen Grafik an wie die vorhergehenden Lebenserwartungen.

Definition von Lebenserwartung: Lebenserwartung wird als durchschnittlich-erreichbares Alter beschrieben, unter konstanten Lebensumständen in einer Population (Destatis 2022). LE wird in dieser Delphi als erwartbares Alter zum Todeszeitpunkt eines männlichen Säuglings verstanden, das 2060 geboren wurde und lebenslang unter den selben Lebensumständen wie im Jahr 2060 leben wird.
Erklärung: Der rote Graph zeigt die LE von Männern von 1980 bis 2020 gemäß den Daten des World Development Indicators (2022). Der orange Graph bezeichnet den Teil, den Sie bitte schätzen sollen. Führen Sie Ihre Cursor jeweils auf die vertikale Linie (für 2030-2060), der orange Punkt wird sich nun schwarz verfärben. Bitte klicken Sie auf der vertikalen Linie auf Höhe Ihres geschätzen Wertes für das Alter als LE für Männer.
Bitte beschreiben Sie anschließend kurz welche Überlegungen zu Ihrer Schätzung über die Lebenserwartungsentwicklung für Männer von 2030-2060 führten.



3. Expertisen Matrix



4. Demographie

MIT WELCHEM GESCHLECHT IDENTIFIZIEREN SIE SICH?
Weiblich

ALTER
unter 29

FÜR WELCHE ART VON ORGANIZATION ARBEITEN SIE HAUPTSÄCHLICH?
Universität

Appendix 2 Questionnaire of the Second Round

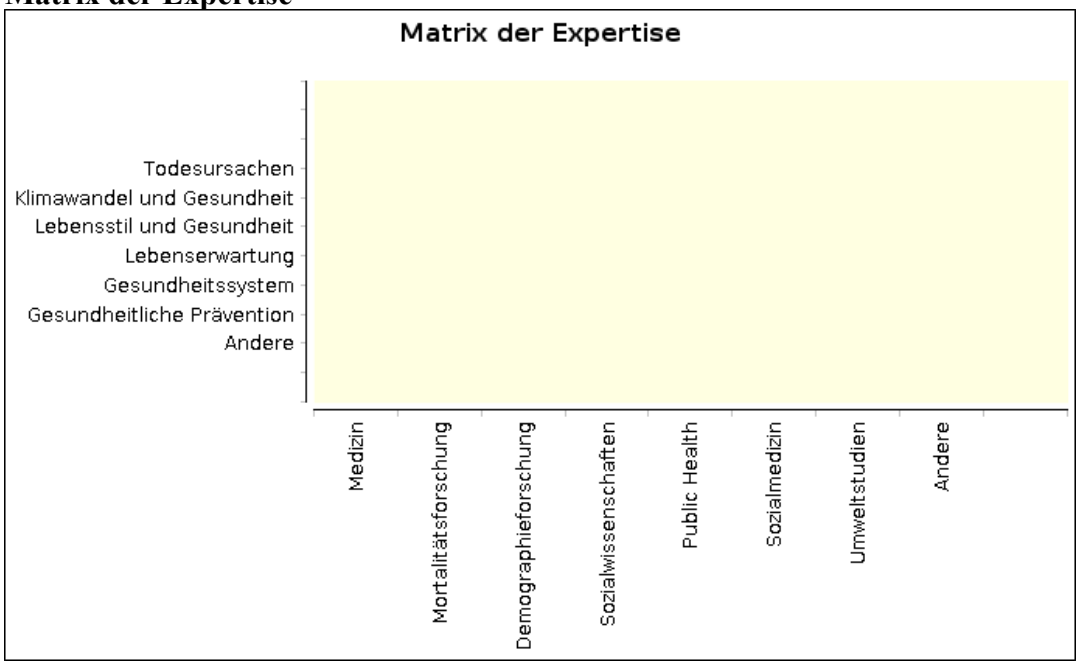
Demographie

MIT WELCHEM GESCHLECHT IDENTIFIZIEREN SIE SICH?
Weiblich

ALTER
unter 29

FÜR WELCHE ART VON ORGANIZATION ARBEITEN SIE HAUPTSÄCHLICH?
Universität

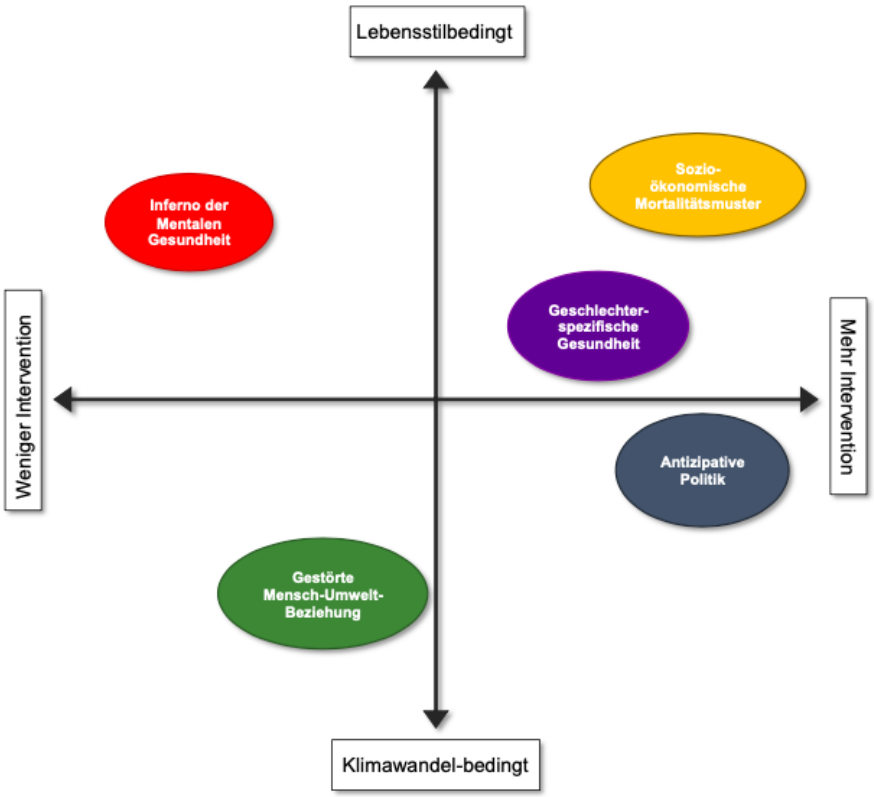
Matrix der Expertise



Logik der Szenarien

Das nachstehende Modell beschreibt die Logik der fünf Szenarien zur Mortalität in Deutschland im Jahr 2060, mit denen Sie sich im Laufe dieses Delphi-Fragebogens auseinandersetzen werden. In allen fünf Szenarien spielen lebensstilbedingte sowie klimawandelbedingte Faktoren eine Rolle. Einige Szenarien richten sich jedoch stärker an einem dieser Pole aus. So spielt der Klimawandel die größte Rolle in den Szenarien **Gestörte Mensch-Umwelt-Beziehung** und **Antizipative Politik**. Die meisten Szenarien

beschreiben zudem bereits politische Interventionen, die zu diesem Zukunftszustand geführt haben. Die Szenarien **Inferno der mentalen Gesundheit** und **Gestörte Mensch-Umwelt-Beziehung** beinhalten keine bis wenig solcher Implikation.



Inferno der mentalen Gesundheit

Die Ungewissheit über die Zukunft in den vergangenen Jahrzehnten hat zu einem starken Anstieg von **psychischen und Verhaltensstörungen** geführt. Die Behandlung dieser Krankheiten ist komplex, was zu einem Anstieg von Suiziden und Gewalt mit Todesfolge bis ins Jahr 2060 führte. Risikofaktoren für psychische Erkrankungen waren gerade bei Frauen erhöhter Stress am Arbeitsplatz, Einsamkeit und die Doppelbelastung von Familie und Beruf.

Bei **Krankheiten des Nervensystems, Sinnesorgane, Gelenke und Bindegewebe** ist die Behandlung ebenfalls nach wie vor unbefriedigend. Die Sterblichkeitsrate durch **neurodegenerative Erkrankungen** nahm aufgrund der alternden Bevölkerung stark zu, während die ehemalige Haupttodesursache der **Herz- und Kreislaufkrankheiten** durch bessere Behandlungsmethoden zurückgegangen ist. Die Prävalenz von *bösartigen Neubildungen* nahm ebenfalls durch die alternde Bevölkerung zu, aber die Sterblichkeit sank moderat aufgrund von Fortschritten in der Behandlung. Auch bessere Gesundheitsversorgung hat zu einem leichten Rückgang von Mortalität durch **Blutkrankheiten und Immunstörungen** beigetragen.

Ungesundes Essverhalten durch stark verarbeitete Lebensmittel haben zu einem Anstieg von **Verdauungssystem-, Ernährungs- und Stoffwechselkrankheiten** sowie

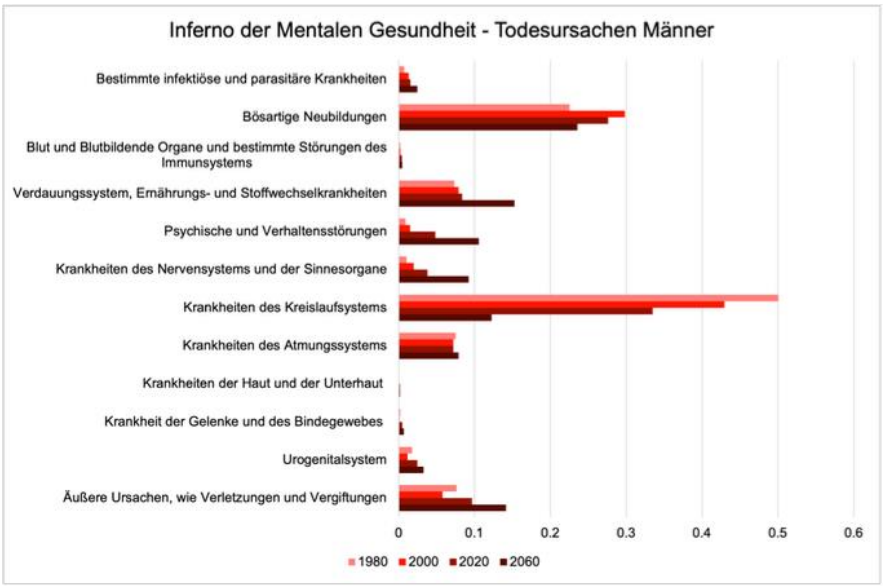
Krankheiten des Urogenitalsystems geführt. Infolgedessen befindet sich die Bevölkerung in einer Adipositas-Pandemie. Umweltbedingte Faktoren wie Umweltverschmutzung haben zu einem leichten Anstieg von **Atemwegserkrankungen** geführt, aber die Sterblichkeitsrate ist gesunken, ebenso wie bei **Krankheiten der Haut und Unterhaut.**

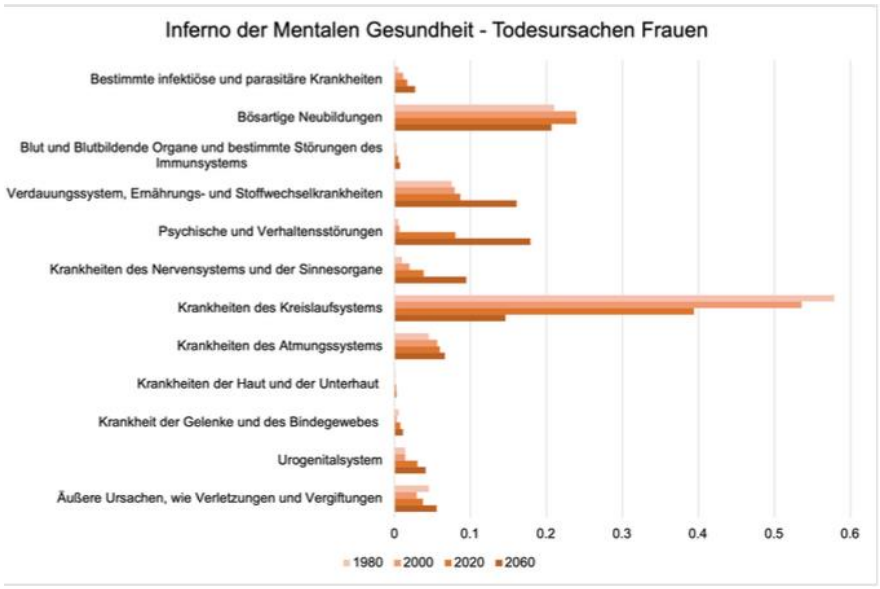
Der Klimawandel hat zu Artenmigration geführt und die Ausbreitung von Parasiten und Viren begünstigt, was das Infektionsrisiko durch beispielsweise Zoonose Erkrankungen (wie z. B. die Vogelgrippe) erhöht hat. Dies hat zu einem moderaten Anstieg von Todesfällen durch **infektiöse und parasitäre Krankheiten** geführt. Der Klimawandel hat auch extreme Wetterbedingungen wie Überschwemmungen, Anstieg der Durchschnittstemperatur, Hitzewellen und Kälteeinbrüche verursacht, die Risikofaktoren für die Gesundheit von Frauen und Männern darstellen. Trotzdem blieb der relative Anstieg von Todesfällen durch extreme Wetterbedingungen gering im Vergleich zu dem starken absoluten Anstieg in anderen Kategorien von Krankheiten.

Weitere Risikofaktoren, die die Entstehung von Krankheiten begünstigten, waren hauptsächlich zunehmend sozioökonomische Unterschiede, ungesunde Konsummuster, Rauchen, übermäßiger Alkoholkonsum, körperliche Inaktivität und ungesunde Schlafrhythmen.

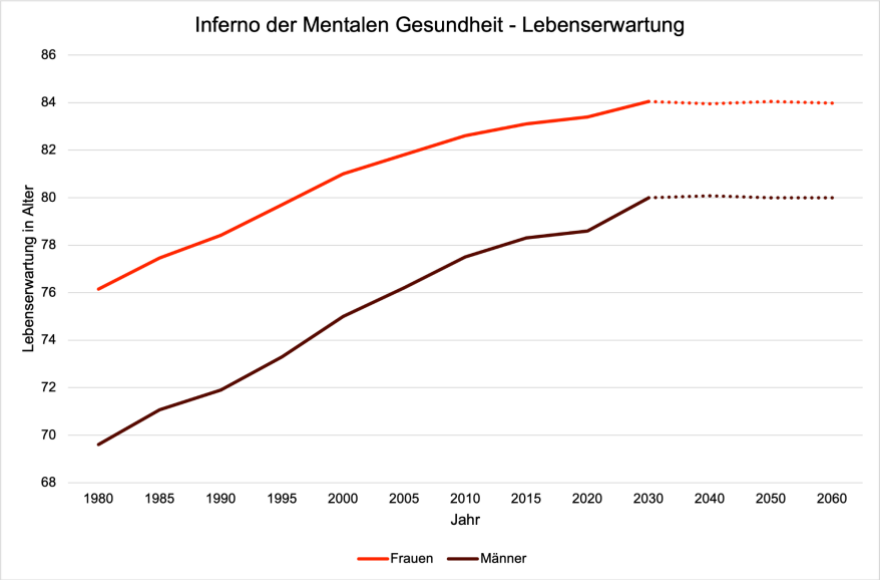
Interessante Annahmen in diesem Szenario sind:

- **Die größte Abnahme an absoluten Sterbefällen im Vergleich zu 2020**
- **Psychische und Verhaltensstörungen als neue Haupttodesursache**
- **Szenario geprägt von Fehlernährung und Adipositas-Pandemie**
- **Lebenserwartung steigt zunächst und erreicht das zweithöchste Niveau der fünf Szenarien, stagniert dann jedoch auf diesem Niveau**





Die Lebenserwartung nahm in Deutschland bis 2030 kontinuierlich zu, stagniert lebensstil-bedingt jedoch seither. Ein ähnlicher Trend konnte im ersten Viertel des Jahrhunderts in den USA beobachtet werden.



Implikationen zum Inferno der mentalen Gesundheit

Gehen Sie davon aus, dass das **Inferno der mentalen Gesundheit** im Jahr 2060 Wirklichkeit geworden ist. Kehren Sie nun gedanklich wieder in das Jahr 2023 zurück und elaborieren Sie in der Kommentarspalte unter diesem Text möglichst genau, ob und wenn ja welche politischen Maßnahmen Ihrer Meinung nach notwendig sind. **Manche Szenarien beinhalten bereits politische Maßnahmen. Sie können diese gerne weiter ausformulieren oder eigene Ideen entwickeln.**

- Formulieren Sie zunächst das **Problem**, das sich Ihrer Meinung nach aus dem Szenario für die Public-Health-Situation in Deutschland ergibt
- Legen Sie ein wünschenswertes **Ziel** fest, das es zu erreichen gilt

Sie können folgende Aspekte in Ihre Überlegungen einbeziehen. Beschreiben Sie Ihre Maßnahmen möglichst explizit für das gesamte Panel:

- Welche **Altersgruppe(n)** sind am meisten von dem **Problem** betroffen und welche **Altersgruppe(n)** sollten eventuell von den **Maßnahmen** angesprochen werden?
- Sind alle **Geschlechter** und **Bevölkerungsgruppen** gleichermaßen von dem Problem betroffen?
- Auf welche **Akteure** zielt die Maßnahme ab (z. B. Individuen/Bevölkerung vs. Institutionen, Branchen, Unternehmen, System etc.)?
- Evtl. in welchem **Bereich** wird die Intervention benötigt (z. B. Lebensmittelproduktion)?
- Welche **Art(en) von Intervention(en)** ist/sind Ihrer Meinung nach angemessen (Prävention, Versorgung, rechtlich, finanziell, Gesundheitskompetenz/Bildung/Information, Restriktion/Sanktion/Verbot, Anreize, Innovation, staatliche Ausgaben)?
- **Formulieren Sie die konkrete politische Maßnahme, mit der Sie auf das Szenario Inferno der mentalen Gesundheit reagieren würden.**

Wenn Sie Ihren eigenen Vorschlag formuliert haben, lesen Sie die Kommentare der anderen Expertinnen und Experten durch. Kommentieren Sie, ob Sie diesen zustimmen würden oder was Ihrer Meinung nach verbessert werden soll. Sie können jederzeit zurückkehren, um an Ihrem Vorschlag zu arbeiten oder an der Diskussion teilzunehmen. Sie können auch an Stelle eines eigenen Vorschlages an der Formulierung einer anderen Expertin oder eines anderen Experten mitarbeiten.

Sozioökonomische Mortalitätsmuster

Im Jahr 2060 konnten viele Todesursachen im Vergleich zu 2020 aufgrund von verstärkten Präventions-, Therapie- und Behandlungsmethoden sowie Anpassungsmaßnahmen besser addressiert werden. Die angestiegene Lebenserwartung und alternde Bevölkerung führen jedoch zu einer Zunahme der Prävalenz und Sterblichkeit von Krankheiten. Zu diesen zählen **bösartige Neubildungen, Krankheiten des Blutes und blutbildender Organe und bestimmte Störungen des Immunsystems, Psychische und Verhaltensstörungen, Krankheiten des Nervensystems und der Sinnesorgane, Krankheiten des Kreislaufsystems und Krankheiten der Gelenke und des Bindegewebes.** Die Sterblichkeit aufgrund dieser Krankheiten nahm jedoch trotz verbesserte Prävention und Therapiemöglichkeiten leicht zu. Von den Angeboten profitierten vor allem Männer, die in der Vergangenheit häufiger von bestimmten Krankheiten betroffen waren, etwa durch das Betreiben riskanterer Sportarten oder eine schlechtere Ernährung. Extremwetterereignisse und Risikofaktoren wie Adipositas und Hypertonie (erhöhter Blutdruck) erhöhten die Prävalenz von **Kreislauferkrankungen**. Die Mortalität durch **Krankheiten der Haut und Unterhaut** ist trotz erhöhter UV-

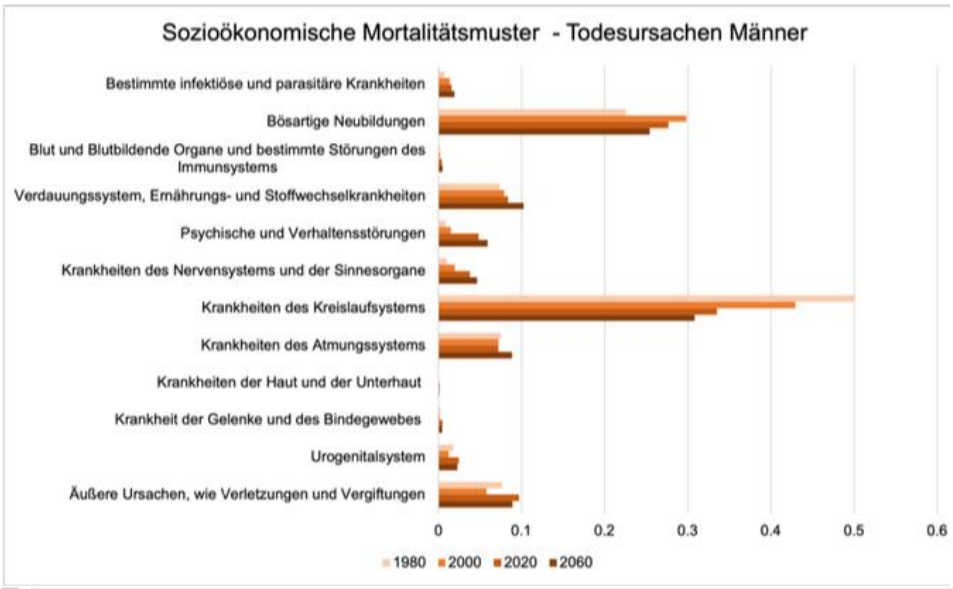
Exposition leicht gesunken, aufgrund verbesserter Screenings und gestiegener Sensibilisierung der Bevölkerung.
Es gab gegensätzliche Trends in der Ernährung durch eine Verschlechterung der Versorgungslage aufgrund von Umweltveränderungen, aber auch durch eine Verbreitung einer gesünderen pflanzenbasierten Ernährung, die die Prävalenz von **bösartigen Neubildungen** beeinflusst haben. Es wurde eine Zunahme von Fehlernährung, Adipositas, Diabetes und Folgeerkrankungen aufgrund von Inaktivität infolge von zunehmender Digitalisierung beobachtet. Niereninsuffizienz durch Hypertonie und Übersterblichkeit durch Exsikkose (niedriger Wassergehalt im Körper) bei Hitzewellen haben zugenommen. Durch epidemiologische Transition von Fehlernährung im Ausland und fehlende Adressierung dieser Problematik sind Menschen mit Migrationshintergrund vermehrt von Adipositas betroffen. Zusammengenommen führten all diese Entwicklungen zu einem moderaten Anstieg der Sterblichkeit durch **Verdauungssystem-, Ernährungs- und Stoffwechselkrankheiten**.
Männer nehmen Präventionsangebote insgesamt seltener wahr und profitieren dadurch weniger, wie der Anstieg von Prostatakrebs und Niereninsuffizienz bei **Krankheiten des Urogenitalsystems** im Zuge der alternden Bevölkerung zeigt. Sterblichkeit durch **Krankheiten des Atmungssystems** und **bösartige Neubildungen**, verursacht durch klimawandelbedingte Luftverschmutzung und aggressivere Pollen, und Chronisch Obstruktive Lungenerkrankungen (COPD), sind bei Männern stärker angestiegen als bei Frauen, möglicherweise aufgrund eines geringeren Rückgangs des Nikotinabusus bei Männern. Maßnahmen konnten die Luftverschmutzung und umweltbedingte Gefahren in Bezug auf ihre krebserzeugende Wirkung reduzieren, jedoch nicht die Exposition gegenüber hormonwirksamen endokrinen Disruptoren (synthetische Stoffe, die wie körpereigene Hormone wirken), was zu einem leichten Anstieg der Sterblichkeit durch **bösartige Neubildungen, Erkrankungen des Blutes und der blutbildenden Organe** sowie **bestimmter Störungen des Immunsystems** führte.
Biodiversitätsverlust, Extremwetterereignisse und Migration haben zu einem Anstieg der Sterblichkeit durch **infektiöse Krankheiten** geführt. Insbesondere unbekannte und in Deutschland eliminierte Krankheiten wie Malaria und Tuberkulose, bedingt durch resistente Antibiotika und verstärkte Migration. Extremwetterereignisse haben zudem die Infrastruktur beeinträchtigt und die Gesundheitsversorgung bei chronischen Krankheiten eingeschränkt. Anpassungsmaßnahmen für Infrastruktur und an neue Erreger konnten den Anstieg von Sterblichkeit durch diese Beeinträchtigungen jedoch abmildern.
Bedingt durch multiple Krisen wie Existenzangst, Eco-anxiety, Solastalgie (Verlust der eigenen Heimat), Burn-out, traumatische Erfahrungen während der Migration und Extremwetterereignisse stiegen **psychische und Verhaltensstörungen** stark an. Die alternde Bevölkerung und damit einhergehende erhöhte Care-Arbeit belasteten zusätzlich besonders die psychische Gesundheit von Frauen. Der Trend zu überzogenen

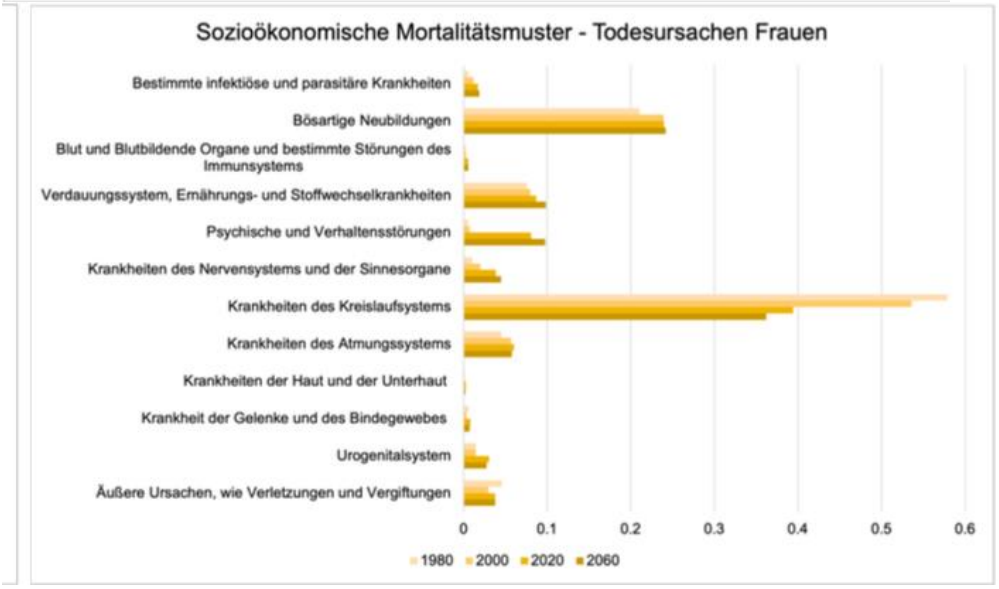
Erwartungen an die eigene Person trug ebenfalls zu einem Anstieg von psychischen Erkrankungen bei. Die stark gestiegene Prävalenzrate von psychischen Störungen ist auf den langfristigen Trend der gesellschaftlichen Öffnung und erhöhte Diagnostik zurückzuführen. **Suizidraten** sind moderat gestiegen, wobei die Suizidrate von Männern traditionell höher lag. Durch den Wandel der Geschlechterrollen förderte die Inanspruchnahme von Hilfsangeboten von Männern. Der Anstieg von psychischen Störungen führte zu erhöhtem Alkohol-, Drogen- und Medikamentenmissbrauch. Durch die steigende Lebenserwartung und Luftverschmutzung erhöht sich außerdem die Demenzrate stark, weswegen **aktive Sterbehilfe** deutlich häufiger in Anspruch genommen wird.

Äußere Ursachen, wie Verletzungen und Vergiftungen: Extremwetterereignisse wie akute Hitzewellen und die allgemein steigenden Temperaturen führten direkt zu erhöhter Sterblichkeit und indirekt zu erhöhter psychischer Belastung und Aggressionspotenzial, mit besonderer Vulnerabilität von Frauen für Gewaltexposition mit Todesfolge. Soziale Ungleichheit, Ausgrenzung, Stigmatisierung, reduzierter sozialer Frieden und Verteilungskrisen verstärken diesen Effekt und erhöhen die Sterblichkeit bei Bevölkerungsgruppen mit niedrigerem sozioökonomischem Status, die häufiger ungesunde nWohnumgebungen ausgesetzt sind. Höherer sozioökonomischer Status begünstigt pflanzenbasierte Ernährung, gerechtere Geschlechterverhältnisse, reduzierte Arbeitsbelastung und Zugang zu Grün- und Wasserflächen und konnte so die Lebenserwartung für diese Bevölkerungsgruppe erhöhen. Die steigende Ungleichheit im Zugang zur Gesundheitsversorgung durch Privatisierung verstärkt die sozioökonomischen Mortalitätsmuster. Die restriktiven Migrationsmaßnahmen der EU haben auch zu erhöhter Sterblichkeit von Flüchtenden aufgrund der Klimakrise geführt.

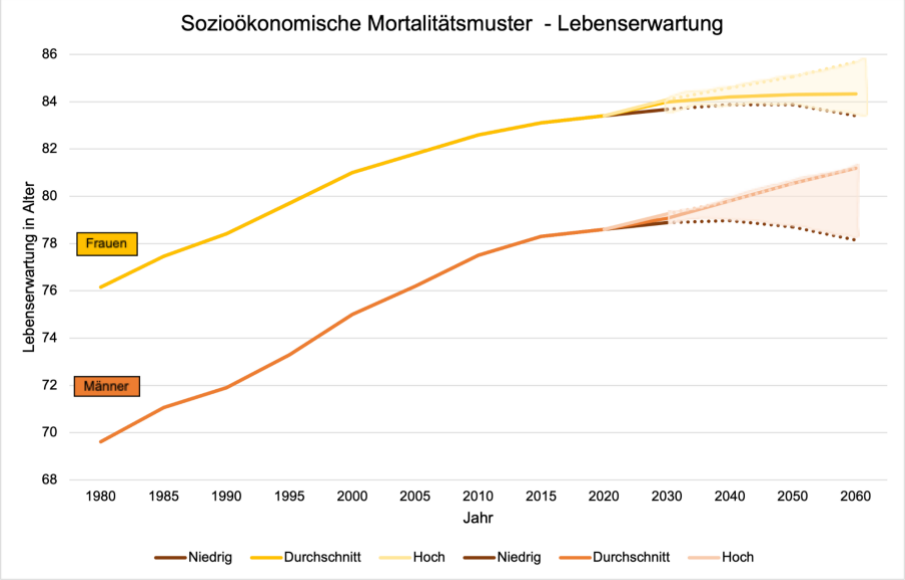
Interessante Annahmen in diesem Szenario sind:

- **Aktive Sterbehilfe**
- **Starker Unterschied in der Mortalität bedingt durch den sozioökonomischen Status**
- **Adipositas als Hauptrisikofaktor**
- **Senkung der Sterblichkeit durch verbesserte Prävention und Behandlung**
- **Verringerung von Schadstoffbelastung und Verbesserung der Luftqualität sowie Anpassungsstrategien für Infrastruktur und das Gesundheitssystem**
- **Dieses Szenario hat das höchste antizipierte Lebenserwartungsniveau**
- **Dieses Szenario hat den zweitstärken Anstieg an absoluter Sterblichkeit und erreicht ein höheres Sterblichkeitsniveau als 2020**





In diesem Szenario ist sowohl eine leichter Antieg der Lebenserwartung, sowie eine leichte Abnahme denkbar. Von allen Szenarien ist in diesem Szenario das Niveau der Lebenserwartung aufgrund der Präventionsmaßnahmen am Höchsten.



Implikationen zum Szenario der Sozioökonomische Mortalitätsmuster

Gehen Sie davon aus, dass das Szenario der **Sozioökonomische Mortalitätsmuster** im Jahr 2060 Wirklichkeit geworden ist. Kehren Sie nun gedanklich wieder in das Jahr 2023 und elaborieren Sie in der Kommentarspalte unter diesem Text möglichst genau, welche politischen Maßnahmen Ihrer Meinung notwendig sind. **Manche Szenarien beinhalten bereits politische Maßnahmen, Sie können diese gerne weiterausformulieren oder eigene Ideen entwickeln.**

Gestörte Mensch-Umwelt-Beziehung

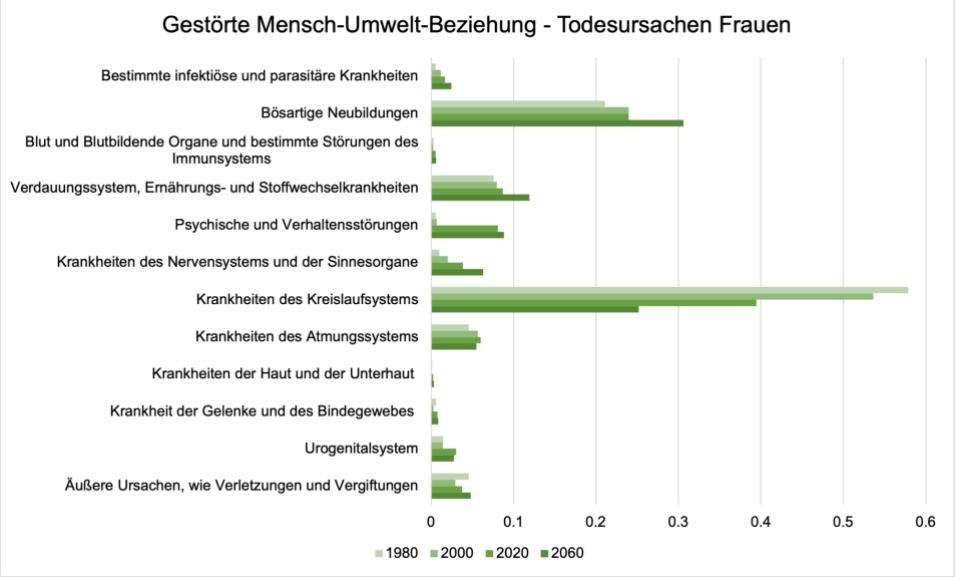
Durch die menschliche chemische Umweltverschmutzung, auch bekannt als "Novel Entities", stiegen einige Krankheiten mittel bis stark an. **Bösartige Neubildungen** wurden dadurch zur Haupttodesursache bei Frauen, da der medizinische Fortschritt mit dieser Entwicklung nicht Schritt halten konnte. **Krankheiten des Nervensystems und der Sinnesorgane** verzeichneten ebenfalls einen starken Anstieg, bedingt durch die Störung der Mensch-Umwelt-Beziehung. Auch ein leichter Anstieg von **Blut- und blutbildenden Organen sowie bestimmten Immunsystem-Störungen** ist auf die Novel Entities zurückzuführen.

Als weitere Hauptursache für den Anstieg von Erkrankungen wurde die Klimaerwärmung identifiziert. Sie führte zu einem mittelstarken Anstieg **bestimmter infektiöser und parasitärer Krankheiten**, da sie die Ausbreitung von vektor- und wasserübertragenen Infektionskrankheiten in neuen Gebieten begünstigte (z. B. durch Mücken oder Zecken übertragene Krankheiten und wasserübertragene Krankheiten durch Bakterien, Viren und Parasiten). Ebenso führte die erhöhte UV-Exposition durch Klimaerwärmung zu einem mittelstarken Anstieg von **Haut- und Unterhautkrankheiten**. Die Exposition gegenüber Chemikalien und damit die Prävalenz von entzündlichen und allergischen Hauterkrankungen nahm durch die Novel Entities zu. Durch vom Klimawandel

verursachte Extremwetterereignisse wie Flutkatastrophen gab es einen moderaten Anstieg von **äußeren Ursachen wie Verletzungen und Vergiftungen**.
Ungesunde Ernährung führte zu einem mittelstarken Anstieg von **Krankheiten des Verdauungssystems**, **Ernährungs- und Stoffwechselkrankheiten** aufgrund von Adipositas und ihren Folgeerkrankungen. **Krankheiten der Gelenke und des Bindegewebes** nahmen leicht zu aufgrund überwiegend sitzender Tätigkeiten.
Die Überforderung mit globalen und gesellschaftlichen Entwicklungen führte in den vergangenen Jahrzehnten zu einem leichten Anstieg von **psychischen und Verhaltensstörungen**.
Allerdings konnte die Luftqualität verbessert werden und in Kombination mit besseren Behandlungsmethoden wurde die Prävalenz von **Krankheiten des Kreislaufsystems** moderat gesenkt. **Krankheiten des Atmungssystems** profitierten ebenfalls von der saubereren Luft, obwohl die verlängerte Pollensaison infolge der Klimaerwärmung zu einer höheren Prävalenz von allergischem Asthma führte und diesen senkenden Faktor aufhob.

Interessante Annahmen in diesem Szenario sind:

- **Eine verbesserte Luftqualität**
- **Novel Entities und Klimawandelfolgen als Hauptrisikofaktoren für die Gesundheit**
- **In diesem Szenario nimmt die absolute Sterblichkeit am meisten zu und nimmt ein höheres Niveau ein als 2020**



Im Rahmen der ersten Delphi-Runde wurde für dieses Szenario lediglich die Komposition von Todesursachen für Frauen ausgearbeitet, es ist jedoch davon auszugehen, dass dieses Szenario ebenso für Männer gilt. Auch die Lebenserwartung konnte in diesem Szenario nicht ermittelt werden.

Implikationen zum Szenario der Novel Entities

Gehen Sie davon aus, dass das Szenario der **Gestörte Mensch-Umwelt-Beziehung** im Jahr 2060 Wirklichkeit geworden ist. Kehren Sie nun gedanklich wieder in das Jahr 2023 und elaborieren Sie in der Kommentarspalte unter diesem Text möglichst genau, welche politischen Maßnahmen Ihrer Meinung notwendig sind. **Manche Szenarien beinhalten bereits politische Maßnahmen, Sie können diese gerne weiterausformulieren oder eigene Ideen entwickeln.**

Antizipative Politik

Bestimmte **infektiöse und parasitäre Krankheiten** verzeichneten einen starken Zuwachs von über 100 %. Dies war auf die Vernichtung natürlicher Lebensräume von Wildtieren und die daraus resultierende Nähe zum Menschen zurückzuführen, was zu einem Anstieg von zoonotischen Infektionskrankheiten führte, die tödlicher als das 2020 ausgebrochene COVID-19-Virus waren. Der Klimawandel und gegen diesen ergriffene Maßnahmen übten Druck auf die Bevölkerung aus und führten zu einem mittel-starken Anstieg von **psychischen und Verhaltensstörungen**, insbesondere bei Frauen. Männer waren jedoch häufiger Suizid gefährdet.

Krankheiten des Nervensystems und der Sinnesorgane, insbesondere altersbedingte Krankheiten wie Alzheimer und Parkinson, verzeichneten einen leichten relativen Anstieg aufgrund der alternden Bevölkerung und des absoluten Rückgangs anderer Krankheiten.

Krankheiten des Atmungssystems verzeichneten den stärksten Rückgang aufgrund von Einschränkungen im Verbrennungsmotor- und Individualverkehr, was zu einer verbesserten Luftqualität führte. Nichtraucherschutzmaßnahmen trugen ebenfalls zu diesem Rückgang bei, obwohl die Tabakindustrie weiterhin ungesunde Alternativen einführte. Bei Frauen scheinen diese Maßnahmen insgesamt stärker gewirkt zu haben als bei Männern. Maßnahmen wie Arbeitsschutz und Bauvorschriften, z. B. Asbestregulierung, in den ersten zwei Dekaden des Jahrhunderts führten zu einem leichten Rückgang von **bösartigen Neubildungen.** Der Trend zu fleischloser Ernährung aufgrund des Klimawandels und verbesserte Früherkennung durch Screening und präventive Maßnahmen wie die HPV-Impfung gegen Gebärmutterhalskrebs führten ebenfalls zu einem Rückgang von **bösartigen Neubildungen**. Inflationsbedingte Armut und ein insgesamt erhöhter Stresslevel der Bevölkerung führten zu ungesunden Ernährungsweisen. Eine schlechte Versorgung der Bevölkerung durch Folgen des Klimawandels (v. a. Dürren, Wasserknappheit, Überschwemmungen und Pflanzenschädlinge) und die schlechte Ernährungsweise schwächten den rückläufigen Trend von **bösartigen Neubildungen** ab.

Maßnahmen für gesündere Ernährung an Arbeits- und Ausbildungsstätten sowie ein Werbeverbot für ungesunde Lebensmittel führten zu einem leichten Rückgang von

Verdauungssystem-, Ernährungs- und Stoffwechselkrankheiten. Männer konnten die Lücke in der tendenziell gesünderen Ernährungsweise von Frauen in den letzten Jahrzehnten überbrücken, daher wirkte sich dieser Effekt besonders stark bei diesem Geschlecht aus. Darmkrebsscreening und ein geringerer Fleischkonsum verstärkten ebenfalls den rückläufigen Trend bei Männern. Auch das Hautkrebsscreening verbesserte sich durch die Risikoadaption an Klimawandelfolgen und präventive Maßnahmen wie Aufklärung über Sonnenschutz bei Kindern führten zu einem leichten Rückgang von **Krankheiten der Haut und Unterhaut**, insbesondere bei Männern.

Männer in der alternden Bevölkerung verzeichneten aufgrund des hohen Risikos für Prostatakrebs im Alter einen leichten Anstieg von **Krankheiten des Urogenitalsystems**, während präventive Maßnahmen wie die HPV-Impfung und eine bessere Aufklärung über sexuelle Gesundheit zu einem leichten Rückgang der Sterblichkeit infolge dieser Krankheiten bei Frauen führten.

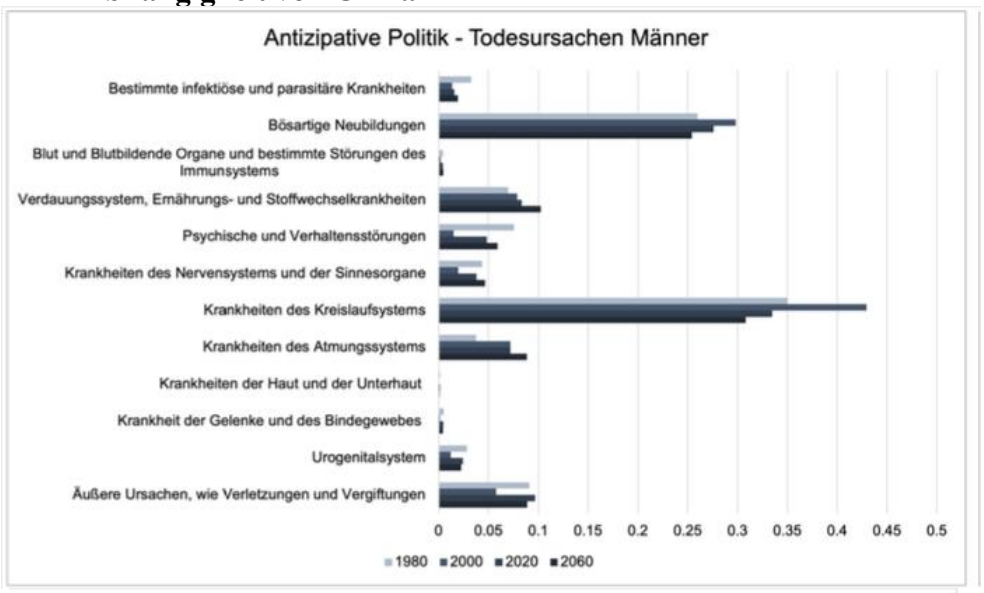
Die erhöhte Aufmerksamkeit für Femizide und die zunehmende Sichtbarkeit von Frauen in der Sicherheitsentwicklung führten insgesamt zu mehr Sicherheit von Frauen. Dadurch sanken Morde an und tödliche Verkehrsunfällev on Frauen. Die Trends bei Todesfällen durch Naturkatastrophen, bedingt durch den Klimawandel, und Verkehrsunfälle haben sich entgegengesetzt entwickelt und insgesamt dazu geführt, dass der Status quo bei **äußeren Ursachen wie Verletzungen und Vergiftungen** beibehalten wurde. Männer waren trotz der erhöhten Todesfälle durch Naturkatastrophen weniger in Verkehrsunfälle verwickelt, was auf den insgesamt gesunkenen Individualverkehr zurückzuführen ist. Andere Todesursachen blieben unverändert. Für Frauen stellten der erhöhte soziale Druck, der zu Ernährungsstörungen beitrug sowie der Mangel an Geburtskliniken und Hebammen aufgrund des Fachkräftemangels weitere gesundheitliche Risikofaktoren dar.

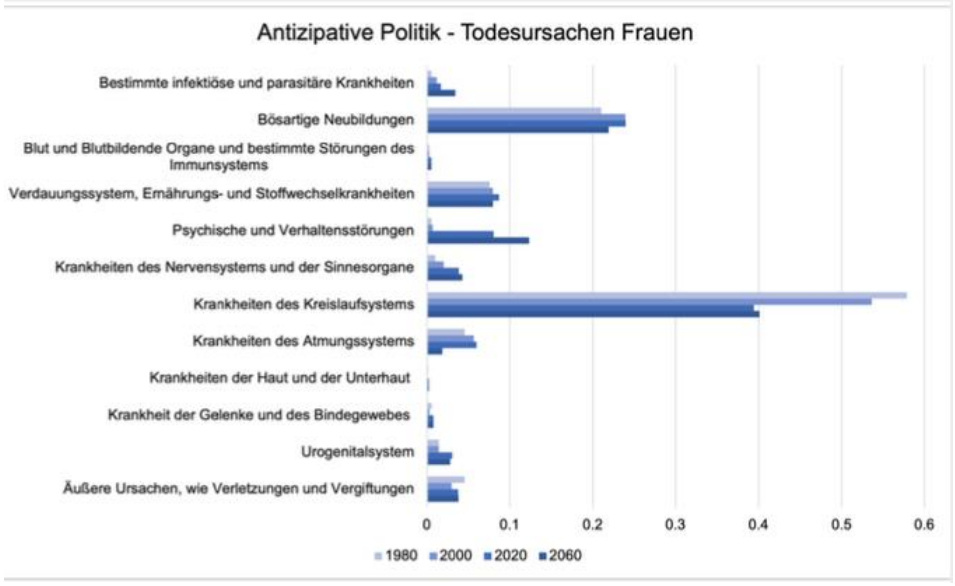
Das aktuelle Problem der Medikamentenversorgung ist durch die in der Vergangenheit geschaffene Abhängigkeit Deutschlands von unsicheren politischen Partnerschaften wie mit China erklärbar, was gegenwärtig zu Engpässen führt und den Markt für giftige Plagiate von Arzneimitteln begünstigte.

In diesem Szenario haben politische Maßnahmen im Bereich Verkehr, Bau, Ernährung und Rauchen sowie verbesserte Prävention und Technologie zu einer insgesamt gesünderen Gesellschaft geführt haben. Allerdings bedrohen der Klimawandel und die Zerstörung von Lebensräumen die öffentliche Gesundheit zunehmend, was sich in einem Anstieg von Infektionskrankheiten, schlechter Trinkwasserqualität nach Überschwemmungen und mangelnder Wasseraufbereitung aufgrund globaler Materialienknappheit sowie abnehmendem sauberen Grundwasser zeigt. Auch hitze- und kältebedingte Todesfälle und andere Naturkatastrophen gehören dazu. Auf gesellschaftlicher Ebene führt die unsichere Zukunftsperspektive zu Stress und Armut, was als einer der Hauptrisikofaktoren für tödliche Erkrankungen betrachtet werden kann.

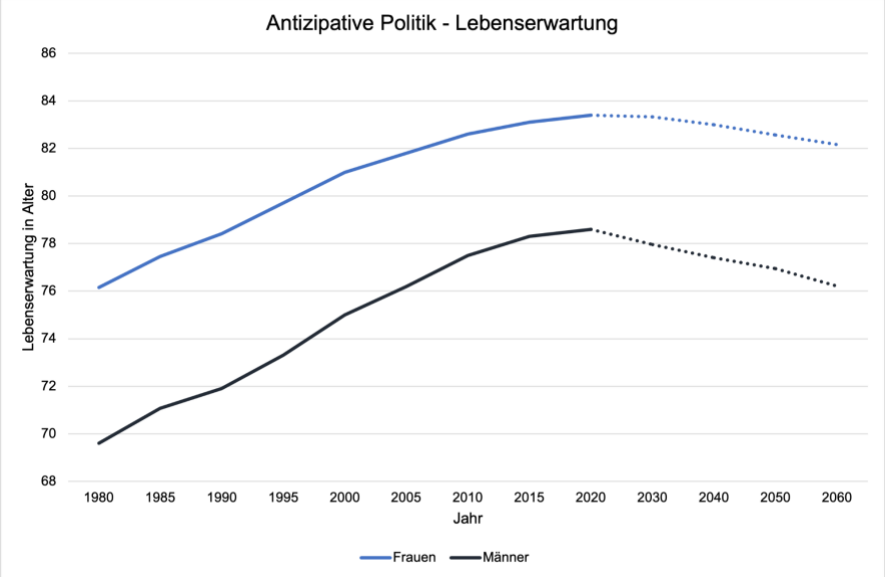
Interessante Annahmen in diesem Szenario sind:

- **Verbesserte Luftqualität**
- **Starke politische Intervention zu Ernährung und Tabak**
- **Hauptrisikofaktoren sind Klimawandelfolgen und die unsichere Zukunftsperspektive**
- **Verbesserte Prävention und Behandlung**
- **Szenario mit der zweitstärksten Abnahme von Sterblichkeit**
- **Szenario mit dem zweitniedrigstem Lebenserwartungsniveau 2060**
- **Unterversorgung von Medikamenten in Deutschland 2060 durch Abhängigkeit von China**





Mangelnde medizinische Durchbrüche und Ressourcenknappheit führten zu einer Stagnation, beziehungsweise zu einem rückläufigen Trend der Lebenserwartung.



Implikationen zum Szenario Antizipative Politik

Gehen Sie davon aus, dass das Szenario **Antizipative Politik** im Jahr 2060 Wirklichkeit geworden ist. Kehren Sie nun gedanklich wieder in das Jahr 2023 und elaborieren Sie in der Kommentarspalte unter diesem Text möglichst genau, welche politischen Maßnahmen Ihrer Meinung notwendig sind. **Manche Szenarien beinhalten bereits politische Maßnahmen, Sie können diese gerne weiterausformulieren oder eigene Ideen entwickeln.**

Geschlechterspezifische Gesundheit

Bei Männern gab es den höchsten relativen Anstieg von **Krankheiten des Verdauungssystems**, **der Ernährung und des Stoffwechsels** aufgrund von ungesunder Ernährung sowie ein erhöhtes Risiko für Adipositas, Diabetes und chronische Darmerkrankungen aufgrund von ungesunder Ernährung. Frauen hatten nur einen leichten Anstieg in dieser Kategorie, da sie im Durchschnitt gesünder essen, jedoch spielt Bewegungsmangel eine größere Rolle. Männer hatten auch den höchsten relativen Anstieg von **Hautkrankheiten**, insbesondere Melanomen und Formen von Hautkrebs aufgrund von häufigerem Arbeiten im Freien und geringerer Nutzung von präventiven Maßnahmen im Vergleich zu Frauen. Es wurden auch geschlechtsspezifische Mortalitätsunterschiede bei **Atemwegserkrankungen** festgestellt, da Lungenkrebs und COPD (Chronisch obstruktive Lungenerkrankung) bei Frauen aufgrund von strenger Tabakkontrolle leicht zurückgingen, während diese Erkrankungen bei Männern anstiegen. Auch die Belastung der Atemwege durch allergene Pflanzenarten und aggressive Pollen war ein Problem.

Es gab einen leichten Anstieg von **Krankheiten des Urogenitalsystems** bei Männern, während die Todesfälle in dieser Kategorie bei Frauen leicht zurückgingen, was auf unterschiedliche Präventionsmaßnahmen zurückzuführen ist. Beide Geschlechter

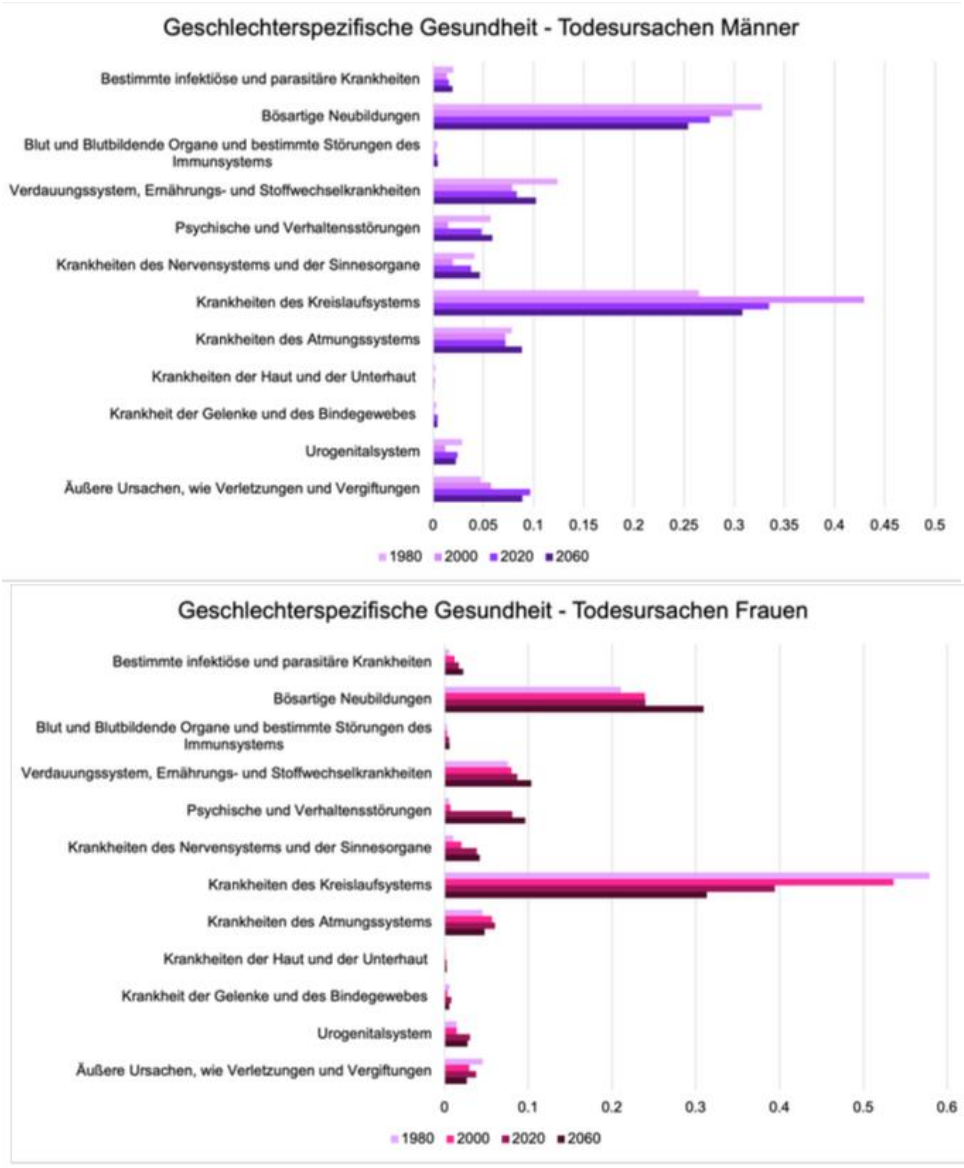
erlebten einen moderaten Anstieg von **infektiösen und parasitären Krankheiten** aufgrund der weltweiten Verbreitung von Infektionskrankheiten durch den Klimawandel, z. B. durch die Tigermücke und Viren, die von Nagetieren übertragen werden, wie Hantaviren. **Bösartige Neubildungen** nahmen moderat zu, hauptsächlich aufgrund der relativen Abnahme anderer Krankheiten. Dieser Effekt war bei Männern etwas schwächer ausgeprägt, da viele Krankheiten bei diesem Geschlecht eher zunahmen als abnahmen, weshalb der Anstieg von **bösartigen Neubildungen** nur gering war. Die Prävalenz von **Psychischen und Verhaltensstörungen** nahm ebenfalls zu, vor allem bei Frauen, und trug zum leichten Anstieg der Sterblichkeit bei. Dies war teilweise auf die psychische Belastung durch den Klimawandel zurückzuführen, aber auch auf eine höhere gesellschaftliche Sensibilisierung, bessere Diagnosemöglichkeiten und verbesserte Überlebensraten. Auch wirkte sich die Klimawandelbedingte bessere Vitamin D Versorgung und die Reduktion von Stressbelastung und Winterdepressionen durch längere Aufenthalte im Freien senkend auf die Sterblichkeit aus.

Bei **Krankheiten des Nervensystems und der Sinnesorgane** gab es einen Anstieg von Augenerkrankungen wie Grauer Star und Schwerhörigkeit. Die Sterblichkeit in dieser Kategorie stieg jedoch nur leicht an, da diese Erkrankungen selten zum Tod führen. Die Sterblichkeit bei **Krankheiten des Bluts und der blutbildenden Organe** sowie bei bestimmten Immunstörungen nahm leicht zu.

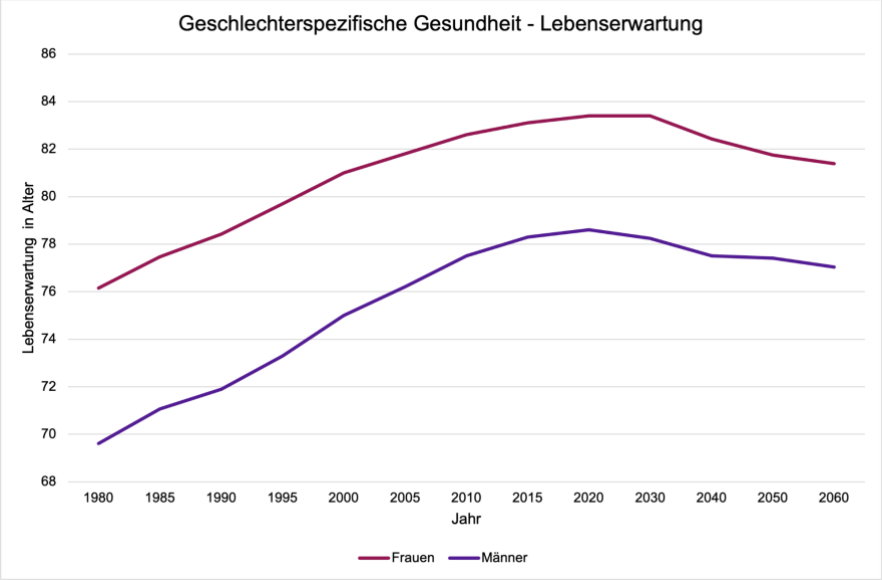
Die Sterblichkeit von **Krankheiten der Gelenke und des Bindegewebes** sowie **äußere Ursachen wie Verletzungen und Vergiftungen** nahm moderat ab. Insbesondere bei Männern war der Effekt bei Verletzungen und Vergiftungen signifikant. Dies ist auf erfolgreiche Arbeitsschutzmaßnahmen, den Rückgang körperlicher Tätigkeiten und verbesserte Prävention in Freizeitaktivitäten zurückzuführen, etwa durch die Nutzung von Helmen und Protektoren sowie verbesserte Sicherheitssysteme in der Kfz-Industrie. Durch den klimawandelbedingten verkürzten Winter kam es seltener zu glättebedingten Unfällen mit Todesfolge. Todesfälle durch **Krankheiten des Kreislaufsystems** nahmen für beide Geschlechter gleichermaßen leicht ab aufgrund besserer Diagnostik und medizinischem Fortschritt.

Interessante Annahmen in diesem Szenario sind:

- **Starke Vulnerabilität von Männern aufgrund eines riskanteren Lebensstils wie häufigeres Rauchen, Berufswahl, ungesündere Ernährung und geringere Nutzung von Präventionsangeboten**
- **Stärkere Tabakkontrolle**
- **Schlechtere Luftqualität durch Feinstaubbelastung**
- **Sozioökonomische Deprivation als Hauptrisikofaktor für die Gesundheit**
- **Geschlechtsspezifischer Unterschied in der Mortalität**
- **Dieses Szenario hat das niedrigste Lebenserwartungsniveau**
- **Leichter Anstieg der Sterblichkeit gegenüber 2020**



Die Lebenserwartung für Frauen und Männer erreichte in den 2020er Jahren ihren Höchstand und sank seither konstant.



Implikationen zum Szenario Geschlechterspezifische Gesundheit

Gehen Sie davon aus, dass das Szenario **Geschlechterspezifische Gesundheit** im Jahr 2060 Wirklichkeit geworden ist. Kehren Sie nun gedanklich wieder in das Jahr 2023 und elaborieren Sie in der Kommentarspalte unter diesem Text möglichst genau, welche politischen Maßnahmen Ihrer Meinung notwendig sind. **Manche Szenarien beinhalten bereits politische Maßnahmen, Sie können diese gerne weiterausformulieren oder eigene Ideen entwickeln.**

Wie wahrscheinlich sind die Szenarien?

Die Realisierung der fünf Szenarien ist unterschiedlich wahrscheinlich. Geben Sie im Folgenden bitte Ihre Einschätzung dazu ab, wie wahrscheinlich jedes Szenario. Wenn Sie möchten haben Sie die Möglichkeit, Ihre Auswahl in den Kommentaren zu erörtern.

Zur Übersicht:

	Inferno der mentalen Gesundheit	Sozioökonomische Mortalitätsmuster	Gestörte Mensch-Umwelt-Beziehung	Antizipative Politik	Geschlechterspezifische Gesundheit
Haupttodes-ursache	Psychische Erkrankungen (Frauen) Bösartige Neubildungen (Männer)	Kreislauferkrankung	Bösartige Neubildungen	Kreislauferkrankung	Bösartige Neubildungen
Annahmen	Adipositas-Pandemie	Aktive Sterbehilfe	Kein großer medizinscher Fortschritt bei Krebserkrankungen	Medikamenten-unterversorgung durch Abhängigkeit von China	Vulnerabilität von Männern durch riskanteren Lebensstil
Hauptrisiko-faktoren	• Fehlernährung • Gewalt und Stressbelastung	• Adipositas • Sozioökonomische Unterschiede	• Novel Entities • Klimawandelfolgen	Klimawandelfolgen	Sozioökonomische Deprivation
Intervention	-	Anpassungsstrategien • Infrastruktur • Gesundheitssystem	-	• Prävention und Behandlung • Ernährung und Tabak	Stärkere Tabakkontrolle
Luftqualität	-	Verbesserung	Verbesserung	Verbesserung	Verschlechterung
Lebens-erwartung	Zweithöchste	Höchste	-	Zweitniedrigste	Niedrigste
Sterbefälle	Größte Abnahme	Zweitstärkster Anstieg	Stärkste Zunahme	Zweitstärkste Abnahme	Leichter Anstieg

Wahrscheinlichkeit der Szenarien

	Sehr wahrscheinlich	Eher wahrscheinlich	Neutral	Weniger wahrscheinlich	Sehr unwahrscheinlich
Inferno der mentalen Gesundheit	○	○	○	○	○
Sozioökonomische Mortalitätsmuster	○	○	○	○	○
Gestörte Mensch-Umwelt-Beziehung	○	○	○	○	○
Antizipative Politik	○	○	○	○	○
Geschlechterspezifische Gesundheit	○	○	○	○	○

Wie ist Ihre Präferenz zu jedem Szenario?

Die Realisierung der fünf Szenarien ist unterschiedlich stark wünschenswert. Geben Sie im Folgenden bitte Ihre Einschätzung dazu ab, wie Ihre Präferenz zu jedem Szenario ist. Wenn Sie möchten haben Sie die Möglichkeit, Ihre Auswahl in den Kommentaren zu erörtern.

Präferenz der Szenarien

	Sehr präferiert	Eher präferiert	Neutral	Weniger präferiert	Gar nicht präferiert
Inferno der Mentalen Gesundheit	○	○	○	○	○
Sozioökonomische Mortalitätsmuster	○	○	○	○	○
Gestörte Mensch-Umwelt-Beziehung	○	○	○	○	○
Antizipative Politik	○	○	○	○	○
Geschlechterspezifische Gesundheit	○	○	○	○	○

Appendix 3 List of Causes of Death Categorized into 12 Groups according to the ICD-10 Standards

1. Certain infectious and parasitic diseases (A00-B99)
2. Malignant neoplasms (C00-D48)
3. Blood and blood-forming organs and certain disorders of the immune system (D50-D90)
4. Digestive system, nutritional and metabolic diseases (E00-E90; K00-K93)
5. Mental and behavioral disorders (F00-F99)
6. Diseases of the nervous system and sensory organs (G00-H95)
7. Diseases of the circulatory system (I00-I99)
8. Diseases of the respiratory system (J00-J99)
9. Diseases of the skin and subcutaneous tissue (L00-L99)
10. Disease of the joints and connective tissue (M00-M99)
11. Urogenital system (N00-N99)
12. External causes, such as injuries and poisoning (S00-T98; U129, V01-Y98)

Appendix 4 Codebook – First Delphi Round's Data

- **Code: Cause** – Describes which factors or events lead to a situation, for example:
    - Temperature
        - Global warming
        - Extreme heats
        - Changes
    - Migration
        - Species migrations
        - Migration from people
        - Internal migration
    - Habitat
        - Change in distribution areas
        - Destruction of the natural habitat by wildlife
        - Habitat change
        - Proximity to wildlife
        - Loss of biodiversity
    - Global factory farming
    - Population structure

        - Ageing population
        - Demography
    - Relative decrease of other diseases
    - Lifestyle
        - Lifestyle-related
        - Nutrition
            - More plant-based diets
            - Decrease of meat consumption
            - Inflation-related unhealthy nutrition
            - Diet behavior (extremely proceed food)
            - Malnutrition
            - Diet-related diseases
        - Sitting activity
    - Increasing life expectancy
    - Climate change
        - Climate change-related worsening diet
        - Climate change-related poor supply
        - Increased climate change-related migration
        - Water scarcity
        - Plant pests
        - The mental impact of climate change
            - Solastalgia (= psychological burden caused by the destruction of one's own home or living environment)
            - Eco anxiety
            - Traumatizing experiences (e.g., migration or extreme weather events)
        - Threatening changes in living circumstances (e.g., Climate change)
        - Increase in allergic diseases
        - Extension and intensification of the pollen season
        - Natural disasters
            - Increase of extreme weather events
            - Flood disasters
            - Storms

        - Heat waves
        - Heavy rain
        - Droughts
        - Extreme weather events (e.g., Heatwaves)
    - Environment
        - Environment-related hazards
        - Increasing UV-Exposition
        - Novel Entities (= human-made chemical pollution of the environment)
        - Increasing chemical-Exposition
        - Exposure to hormonally active endocrine disruptors
        - Environmental factors
        - Exposition
        - Disruption of the human-environment-relationship
        - Environmental pollution
        - Air pollution
        - Concrete diseases
            - Tuberculosis
            - Malaria
            - Zoonotic diseases and vectors
                - Avian flu
                - Tiger mosquito
    - Cancer-promoting political measures
    - Lowering cause
        - Lowering of air pollution
    - Better healthcare supply
    - Destigmatization of mental illnesses
    - Financial
        - Economic crises
        - Living expenses
    - Multiple crises
    - Pandemics
    - Overload of the modern world
    - Uncertainty of the future

    - Apparent increase through better diagnostic
    - Limited treatment options
    - Increase of diseases as risk factors
        - Increase of Adiposity
        - Increase of Hypertonia
    - Less outreach behavior by men from prevention
    - Societal
        - Reduced social peace
        - Increased social inequality
        - Societal developments
    - Supply
        - Distribution crises
        - Dependence on China and other global players in drug supply
        - Hardly any reserves
- **Code: Impacts** – What is the outcome of causes, what are the resulting situations, such as the increase of concrete diseases or epistemological situations for example:
    - Zoonosis
    - Vectors
        - Infections, infectious pathogens
        - Parasite
        - Viruses
        - Vector transmitted diseases
        - Water-transmitted infectious diseases
    - Pandemic
    - Pandemic extent
    - Resistance
        - Resistance of tuberculosis
        - Antimicrobial Resistance (AMR)
        - Resistance of antibiotics
        - Antibiotic-resistant pathogens
    - Paralysis of infrastructure
    - Malignant neoplasms
        - Cancer disease

        - Malignant neoplasms
        - Malignant diseases
    - Digestive system, nutritional and metabolic diseases
        - Gastrointestinal malignancies
        - Diabetes
    - Mental and behavioral disorders
        - Dementia
        - Mental illnesses
        - Suicide
        - Burn-out
        - Mortality through mental illnesses
    - Diseases of the nervous system and sensory organs
        - Eye diseases (Cataract)
        - Hearing impairment
        - Alzheimer
        - Parkinson's
        - Dementia
        - Neurodegenerative Illnesses
        - Dementia diseases
    - Diseases of the circulatory system
        - NCD (= Non-Communicable Diseases)
        - Stroke with fatal outcome
        - Cardiovascular diseases
    - Diseases of the respiratory system
        - Lung cancer
        - COPD (= Chronic obstructive pulmonary disease)
        - Respiratory disease
    - Diseases of the skin and subcutaneous tissue
        - Melanomas
        - Forms of white skin cancer
        - UV-related diseases
        - Inflammatory and allergic skin diseases
    - Men predominantly work outdoors and are more vulnerable to diseases of the skin and subcutaneous tissue

    - Diseases of the urogenital system
        - Cervical cancer
        - Increase in risk factors for kidney insufficiencies
        - Excess mortality due to exsiccosis
    - Increased aggression potential (intimate partner violence, homicide)
    - Death due to violence
    - Increased suicide rate
    - Suicide
    - Depression
    - Anxiety
    - Mental illnesses
    - Trauma caused by livelihood-destroying events
    - Possibly more use of 'alternative' or toxic remedies, or more counterfeit pharmaceuticals on the market
- **Code: Evaluation** – How are changes operationalized, for example:
    - Evaluation of increase
        - Increase
        - Occur more frequently
        - Increase in frequency
        - Marginal increase
        - Slight increase
        - Relative increase
        - Further increase
        - Risk of global spread
        - Can become more important
        - Emergence
        - Spread
        - Favored
        - Deadly
        - Increasing incidence
        - Increase in cases of death
        - Strong increase in the prevalence and mortality
        - Increasing trend
        - Increase in morbidity

        - Apparent increase through increasing diagnosis
        - Actual increase
        - Significant increase
        - Moderate increase in cases of death
        - Strongest increase
        - More people die
        - Massive increase
        - Rise
    - Evaluation of decrease
        - Become rarer
        - Go back further
        - Being reduced
        - Decrease
        - Reduced mortality
        - Slight decrease
        - Reduced
        - Rare cause of death
        - Rare
        - Decline
        - A continuing trend of decrease
        - Sink a little
        - Decrease of mortality
        -
    - Status quo
        - No increase in cases of death
        - Developments that cancel each other out
        - Unchanged mortality
        - Generally, of low importance for overall mortality
        - Stagnation
        - Steady
        - No big change
    - Prevalence
        - No higher mortality, only a higher prevalence
        - Increase in prevalence

        - Increase in incidence
    - Main cause of death
        - Main cause of death (Digestive system, nutritional and metabolic diseases)
        - Mental and behavioral disorders are one of the main causes of death
    - Men are more ‘successful’ in suicide
- **Code: Lowering Measures** – Described measures to lower mortality, for example:
    - Adaptive measures
        - Adaptive measures in construction
        - Medical adaptive measures
    - Treatment
        - Better treatment
        - New treatment measures
        - Improved therapy
        - Adapted therapy methods
        - Adapted early detection methods
        - Adapted therapy methods
        - Improved therapy options
        - Recent developments in dermatooncology
    - Prevention
        - Improved prevention
        - Adapted early detection methods
        - Improved diagnostic
        - Higher alert to symptoms
        - Higher chances for diagnosis
        - More frequent diagnosis
        - Prevention (e.g., Children learn sunburn protection)
        - Screenings
            - Breast cancer screenings
            - Colon cancer screenings
            - Skin cancer screenings
        - HPV vaccination

        - Improved prevention and care of cervical carcinoma
        - Improved care of prostate carcinoma
    - Preventive measures of the past
        - Non-smoker protection
        - Dealing with asbestos
        - Occupational safety
        - Improved working environment (e.g., hardly any coal workers)
        - Effective policy in recent years
    - Pushback on lobbyists
    - Healthier food in canteens and daycare centers
    - Improved air quality
    - Strong tobacco control policy
    - Sensibilization
    - Openness to talk about sexual health
    - More prostate cancer due to increasing life expectancy
    - Decrease of violence against Women
    - Decrease of femicides
    - Increasing consideration of women in safety development (e.g., introduction of female crash dummies) leads to lower mortality among women
- **Code: Examples** – When concrete examples of a situation are described, for example:
    - COVID-19 Pandemic
- **Code: Concerned Group** – When a specific risk group according to dimensions such as sex, age, socio-economic status, occupation, migration status, and so on are mentioned, for example:
    - People with migration backgrounds are particularly concerned, as measurements in other countries are partly way less
    - Age cohorts
        - Children
        - Teenagers
        - Old age groups
    - Sex
        - Women

        - Men
- **Code: Lowering Factors** – Factors that lower the mortality of specific diseases but their origin is not necessarily a policy measure but something else as societal developments and so on, for example:
    - Less meat consumption
    - Decrease of nicotine abuse
    - Traffic
        - Less internal combustion cars
        - Less motorized individual traffic
        - Less deadly accidents through less car traffic
- **Code: Problem amplifying factor** – Factors of all origin that cause an increase in mortality for specific diseases, for example:
    - Complexity of mental illness treatment
    - Air pollution
    - Damaging innovation of the tobacco industry
    - No good treatment option yet for diseases of the joints and connective tissues
- **Code: Prognosis** – Statements on developments in the future, for example:
    - The extent of deadliness depends on the extermination of relevant population groups
    - Increasing life expectancy in Germany will be insignificant
    - Prevention and Treatment
        - Longer course of diseases due to progress
        - Medical progress cannot keep pace with increasing diseases
        - Preventive measures of the past will have a lowering effect on cancer prevalence in the future
        - Other diseases, such as Anemias are worldwide screened and treated better
        - Improved skin cancer screening in the upcoming years due to risk adaption
        - No breakthroughs in the treatment of diseases of the nervous system and sensory organs
    - Environment-related hazards in Germany will be further addressed and be lowered in their carcinogenic effect

- Assisted suicide as an answer to dementia
- Other categories capture more deaths and result in a smaller relative increase in deaths in the category of external causes, such as injuries and poisoning

Appendix 5 Codebook – Second Delphi Round's Data

- **Code: Problem** – an aspect described as an issue for health in the context of the scenario description, for example:
  - Mental health
    - Increased burden on mental health
    - Complex treatment of mental and behavioral disorders overloading the healthcare system
    - Excessive demand for psychotherapists and psychiatrists
    - Regional difference in mental health care supply
  - Society
    - Fragmentation of society
    - Growing individualism
    - Influence of fake news
    - Potential infodemic
    - Socioeconomic differences
    - Health literacy as competence is not equally present in all layers
    - Socio-economic-related increase in diseases
  - Increase in death or prevalence
    - Increase in diseases of the nervous system and sensory organs
    - Increase in Adiposity
    - Obesity-related diseases
    - Increase in the prevalence of mental illnesses
    - Increase in the prevalence of Alzheimer
    - Death through heat
    - Increase in death and disease prevalence through chronicle UV-Exposition
      - Actinic keratoses
      - Malignant melanomas

                - Non-melanocytic skin cancer
                - Basal cell carcinoma
                - Squamous cell carcinoma
                - "White skin cancer"
        - Unhealthy advertisement
        - Environment and climate change
            - Climate change impact on health
            - Alienation from nature
            - Drivers of the environmental pollution and climate crisis
            - Increase in tropospheric ozone
        - Paralyzing of the infrastructure through extreme weather events
            - Sewage
            - Wastewater
            - Treatment plants
            - Spread of pathogens
            - Losses of healthcare infrastructure
            - Undersupply of medication for chronic diseases
        - Dependence on other countries in drug supply
- **Code: Aim** – the target defined on a desirable future state, such as the mitigation of the problem defined, for example:
    - Mental health
        - Mental health promotion
        - Capacity and availability of mental health care
        - Nation-wide system of prevention and early detection
    - Strengthening health care system
    - Capacities for the preventive and health-promoting measures
    - Health promotion
    - Society
        - Promotion of communitarianism
        - Strengthening the social security of the population
        - Conceptualize methods of action both with respect to the availability of and access to socially sensitive and responsive health literacy within wider programs of prevention and health promotion

  - Mitigate uncertainty caused by future anxiety
  - Lifestyle
    - Incentives for a healthy lifestyle
    - Affordable lifestyle changes
  - Monitoring
  - Discussion
  - Regulating
  - Environment and climate change
    - Measures that target environmental protection and health
    - Mitigating climate change in the light of public health
  - Higher demand for assisted suicide
  - Health policies
    - Health in all policies
    - Health policies based on natural sciences and systematic public health research

- **Code: Intervention** – a concrete proposal of a measure to reach a certain aim for the mitigation of the defined problem, for example:
  - Green social prescribing (e.g., community gardens)
  - Community garden projects
  - Insect hotels
  - Health care system
    - Train general practitioners in mental health
    - Empower general practitioners in psychosomatic medicine and early counseling to intervene and refer
  - Counseling at specific transition points
    - Entry and final exams
    - Every decade in somebodies' life
  - Education
    - Life skill courses for all children with refreshments
    - Target group-related education about the impact on the mental wellbeing of the climate crisis
    - Health literacy as part of the curricula
    - Knowledge transfer
    - Create a healthy environment and practice the trained knowledge

        - Organized activities to train health literacy
    - Economic incentives
        - Tax reduction for healthy food
        - Higher tax for unhealthy food
        - Benefits from the health insurance companies
    - Short-term cures are offered every decade for employers
    - Regulation of malevolent artificial intelligence and automated chatbots
        - Monitoring
        - Public discussion
        - Regulating and blocking
    - Public Health Service (ÖGD)
        - Strengthening the Public Health Service (ÖGD) with professionals
        - ÖGD as advising actors
        - Monitoring and providing regular health reports
    - Regular screenings and checkups
    - Telemedicine
    - Infrastructure
        - City planning away from car-centered towards improved bike and public transportation infrastructure
        - Electromobility for disabled people
        - Affordable and attractive public transportation
    - Climate change
        - Making the planetary health diet attractive, affordable, and easily accessible to everyone
        - Mitigation of climate change to reduce its impact on health
        - Advocating One Health, thus the inextricable intertwining of human health, animal health, and ecosystem health
    - Investments
        - Large investment in the pharmaceutic industry
        - Governmental Investment in Gender Medicine
    - Performance of research stratified by sex
- **Code: Kind of Intervention** – the classification of the proposed intervention, such as primary, secondary, or tertiary prevention, in the means of education or

training, economic incentives or social restriction, such as laws or prohibitions, for example:

  - Prevention
    - Primary preventive measures
    - Secondary preventive measures
  - Economic incentives
    - Subvention
    - Tax reduction
    - Tax increase
    - Attractive capital allocation criteria
  - Education
    - Training
    - Education
    - Health Literacy Education
  - Laws
  - Research
  - Government expenditure

- **Code: Actors** – the body or bodies that are identified as responsible for carrying out the proposed intervention, for example:
  - Political bodies
    - Local governments
    - Communal level
    - Federal level
    - State level
    - Government
    - EU-Level
    - International level
    - United Nations Organizations
  - Policymakers
  - General practitioners
  - Health care system
  - Public Health Service
  - Public health field
  - Legislative bodies

  - Educational institutions
  - Employers
  - Health insurance companies
  - Scientific community
- **Code: Impact** – the expected outcome of the suggested intervention, for example:
  - Mental health
    - Improving well-being
    - Improved mental health
    - Increase mental health care supply
  - Environment
    - Environmental protection
    - Care for the environment
  - Society
    - Intergenerational exchange
    - Social coherence
    - Adequate health literacy across all socioeconomic levels and within all social groups
  - Reduction of diseases through a healthier lifestyle
  - Reduction of chronic diseases caused by climate change impact
  - Adequate capacity of care through a package of prevention and health-promoting measures
  - Politics
    - Science-policy-practice-HiaPnetwork rooted in the One Health/ Planetary-Health framework
    - Implementation of a correction and adaption cycle of health policy measures
    - Long-term strategy with interim goals and accountability mechanisms
- **Code: Target Group** – a group of people concerned mainly with the problem of health identified, the group can be classified according to several dimensions, such as sex, age, socio-economic status, occupation, migration status, and so on. Those vulnerable people are identified as the target group for measures, for example:
  - Families

        - Families with children at preschool and secondary school levels
        - Caretakers of family members
        - Single parents
        - Parents
    - People in tertiary education
        - Universities
        - Professional training
    - Age cohort
        - Every age group is affected
        - Older age cohorts
        - Younger age cohorts
        - Adults
        - Children
    - Every person
    - Socio-economic status
        - People of lower socio-economic status
        - All social layers
        - People of different socio-economic groups
    - Migration and ethnicity
        - People with a migration background
        - Ethnical groups
    - People shortly before retirement
    - Outdoor workers have a long exposition to UV
    - People who spend their free time outside
    - People with previous illness (multi-morbidity)
- **Code: Surrounding** – the environment in which the health-threatening issue occurs, such as working environment, educational institutions, nursing homes, canteens, living environments, recreational spaces, and so on, for example:
    - In contact with doctors
    - Work environment
    - Educational institutions
        - Schools
        - Universities
    - Nursery homes

- Living environment
- Neighborhood
- Mobility routes
- Food environment
- Health politics

Appendix 6 Abstract in German

Zusammenfassung:
Die vorliegende Arbeit beschäftigt sich mit der Entwicklung der Sterblichkeit in Deutschland im Jahr 2060 und den daraus resultierenden Implikationen für die Politik. Das Thema dieser Arbeit ist in der Disziplin der Demografie angesiedelt und ihr methodischer Ansatz in der Zukunftsforschung verwurzelt. Ziel ist es, zur Reduktion der Unsicherheit über die Sterblichkeitsentwicklung in Deutschland in den kommenden Jahrzehnten beizutragen und der öffentlichen Verwaltung sowie den politischen Entscheidungsträgern Erkenntnisse über den möglichen künftigen Bedarf an medizinischer Versorgung bereitzustellen. Zwei Fragestellungen sind maßgeblich:

1. Wie werden sich die Sterblichkeitsmuster unter dem Einfluss des Klimawandels und der Veränderung des Lebensstils in Deutschland im Jahr 2060 verändern?
2. Welche Maßnahmen könnten geeignet sein, auf die untersuchten Veränderungen zu reagieren?

Die Datenerhebung wurde in einem zweistufigen policy Delphi-Verfahren durchgeführt. Das hierfür eingesetzte Expertengremium zur *Mortalität in Deutschland 2060* bestand aus insgesamt 16 Wissenschaftlern mit überwiegend medizinischem Hintergrund und Fachwissen in mindestens einem der für die Studie relevanten Bereichen. Diese waren Public Health, Umwelt und Gesundheit, Lifestyle-Medizin, Demografie, Epidemiologie und Gesundheitspolitik. Die Daten der ersten Runde wurden mit einem mixed-method Ansatz von Clusteranalyse und herkömmlicher qualitativer Inhaltsanalyse untersucht. Die quantitativ ermittelten Cluster wurden mit Handlungssträngen untermauert, welche sich aus der qualitativen Datenanalyse ermittelt ergaben. Hieraus wurden fünf Szenarien abgeleitet: *Mental Health Inferno*, *Socio-economic Mortality Patterns*, *Disturbed Human-Environment Relationship*, *Anticipatory Policy*, and *Gender-Specific Health*. Jedes Szenario beschreibt die Zusammensetzung der Todesursachen auf Grundlage von 12 Kategorien, die nach ICD-10-Standards geclustert wurden, die Vorhersage der Lebenserwartung sowie gesundheitsrelevante Faktoren des Lebensstils und des Klimawandels. In der zweiten policy Delphi-Runde formulierte das Expertengremium für

jedes Szenario Politikempfehlungen, die mittels konventioneller qualitativer Inhaltsanalyse ausgewertet wurden.

Das wichtigste Ergebnis dieser Studie war, dass die prognostizierte Lebenserwartung langsamer steigen wird als bei allen anderen in der Literaturübersicht vorgestellten Studien. Einige Einschätzungen des Expertengremiums deuten darauf hin, dass die Lebenserwartung in Deutschland bis 2060 möglicherweise nicht nur langsamer steigt, sondern eine stagnierende oder rückläufige Tendenz zeigt, maßgeblich getrieben durch den Wandel im Lebensstil und im Klima.

Schlagwörter: Policy Delphi, Szenarien, Mortalität, Deutschland, 2060, Lebensstil, Klimawandel