Approaches to measuring climate change impacts for medical insurers

Understanding the morbidity and mortality risks from climate change

Joanne Buckle, FIA
Alexander Krauskopf, Aktuar DAV, CERA
Natasha Singhal, FIA

This paper offers a framework for modelling the impact of events related to climate change on medical insurers.

Identification and quantification of the precise impact of climate change on future healthcare use can be challenging. The “cause-to-effect” path is not well-defined and historical data to assess the impact of future climate-related events is extremely limited. In this paper we explore a conceptual framework for considering the impact of climate change on medical insurers and talk about some of the research we have done using historical data in the UK and Germany to help develop parameters for future modelling.

We focus on the physical risks of climate change on insurance for medical insurers but note that the operational risks arising from climate change are material and transition risks may also be significant, including the impact on an insurer’s asset side of the balance sheet from changing financial markets.

Climate change, health and healthcare usage

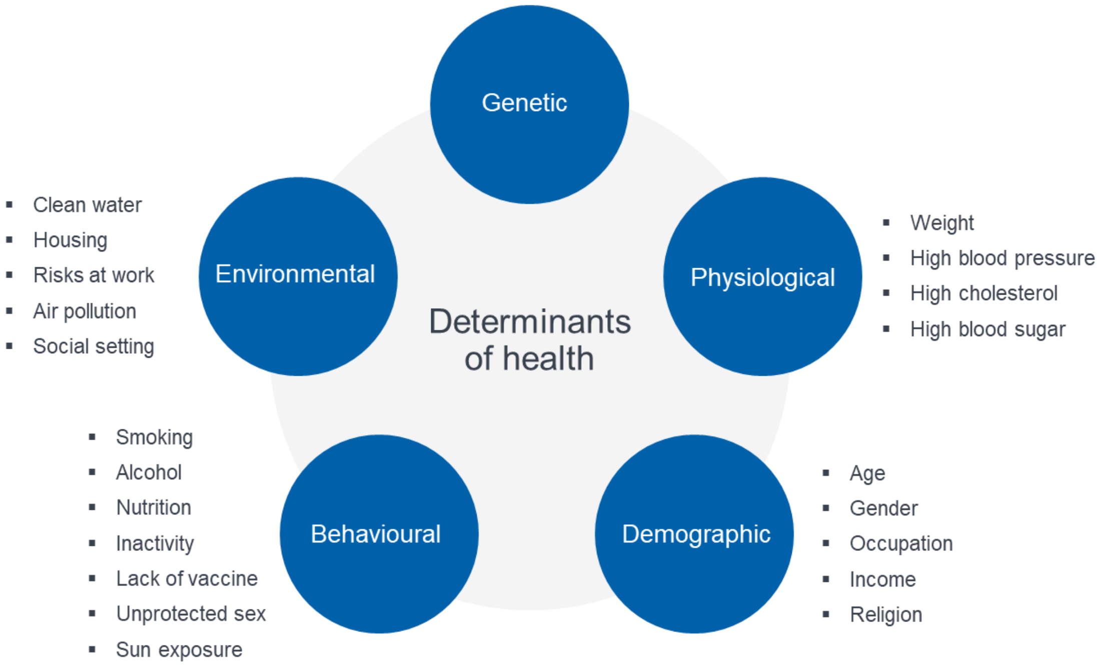
Climate change can impact health both directly and indirectly, but identification and quantification of the precise impact of climate change on future morbidity and mortality, hence associated healthcare utilisation, can be challenging. Direct impacts may include, for example, the additional use of emergency services due to injuries and exacerbation of chronic illnesses from weather catastrophes. Direct impacts may also include secondary impacts on mental health from specific events, for example, stress related to lost property or possessions after a flood or wildfire. Indirect impacts can be equally important; for example, during a flood, patients may not be able to access their usual healthcare providers, utilisation rates may fall and the profile of claims costs experienced may change significantly. There may also be long-term impacts from macroeconomic changes, such as increases in inequality and cost of living due to carbon-reduction initiatives that may have significant impacts on health.

Considering the interconnectedness of factors affecting health is an important starting point in considering potential climate impacts. Figure 1 includes an illustration of determinants of health, which demonstrates some of the above-mentioned complexity. For most insurers, the contextual data they receive about an individual patient’s health is limited and does not allow them to build a full picture of the determinants of health for their portfolios. In general, insurers hold three types of relevant data here:

1. A small proportion of the demographic variables from enrollment data such as gender, age, location etc.
2. Some physiological and behavioral data from any initial medical underwriting or regular health questionnaires.
3. Historical claims data, which potentially provides some genetic and physiological information.

Healthcare data in the three categories above held by insurers are frequently not detailed enough to allow an accurate representation of the factors that affect a population's health, limiting the ability to understand how these factors interact with one another, and so the picture is incomplete. There may also be limitations on the extent to which data can be used due to local data protection and privacy regulations. Nevertheless, several tools are available which can help insurers build a profile of their insured populations and identify specific risk-factors for climate-related events.

FIGURE 1: SOME OF THE INTERCONNECTED DETERMINANTS OF HEALTH



Modelling considerations

Given the industry's limited understanding of the drivers of health and healthcare usage in most medical insurance portfolios and their links to climate change, we require a specific framework to help us translate climate-related scenarios into impacts on health. This will aid in understanding the impacts of climate change on healthcare utilisation patterns and costs, as well as in estimating plausible parameters for any model of impacts.

A useful starting point to building an understanding of the impact climate change might have on healthcare is to start with considering the different ways in which climate change can impact a specific service within a healthcare system. For example, we could consider specifically the impact of climate change on utilisation for different conditions, and then the impact on the average costs of services separately. Once each individual impact pathway is identified by service, quantification of the impact by service and the intra-relationships between individual service pathways would build a picture of the overall impact, with a traceable view of the causal pathway.

We have developed the framework shown in Figure 2 to work through understanding and quantifying the impacts of climate change events on a medical insurers' expected claims experience.

Building a meaningful population segmentation based on limited historical data is possible but challenging in many markets. Nevertheless, it is important to be able to categorise the population appropriately to estimate vulnerability and to cross-reference this vulnerability with the most likely climate change events in a specific geographical region. By working through a causal model, looking specifically at how each potential event may have an impact on the specific services that would be used by a specific population segment at a specific point in time and aggregating the results, we can build insights into the relative impact of different climate-related events, both in the short and long term.

FIGURE 2: FRAMEWORK FOR UNDERSTANDING AND QUANTIFYING THE IMPACTS OF CLIMATE CHANGE EVENTS FOR MEDICAL INSURERS[1]

Population segmentation	▪ Required to understand the underlying health condition of the population, and overall susceptibility ▪ Population segmentation with a chronic element is preferred, as whilst chronic conditions are not often covered by medical insurers, they may lead to acute flare-ups. ▪ Research[1] shows those with comorbidities or chronic conditions are at more risk to experience a climate change event compared to healthy individuals.
Defining scenarios to model	▪ Scenarios should be clearly defined, with a low, medium, and high scenario for each climate change event considered. ▪ Scenario definition should specify the affected areas within each scenario and, therefore, the proportion of the portfolio insured population that would be affected, e.g., a low-severity flood in a specified city may only affect a small proportion of the insured population vs. a high-severity flood scenario, affecting a number of cities.
Impact of scenario on acute and chronic conditions	▪ Through historical data and research. The likelihood of chronic flare-ups, by condition, and by acute conditions, such as injury, should be estimated. ▪ Each climate change event will affect a different range of conditions, though there may be some conditions susceptible to all climate events. ▪ Consideration of immediate, mid-term and longer-term impacts will be crucial at this stage, as for example injuries may take place immediately, but mental health conditions may develop at a slower pace.
Identify service categories with varied utilisation	▪ Using the array of conditions affected by a climate change event, the service categories affected can be identified, alongside the expected change in utilisation as a result. ▪ Utilisation may increase or decrease from offsets as a result of indirect effects, e.g., if a climate event restricts access to healthcare providers, there may be a reduction in utilisation. ▪ Using a defined set of service categories will increase analysis capabilities when comparing different climate change scenarios and their impacts.
Movement of healthy index of population	▪ A climate change event may exacerbate an individual's health condition, which previously may have had little effect on their quality of life, e.g., someone with mild asthma may become more susceptible to asthma attacks following a severe attack during a climate change event. ▪ Such an event will change the health distribution of the population, with members transitioning to lower health conditions over time. This may increase the average costs a medical insurer can expect in a normal year.

Key risks for medical insurers

It is also helpful to understand a little about the composition of risk in a typical medical insurance portfolio and how that risk composition differs between short-term and long-term insurance. In this section we discuss potential impacts due to climate change on key risks for medical insurers, identifying parts of a medical insurer's risk portfolio with the greatest exposures to climate-change-related events.

UNDERWRITING RISK

Underwriting risks arise from inaccurate assessments of risks when writing insurance policies, including but not limited to pricing and rating methodologies, terms and conditions and insufficient medical underwriting processes.

For most European medical insurers, health underwriting risk is a significant component of their risk profiles. We consider some of the component parts below.

Morbidity risk

Climate change events can impact the morbidity risk for medical insurers to varying degrees depending on factors such as the scale, location and frequency of the climate change event. Calculating the changing morbidity burden can be extremely challenging for both short-term and long-term insurers, due to the vast nature of what is included in morbidity risk and the many factors that it varies by, such as age, genetics, comorbidities and chronic diseases. In addition, the burden of morbidity may not translate directly into healthcare usage and predicting future usage requires an additional prediction of future medicines and technologies.

Morbidity risks translate into changes in both frequency and severity of healthcare usage and arise due to changes in both long-term trends and one-off events. Insurers writing health business as Similar to Life Techniques (SLT) long-term contracts have to consider 30-year-plus time horizons for the impact of climate on health. For non-SLT (NSLT) business, insurers' contracts can be repriced each year, therefore theoretically limiting the risks related to climate, as they can simply be priced in as they emerge. In reality, climate change means a higher frequency of disruptive climate events with associated short-term and long-term increases in healthcare usage and not just an impact on longer-term trend. Therefore, short-term medical insurers also need to consider the longer-term time horizon to ensure they have accounted for both short-term and longer-term uncertainty, or they risk a future of significantly more volatile loss ratios, which in turn may give rise to the need to hold higher levels of capital.

Some examples of how climate events can affect both frequency and severity for medical insurers include:

- A one-off climate change event will directly impact the frequency of healthcare service use, but this varies depending on the service and the type of climate change event. For example, immediately after a flood there may be increased utilisation for injuries, but reduced utilisation for those unable to travel to a routine appointment. Climate change will also likely have secondary effects on utilisation, potentially for many months or years after the initial trigger event.
- A one-off climate change event can affect the costs related to healthcare services if there is a disruption in the supply of healthcare equipment to healthcare providers or if the severity of a healthcare condition suffered is worsened by a climate change event, e.g., asthma attacks triggered by the climate change event requiring a higher level of intervention than if there had been no climate change event. Climate events may also change the pattern of provider access—encouraging people to access more or less expensive providers than would normally be the case—which may change the overall average costs of services.
- Climate change can also impact the frequency with which extreme events take place for natural disasters, and the intensity of extreme events may also change. For example, epidemics may occur more frequently and have more severe and wide-ranging impacts, rather than being confined to one geographical region.

Mortality risk

In SLT regimes, mortality risks also influence the premium. Studies show heat-related excess mortality, especially among older people with pre-existing conditions and infants and young children (e.g., by the Robert Koch Institute[2] in Germany for the years 2003, 2006, 2010 and 2015). However, milder winters because of global warming could also result in a decrease in cold deaths that partly offsets additional heat-related deaths. In addition, according to the World Health Organisation (WHO), 7 million deaths are observed worldwide each year due to air pollution. Even within the EU27,[3] which is far less affected by air pollution than other parts of the world, there is a premature mortality due to air pollution of 80 persons per 100,000 inhabitants.[4] Another risk is the increase in infectious vector-borne diseases in the EU. They are often transmitted by mosquitoes, whose living conditions are improving due to global warming, making greater migration possible and thus increasing the probability of transmitting infectious diseases.

Overall, if mortality risk grows, it may lead to an increase in medical costs shortly before death; on the other hand, a reduction in life expectancy typically reduces insurance premiums. Over the longer term, climate change events may increase the future claims cost, leading to higher premiums. While this is not necessarily an issue for solvency margins, it does affect future affordability for insured populations. Combined with an aging population, potential for selective lapsing and "normal" medical inflation, which is typically higher than wage growth or consumer price index (CPI) inflation, and a low interest rate environment, climate change will likely pose significant challenges for medical insurers. For the medical insurance industry it is likely that the transition to a net-zero industry will have impacts on gross domestic product (GDP), inflation and the unemployment rate. This could lead to additional problems with the affordability of the future premiums and higher lapse rates for medical insurers.

MARKET RISK

Market risks are relevant, especially in long-term medical insurance markets where aging reserves are built up for financing future claims costs. To take into consideration market risk, an actuarial interest rate also can be included in the premium calculation. In these cases, the future movements of financial markets, especially future interest rates, spreads and stock prices, are a relevant component for the future profitability, risks and premium development of a medical insurance company. Due to climate stress scenarios, transition risks will likely lead to significant macroeconomic and financial effects. Some examples include:

- A higher carbon dioxide cost will lead to higher production costs for the medical insurance industry on the one hand and a higher burden to private households on the other hand (e.g., driven by a higher inflation rate), which could have a negative effect on the future development of GDP.
- A higher unemployment rate could result from the above, causing slow transition and possibly reducing public revenues (by tax and/or social security contributions) and/or increase the public deficit.

The above issues will bring a high level of uncertainty in the future movement of interest rates and equity markets.

OTHER RISKS TO CONSIDER

Reputational risk

There is some reputational risk if climate change events in a certain year adversely affect claims experience and premiums are forced to increase significantly in comparison to past years. Additionally, if medical insurers are not seen to be providing risk-management solutions to help customers manage the impact of climate change on their health, it could negatively impact the insurers' public image. That is in addition to any negative impacts from reputational risks relating to an insurer's operations, such as an unwillingness to commit to carbon neutrality or limit the insurance of carbon-intensive industries.

Transition risks in the German market

A key metric for medical insurance in Germany is future premium development. Due to the long-term contracts in private health insurance (PHI) in the country, transition risks have a significant impact on future premium and profitability development, in addition to physical risks.

In its climate scenarios, the Network of Central Banks and Supervisors for Greening the Financial System (NGFS)[5] describes various transition scenarios to a carbon-neutral economy with a range from "no/slow transition" (current policies scenario) to "transition to CO2-neutral economy by 2050" (net-zero 2050 scenario). For each of the scenarios, future socioeconomic developments and projections of energy, emission and economic developments are carried out. In particular, the relationship between energy prices (carbon price for emission control) plays an important role. Using a macroeconomic model, the relevant key figures such as inflation, long-term interest rate and GDP up to the year 2050 are determined for each scenario. These measures can be used as a basis for projecting the future development of premiums and profits in private medical insurance in Germany. In addition to "normal" inflation, the effects of physical risks due to climate change are also a driver of medical inflation and thus of future premium and surplus development. Due to the building-up of an aging reserve in PHI, the future development of interest rates also plays a decisive role. In this respect, the climate scenarios show different effects of the transition paths. There are considerable uncertainties, especially with regard to the behaviour of the European Central Bank (ECB), which cannot be anticipated (e.g., increasing government debt-to-finance investments for the transition to a carbon-neutral economy).

For this reason, it is important to examine the course of contributions and surpluses based on various scenarios and different options for action. This will assist to obtain transparency about the effects and to be able to derive suitable mitigations at an early stage.

Examples of potential climate change impacts in the UK and Germany

CLIMATE CHANGE IMPACTS ON MEDICAL INSURERS IN THE UK

In this section, we consider a specified example scenario in the UK and look at how this climate change event may affect a medical insurer's claims costs and hence underwriting risk.

Scenario: The UK experiences extreme rainfall in London and the South-East of England, flooding all roads and properties within flood risk zones. In addition to this, the River Thames floods over its banks and onto the adjacent pavements. We consider a medical insurer with a profile mainly consisting of working professionals, with some consumer/retail business, with an average insured age over 60. Coverage is for planned surgical interventions, presurgery diagnostics and post-surgery follow-up, but limited primary care and no emergency coverage. Outpatient mental health and counselling is covered to an annual limit.

FIGURE 3: IMPACTS ON THE HEALTHCARE SYSTEM OF FLOODING

IMPACT	TERM OF IMPACT	DESCRIPTION AND LINK TO POPULATION PROFILE
Displacement and disruption	Short Term	Flooding of properties will cause displacement of individuals from their homes with relocation being likely in temporary accommodations at first. A more long-term solution for displaced individuals may fall outside of their original locations. Relocation may limit an individual's ability to access healthcare service providers. Flooding may lead to disruption in clean water supply, electricity and other factors such as access to food or medication.
Injury	Short Term	Flooding may cause direct injuries, for example those trying to escape floodwater or move heavy belongings out of the way of water. Injury can vary from mild to severe, e.g., electrocution. Having an older population profile increases the potential risk of injury, as they will be more vulnerable to injury during relocation or when travelling.
Mental health	Mid to Long Term	Less immediate and potentially slightly more mid-term to long-term would be mental health-related claims resulting from a change in routine, additional mental stress from displacement and the knock-on effects such as the stress on an individual and their relationships. Such effects may include the loss of property and/or other valuable assets.
Chronic disease flare-up	Mid to Long Term	Existing underlying mental health disorders may lead further to chronic disease flare-ups, which may be stress-related or flood-induced. These flare-ups may impact people who have previously managed their conditions well, or those who may have had symptoms but had not been fully diagnosed or experienced significant poor health as a result. Examples include heart attacks from additional stress, problems with high blood pressure because of stress or flare-up of asthma caused by air pollution from debris. Medical insurers in the UK have limited information on the chronic conditions of their members and many have some data on member demographic and behavioural aspects linking to health. Insurers are likely to see increased claims from acute events arising from chronic flare-ups.
Health-related quality of life impact	Long Term	Research[6] into health-related quality of life (HRQoL) in England found that the HRQoL values were lower in regions that were flooded. Those living in commonly flooded areas were disrupted from their normal lives up to two to three years after the flood event. The impact of flooding included increased difficulty with anxiety, depression, activities of daily living and pain and discomfort. It is difficult to quantify the financial impact on insurers as it will depend on where these conditions manifest and which services people seek to manage them. Medical insurers generally have annual coverage limits on their policies, including the exclusion of chronic conditions, which helps to limit the potential costs to them.

FIGURE 4: RISKS INSURERS MAY FACE IN FLOODING SCENARIO

UNDERWRITING RISKS

RISK	DESCRIPTION
Limited information on policyholders' current health condition	London and the South-East of England represent a large market for medical insurers, with members generally either having corporate medical insurance or high levels of disposable income with which they choose to purchase medical insurance. Medical insurers will have limited to no health data on corporate book policyholders due to no underwriting requirements. Medical insurers will also be exposed to policyholders on their individual books. These policyholders are generally older and potentially subject to higher levels of chronic disease and accidents.
Indirect risks from operational risks to healthcare providers	Medical insurers have underwriting risk exposure to the operational risks presented by healthcare providers who may no longer be able to provide care or have to move patients they are looking after to other hospitals, if the providers' own premises are flooded. Virtual appointments to services, such as general practitioners (GPs) and physiotherapy, will help to alleviate some of this risk; however, for those undergoing treatment or accessing physical services such as rehabilitation, there will be a sudden inaccessibility and potential requirement to find alternative sources for treatment. Medical insurers may need to reconsider network options for policyholders who may find that they are relocated outside of their network option ranges or include non-contracted healthcare providers in the coverage. This could change the average cost of services and therefore the risk premium that a medical insurer experiences.
Alternative care	Further, the disruption in access to healthcare services could lead to requirements to provide alternative care for patients in fragile conditions, e.g., those undergoing cancer treatment, or to provide inpatient options for those who may be displaced but unable to find a suitable alternative, including any hospitals that may be flooded and/or compromised.
Change in average cost of services over the short-term to mid-term	If hospitals in London and the South-East of England are compromised in providing any healthcare services, the demand for hospitals outside of the area may increase, which may reduce the cost of services, as generally hospitals in London are significantly more costly than outside of London.
Change in utilisation of services over the short-term to mid-term	Injury as a result of flooding would likely lead to increased utilisation of emergency response requirements. As this service is provided by the state in the UK, medical insurers will have limited exposure to this risk. However, following an emergency response, those with medical coverage may choose to use their insurance for any surgical procedures, consultations or tests in the following months, as necessary.

OTHER RISKS

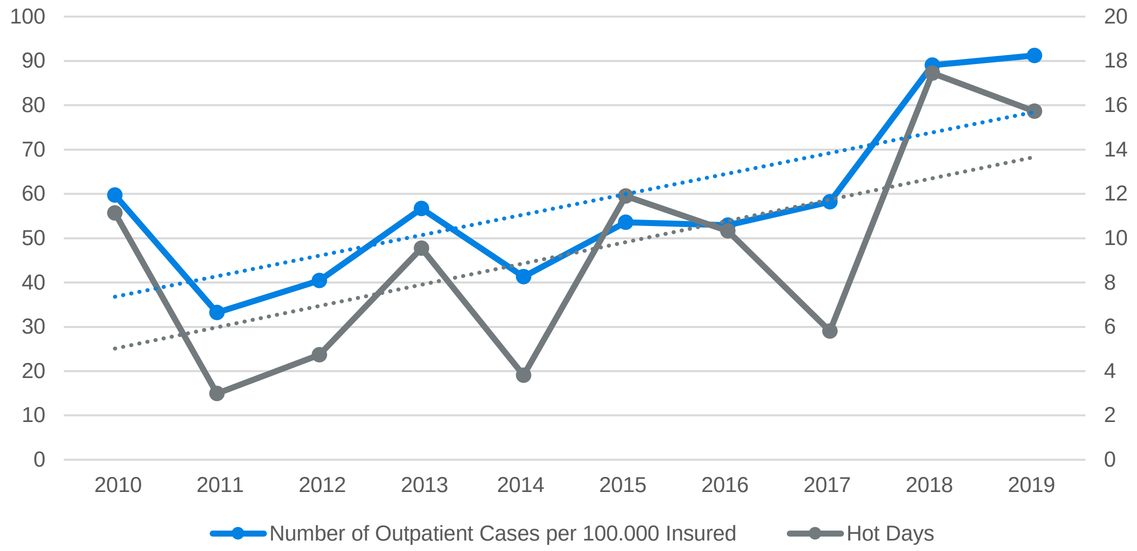
RISK	DESCRIPTION
Reputational	Insurers may be open to reputational risk, with those able to assist their members in receiving and accessing care in the easiest and smoothest methods benefiting in the longer run. Those that may struggle to provide services to members may face complaints and potential lapses.
Operational	A number of medical insurers within the UK have offices based within London. Flooding may also present an operational risk to an insurer's ability to continue operations, such as customer services, claims approval and other services to help relocate patients effectively and immediately.

CLIMATE CHANGE IMPACTS ON MEDICAL INSURERS IN GERMANY

The increasing frequency, severity and uncertainty of physical climate change impacts may impose material impacts on a health insurer's risk profile in both the short term and the long term, given the long-term nature and guaranteed renewability of the German health insurance system and the sensitivity of mortality and morbidity rates to life expectancy (*Sterbewahrscheinlichkeit*) and expected per capita healthcare claims (*Kopfschaden*). Consequently, insurers should consider identifying and quantifying climate-related risks, in order to tackle the challenges associated with adjusting premium (e.g., underestimating the severity or frequency of future extreme weather events based on the past data may result in bias in pricing) as well as changes in underwriting and product design, to meet changing health needs.

The risk of increased morbidity or mortality from climate change can be event-driven (acute) due to heatwaves, floods, windstorms or wildfires, as examples, or longer-term (chronic) due to shifts in climate patterns, which may include an increased number of hot days, changes in precipitation or extreme weather variability. These changes can result in short-term sudden spikes as well as affecting long-term trends, as shown in Figure 5 below. Both short-term and long-term effects may lead to higher claims costs.

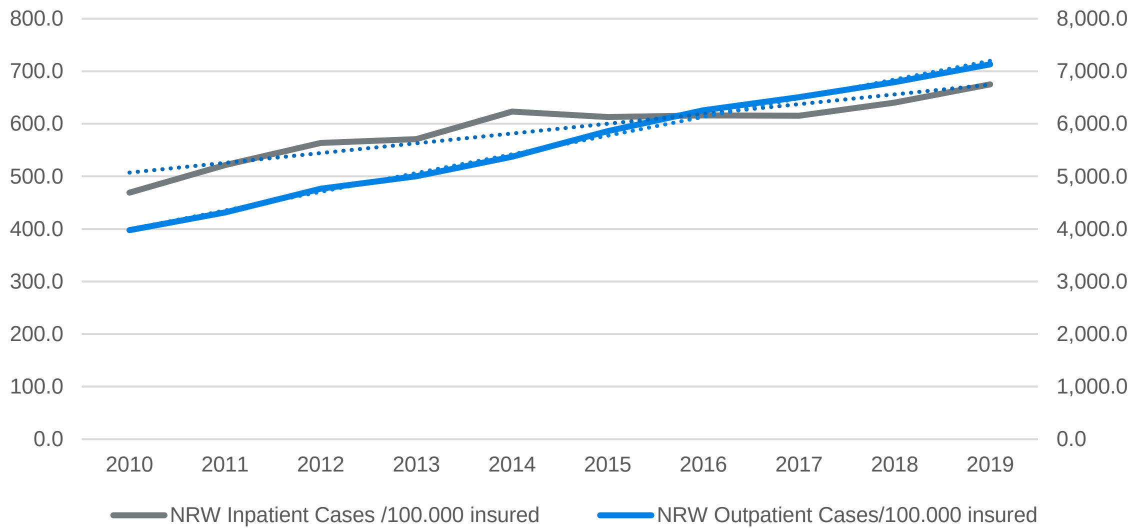
FIGURE 5: OUTPATIENT CASES DUE TO HEAT STRESS-RELATED ILLNESS (HEAT FATIGUE, HEAT EXHAUSTION, HEAT CRAMPS AND HEAT STROKE) IN RELATION TO THE NUMBER OF HOT DAYS IN NORTH RHINE-WESTPHALIA[7] (NRW), GERMANY[8]



The following examples illustrate the physical risks and related health outcomes.

- Temperature change and volatility: Due to the impacts of heatwaves on mortality and morbidity, e.g., hot days lead to measurable increases in hospital admissions among the vulnerable groups (infants and small children as well as insureds over 75 years).
- Change towards optimal conditions for spread of disease: It is possible that climate-related risks could increase the prevalence of pandemics or outbreaks of vector-borne infectious diseases due to a wider spread of disease-carrying insects. The rising temperatures and warmer winters have contributed to a geographic range expansion of tick vectors that transmit Lyme disease and tick-borne encephalitis.[9]
- Increased ultraviolet radiation (UVR): Exposure to high levels of UVR has been associated with human health in terms of causing skin cancer and eye damage.[10]

FIGURE 6: INPATIENT CASES AND OUTPATIENT CASES OF MELANOMA AND OTHER MALIGNANT NEOPLASMS OF SKIN (ICD: C43-C44[11]) FROM 2010 TO 2019 IN NRW, GERMANY[12]



CASE STUDY OF PAST EVENTS[13,14]

COVID-19 impact on mis-pricing risks for UK medical insurers

The COVID-19 pandemic has strong links to the expected impacts of climate change, with a research group proving a direct causal role of climate change in the COVID-19 pandemic.[13] Through deforestation and destruction of ecological areas, humans and animals live closer now, which is believed to have contributed directly to the transfer of SARS-CoV-1 and SARS-CoV-2 to humans.

Medical insurers have seen firsthand the impact of the pandemic as a climate event. Below are some key takeaways:

- Post-pandemic medical insurers have higher levels of uncertainty in their pricing and in their expected claims experience in the coming years. The mis-pricing risk appears to be significantly higher than allowed for in Solvency Capital Requirement (SCR) calculations under the Standard Formula, which assumes that a 5% deviation in the loss ratio is a 1-in-200-year event. Many medical insurers experienced movements in loss ratios greater than 5% over the initial period of the pandemic in 2020, although the long-term effect will be lower, given that there is an expectation many of these initial reductions in claims will simply be deferred rather than forgone.
- In the UK, healthcare providers faced disruption in providing services, resulting in lower utilisation rates. Medical insurers considered premium rebates to offset the low utilisation and stem a potential increase in lapses. Insurers experienced a higher use of telemedical services instead.
- The delayed access to healthcare service may mean future claims may be for more severe healthcare conditions due to the delay in accessing healthcare services, resulting in higher average costs to medical insurers.
- The COVID-19 virus itself has left a number of previously healthy people with long-term health conditions and the future effect on medical insurance utilisation is highly uncertain.
- Analysis of medical insurers' 2020 Solvency and Financial Condition Reports[14] (SFCRs) shows that, although average SCR ratios over all medical insurers did not fall from 2019 to 2020, the distribution of risk changed, with a higher proportion of the total risk sitting in health underwriting risk in 2020.

Conclusions

We have presented a framework for modelling the impact of events related to climate change on medical insurers. Because of the complexity of this topic, it is difficult for health payers to conceptualise the potential impact on claims costs for health portfolios. Even once the model has been conceptualised, parameterisation is challenging. While the historical data analysis carried out, described in the below appendix, helps with some parameterisation, it is clear there are significant limitations, due to the granularity of clinical coding, the lack of generalisability from historical events to future events and the difficulty in following cause through to effect from climate change and health burden, through to impacts on claims experience from healthcare usage or mortality for a portfolio with specific demographic, health and geographical characteristics.

Both short-term and long-term medical insurers face significant future challenges in the affordability of their products. This arises from two main sources: 1) the likely increase in claims costs, due to both climate-related events and other sources such as new medicines and technologies, and 2) the potential macroeconomic effects of climate change and decarbonisation on living costs, GDP growth and hence disposable income. Alongside these trend issues, medical insurers face significant uncertainty about the future and, thus, even short-term medical insurers cannot afford to be complacent about the impact of long-term trends. COVID-19 has given us a small glimpse of the impact of higher levels of uncertainty and the disruption to business models from increases in financial, market and operational risks. Climate change has the potential to significantly magnify that level of uncertainty.

Appendix 1: Historical utilisation analysis

ANALYSING TRENDS IN POTENTIALLY CLIMATE-RELATED ADMISSIONS IN ENGLAND NHS INPATIENT DATA

To parameterise any climate model, we need to consider the historical data, while equally recognising its limitations given the changing climate. We have carried out an analysis of trends over a 10-year period for England NHS inpatient admissions[15] using bespoke "climate flags" we have created. These flags group ICD-10[16] diagnosis codes into categories to identify potentially climate-related admissions, and therefore the proportion of total admissions in a year that may be linked to a climate change event.

Our clinical mapping groups ICD-10 codes into categories based on the type of climate event the admission might relate to, and then these categories are further split into subcategories for the type of admission. The six climate categories created are:

- Change in vector or disease agent
- Increasing allergens
- Water quality impacts
- Water and food supply impacts
- Extreme temperatures
- Severe weather

Typically, ICD-10 codes include cause and impact codes and, to get the most accurate identification of a climate-related activity, both of these codes are required. A key limitation to this analysis is that the data used did not include causal ICD-10, meaning that it was not possible to determine whether an ICD-10 code, such as "sunburn," was related to a heatwave or a sunny day.

FIGURE 7: PROPORTION OF ADMISSIONS IN NHS FINANCIAL YEAR, PER 1,000 LIVES, BY CLIMATE EVENT TYPE, OVER ALL AGES WITHIN ENGLAND

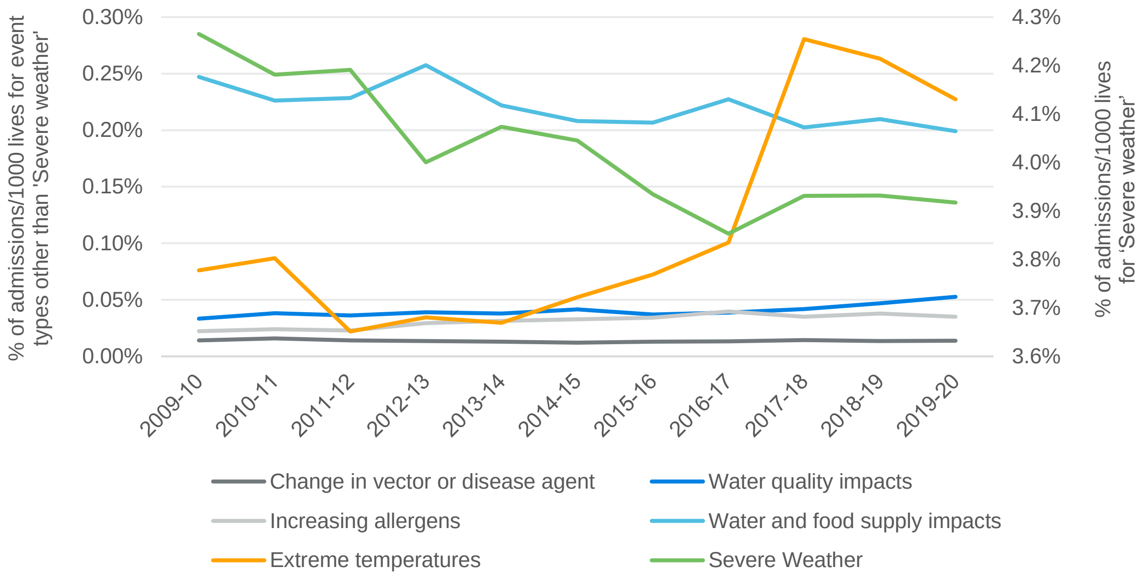


Figure 7 shows that the category with the largest proportion of admissions per 1,000 lives is "severe weather" in all years, though there is a decreasing trend. Reviewing the ICD-10 codes that mapped to the "severe weather" category showed that the admissions may also relate to general accidents, e.g., a storm causes physical injury. Whilst climate events can cause physical injury, there are numerous other events that can cause physical injury as well. This is a result of missing causal ICD-10 codes. A data set with both cause and impact ICD-10 codes is expected to be more representative of admissions relating specifically to "severe weather."

Figure 7 also shows that there is an increasing trend in the proportion of total admissions per 1,000 lives from 2017 and 2018 onwards for "extreme temperature." This category includes events linked to extreme hot and cold weather. The subcategory driving this trend is "Flu/Influenza With Identified Virus," which shows an increasing number of hospital admissions per 1,000 lives from 2017 and 2018 onwards. The increased levels of admissions from the flu were reported at the end of 2017 and early 2018, though it was not considered an epidemic. The winter of 2017-2018 was a particularly cold winter, with even London seeing snow regularly until March 2018 that year.[17]

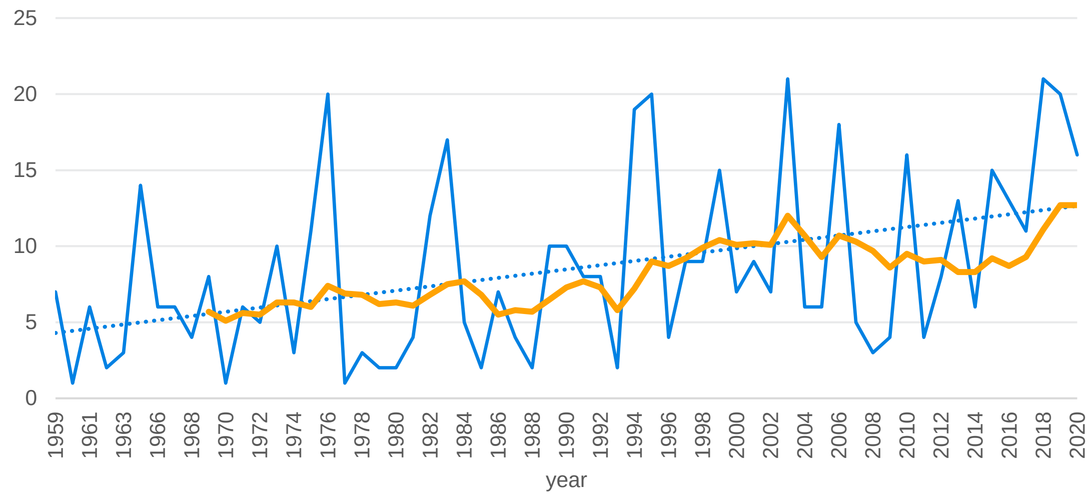
We analysed the above trends by age bands also. Generally, the trends by age band have a similar pattern to Figure 7, although trends are more pronounced for some ages bands than others. For example, the over-75 category generally shows increasing trends for all climate event groups. This highlights the potential increased risk for the elderly to changes in their environment due to climate events.

Key limitations to this analysis include the lack of causal ICD-10 codes as well as a lack of granular data to segregate admissions by area or by shorter time periods, e.g., months. Data by area would help to identify changes in utilisation relating to a specific climate event and data by shorter time periods would potentially capture spikes in utilisation relating to a climate event.

ANALYSIS ON GERMANY DATA

Temperature-related mortality and morbidity is of current scientific and public health interest in Germany because of the persistently high number of extreme weather events, excess heat deaths and the aging population.[18] The average temperature in Germany has risen by 1.5℃ since records began in 1881 and it is projected that this trend will continue.[19,20] A report from Germany's National Meteorologic Service, Deutscher Wetterdienst (DWD),[21] shows that the number of hot days (daily maximum air temperature of at least 30°C) has tripled since the 1950s.[22] See Figure 8. As heatwaves become more frequent, the disease burden of cardiovascular morbidity may increase in susceptible individuals as a direct consequence of global warming. Cardiovascular diseases (CVD) are the leading cause of death according to statistics from the Federal Statistical Office (Statistisches Bundesamt). They account for around a third of all deaths in Germany (in 2020, women: 36.62%, men: 31.97%).[23]

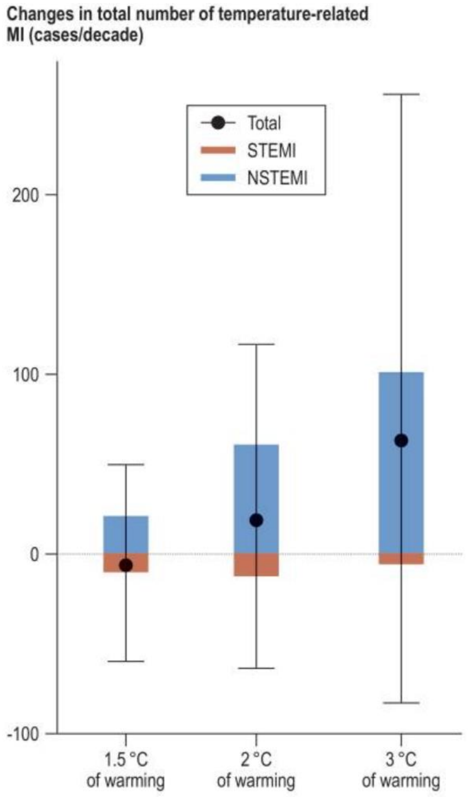
FIGURE 8: NUMBER OF DAYS WHEN MAXIMUM AIR TEMPERATURE EXCEEDS 30°C IN COLOGNE.[24] 1959-2020[25]



A study[26] projecting future temperature-related myocardial infarction (MI) events in Augsburg, Germany, at increases in warming of 1.5°C, 2°C and 3°C, shows that, in a low-emission scenario limiting global warming to 1.5°C throughout the 21st century, MI cases will decrease slightly per decade. In a high-emission scenario, with warming of 2°C and 3°C, temperature-related MI cases will increase per decade, with significantly higher rates at the 3°C scenario.

The plot in Figure 9, from the study, shows the changes in temperature-related MI cases per decade projected for 1.5°C, 2°C and 3°C of warming by MI type, ST-segment elevation myocardial infarction (STEMI) and non-STEMI (NSTEMI). Red and blue bars represent changes in the temperature-related number of STEMI and NSTEMI events in future decades relative to the 2010-2019 data. Black dots and vertical lines denote changes and 95% empirical confidence intervals in the temperature-related total number of MI events.

FIGURE 9: CHANGES IN TOTAL NUMBER OF TEMPERATURE-RELATED MI[27]



In Germany, CVD events are frequent and are one of the most expensive diseases to treat. Generally, hospitalisations due to CVD have a high financial impact on the budget of German sick funds.[28] CVD events like myocardial infarction (MI), unstable angina, heart failure (HF), stroke and peripheral artery disease (PAD) have high financial impacts on the German healthcare system. Health costs can include effects due to deaths and hospitalisations as well as effects of lost labor and a loss of quality of life while being hospitalised. Treatment costs of CVD are mostly incurred during the acute phase of events, which often involve intensive treatments, but include long-term treatment and care post-event as well. Hospitalisation costs are one of the major cost drivers.[29] Consequently, it is critical to identify and understand the environment risk factors that have potential associations with cardiovascular events.

To gain a more comprehensive picture of the temperature-related health burden of CVD in Germany, we used a 10-year healthcare claims data set to quantify the exposure-response association between ambient temperature and disease-specific hospital admissions in different climate regions, e.g., temperature-related hospital admissions by specific subgroups such as cardiovascular or respiratory admissions. The data set contains information on age, gender, day of admission and postal code of residence (to determine climate zones) as well as the invoiced diagnosis with ICD-10 classifications.

The weather data are provided by the DWD. The meteorological data (daily maximum and minimum temperatures) for each period were obtained from the monitoring station in big cities and then the average temperatures were calculated and used as base temperatures for climate regions. We used quasi-Poisson generalised additive models and distributed lag nonlinear models to estimate the cumulative effects of temperature on hospitalisations among different subgroups across multiple days.[30,31] We observed a nonlinear temperature-hospital admission relationship among several subgroups, with increases in relative risk (RR) above and below the minimum hospital admission temperatures that correspond to heat and cold associations, respectively. In subgroup analyses, admissions for both cardiovascular and respiratory diseases increased during extreme heat and cold.

We also observed that a small change of high ambient temperature may result in exponential change in hospital admissions of genitourinary system diseases. Temperature and cardiovascular cases generally showed U-shaped associations, with a significantly increasing risk for cold but a non-significantly increasing risk for heat. However, a positive correlation can often be found in the other studies,[32] although this does not address all CVD events. Previous studies have proven that extremely high air temperature might trigger the onset of cardiovascular events in vulnerable subpopulations (e.g., the elderly, diabetics) and suggested that people died rapidly from climate change-related cardiovascular diseases before they were sent to hospital.[33]

Tackling temperature-related health threats requires a sound risk management process. Given the high cost of hospitalisation, it appears that efforts to reduce the economic burden of CVD should focus on avoidance of CVD hospital admissions. Other meteorological factors, such as low atmospheric pressure, humidity, high wind speed and high rainfall should also be investigated to understand the underlying mechanisms in more detail and develop public health interventions that might mitigate peaks in cardiovascular events during excessive cold and heat. Additionally, emerging evidence has demonstrated the association between increased risk for cardiovascular events and acute exposure to environmental pollutants, due to their effect on the coagulation cascade and on platelet function. It appears that during the winter this may be responsible, at least in part, for the seasonal variation in the incidence of cardiovascular diseases, especially in big cities.[34]

CONTACT

Joanne Buckle
joanne.buckle@milliman.com

Natasha Singhal
natasha.singhal@milliman.com

Alexander Krauskopf
alexander.krauskopf@milliman.com

ENDNOTES

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