Resilient Cities Reimagining Health

Partnership of:

RESILIENT CITIES NETWORK | Sustainable Markets Initiative

The Case for Action:

The power of prevention to support health in a changing climate

Led by:

reckitt | Bupa

With support from:

Yale SCHOOL OF PUBLIC HEALTH | Mode Economics | sanofi

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Foreword

By Kris Licht, CEO, Reckitt, and Iñaki Ereño, CEO, Bupa
Co-leads of Resilient Cities, Reimagining Health, on behalf of the Sustainable Markets Initiative Health Systems Task Force.

As global healthcare companies, we have the privilege, and responsibility, of supporting the health of millions of people worldwide.

Yet, we're part of a health system that is facing ever increasing strain, with rising rates of chronic disease, ageing populations, and increasing costs of care. In the 21st century, 4.5 bn people around the world lack reliable access to healthcare, and 2.1 bn lack access to safely managed drinking water.[1,2] Climate change, now widely regarded as one of the greatest threats to human health, is exacerbating these challenges, with vulnerable and low-income communities bearing the greatest burden. At the same time, health systems are contributing to worsening the climate crisis – responsible for approximately 4.5% of total global net emissions.

Now is the time to break this cycle. As pressures on our health and health systems grow, we urgently need to rethink our approach to healthcare. We need to transition away from reliance on just treating people when they are sick, to a more holistic approach, which reaches people before they become patients, placing much greater emphasis on keeping people well, for longer. As we instinctively recognise but often struggle to prioritise in policy or in practice, good health and wellbeing begin not in hospitals and clinics but in our homes, habits and communities.

Reimagining healthcare means keeping people healthier for longer, looking beyond hospitals and clinics and tackling the broader factors that affect people's health. This includes supporting individuals and communities to take charge of their own wellbeing through self-care, using new technology to make care easier to reach, more efficient, and personalised. It also involves supporting communities as they deal with the growing challenges of environmental change.

Cities can be a key driving force to lead this change. 70% of the global population will live in urban settings by 2050. Also, city authorities can bring together key public and private actors to drive many of the needed changes. But cities have told us that they need help in making the case for investing in health and drive this preventative agenda. Here's the opportunity.

Reimagining health in this way is not optional. It is one of the most powerful levers we have to build a healthier, more sustainable future - for people, for communities, and for the planet we all share.

This initiative builds on the important work already undertaken by the Sustainable Markets Initiative Health Systems Task Force, which, since its inception at COP26 in Glasgow, has brought together leading voices from across the sector, to help build cleaner, better health systems. As members of this group, Reckitt and Bupa are fully committed to contribute to reducing emissions from the health systems we're part of, starting with our own operations and supply chains.

Resilient Cities, Reimagining Health is one strand of that effort - translating the Task Force's vision, into practical, city-level action on prevention and resilience. Our work, together with an incredible array of committed and expert partners, is focused on helping to safeguard health, reduce growing pressures on health systems, and lower the cost of care for people and our planet.

This report is just the beginning of our programme. It is a huge privilege to be working in partnership with a network of cities, from Rio de Janeiro, to Lagos, Mexico City, to Greater Manchester, and many more besides, that together represent almost 120 million lives world-wide.

We know this is not a silver bullet. Preventative health is one vital part of a much wider set of solutions needed to protect human and planetary health. But this work offers huge potential to shape health outcomes in communities around the globe, defining practical recommendations that cities can act on now.

Together, we have an opportunity to help lead the long overdue global shift in healthcare systems from reaction to resilience.

Kris Licht
CEO, Reckitt

Iñaki Ereño
CEO, Bupa

Foreword

As city leaders, our work is grounded in the wellbeing of our residents. Every day, we are on the front lines, navigating the complex challenges that shape people's lives — from ensuring clean air and safe streets to providing economic opportunities and delivering reliable public services. Today, we face a convergence of crises unlike any before: health systems across the world are under severe strain and a rapidly changing climate that multiplies threats to our communities. Chronic stresses like air pollution and non-communicable diseases are now colliding with the acute shocks of deadly heatwaves, floods, and new infectious disease outbreaks.

This is not an abstract forecast. It is the reality in our cities right now. That is why this report, *The Case for Action: The power of prevention to support health in a changing climate*, is both timely and essential. It provides a powerful and practical roadmap for moving beyond a model that reacts only when people are sick, towards one that creates environments that keep people healthy in the first place.

Cities asked for this - loudly. In a Yale–R-Cities study funded by The Rockefeller Foundation, 80%+ of cities committed to sharing data, joining peer learning, and piloting climate–health–equity solutions - demand that launched the world's first city-led global Community of Practice on climate and health, now scaled by SMI's Health Systems Task Force with Mode Economics and Yale, uniting 29 cities across 19 countries to share learning alongside testing and ultimately scaling tools and interventions that work.

Across the Resilient Cities Network, city leaders see this need every day. In Greater Manchester, they stress the importance of having the data to build resilience at the community level, as "some residents face greater health risks." Mexico City leaders remind us that cities "face countless competing priorities," and highlight how reliable data is essential to guide investments. For Rio de Janeiro, the message is clear: "data is essential to building effective responses." In my own city of Glasgow, we embed health inequalities data into our policy and decision-making processes for investment and economic development. And as the Chief Resilience Officer for Lagos notes, this report empowers "cities to lead with practical solutions and shared learning." All of us, as fellow city leaders, welcome this report.

This report provides the evidence and the framework to help us get there: a future where health and equity are at the centre of climate action. By empowering cities with the data, knowledge, tools, and capacity to act and measure the impact, we can protect communities, reduce inequalities, and build a healthier and more sustainable future. This is a call to action for mayors, city managers, resilience officers, public health officials, and urban planners everywhere: pick a pilot portfolio, assign clear owners, blend funding, and track a concise set of KPIs - with civil society, residents, healthcare and insurers, employers, utilities and developers at the table.

Let us accelerate preventative solutions that safeguard our residents and create fairer, healthier, more resilient cities for all. I invite you to read this report and join us in this vital work.

Councillor Susan Aitken
Leader of Glasgow Council, Chair of Resilient Cities Network

Executive summary

Cities are at the forefront of a global health crisis exacerbated by climate change. This report presents the case for a new approach for city leaders to build healthier, more resilient communities by shifting from overreliance on reactive models of healthcare towards proactive, place-based approaches. It finds that even modest steps in this direction could save more than 725,000 lives a year and $70bn in care costs, cutting emissions, improving equity, and enhancing economic growth.

The current healthcare model faces severe, mounting stresses – compounded by climate risks. While per capita spending on health has doubled since 2000, 4.5 billion people still lack secure access to healthcare.[3,4] Rising burdens of chronic disease, ageing populations, rising healthcare emissions, and increasingly constrained public budgets mean current healthcare models will be difficult to sustain. Rapidly mounting climate risks to public health and healthcare systems, which include extreme heat, air pollution, and flooding – as well as knock-on impacts on water- and vector-borne diseases and food security – heighten the challenge, with most major sources of disease highly sensitive to climate risks. In urban areas, deaths from heat stress and air pollution are set to increase by more than 20% over this decade – by 2030 these could be more than double those from transport accidents.[5] All people will be impacted, but the poorest are set to bear the brunt of the impact.

This report presents the case for a reimagined approach to health in cities. Such an approach seeks to correct an overreliance on top-down, reactive models and move towards more holistic approaches that emphasise keeping people well for longer, with a greater focus on the environmental drivers of health. This new approach seeks not only to improve health outcomes, but to do so in an inclusive manner that also saves healthcare costs and reduces healthcare emissions, which currently account for 4.5% of the global total.[6]

While every city has different needs and capacities, this report identifies broadly shared challenges, where simple solutions have the potential to make significant impact. For example, in fast-growing cities there is a focus on empowering communities to avoid risks of infectious diseases, while in more established but ageing cities there is a need to retrofit infrastructure and advance preventative strategies for physical and mental health. Certain solutions related to urban greening and mobility, hygiene, preventative healthcare and emergency response are widely applicable at low cost. A macro analysis of how they could be applied across 11,000 cities globally covers:

- → **Urban planning interventions that reduce environmental stresses.** For example, measures to alleviate urban heat and air pollution such as green space, cool roofs, and congestion management could reduce related deaths by 15%.
- → **Programmes to empower communities to respond to extreme events.** For example, a set of emergency planning and community engagement measures, supported by early warning systems, could reduce heat deaths by 13%.
- → **Enhancing urban systems to increase resilience.** On Water, Sanitation, and Hygiene (WASH), short-term measures to improve sanitation and hygiene could reduce related deaths by 6%, while water infrastructure upgrades could further reduce deaths by 11%.
- → **Preventative approaches to public health**, focused on conditions that cause vulnerability to climate risks. Programmes to promote physical activity and healthy eating could reduce related deaths by 6%.

These and other similar interventions are inherently inclusive, promoting both collective and individual wellbeing, while supporting economic growth. For example, all city inhabitants benefit from improved air quality, with benefits concentrated in communities that currently suffer most, including lower income communities and older adults (over 65s), who have a 16x higher mortality rate from air pollution.[7] By reducing the need for healthcare within the formal system, just the small set of interventions modelled in this report could save almost $70bn in annual healthcare costs and 15.6 $MtCO_2e$ in associated emissions (amounting to more than the annual emissions of Prague, or Accra).[8] Healthier cities are more prosperous cities, and many of these interventions contribute directly to economic growth. For example, measures to reduce urban heat can mitigate the effect of heat on labour productivity, which can be up to 50% for moderate intensity work.[9]

Cities have a leading role to play in the adoption of this approach. City authorities are uniquely placed to drive forward this programme and maximise synergies with overlapping agendas on economic growth and climate resilience. They typically control many of the critical levers – such as on urban planning and emergency response – and have a wider convening and coordinating role that can draw in and align contributions from other stakeholders. These stakeholders include:

Community groups whose input and support is essential in developing and implementing plans, and who play a critical role in shaping the way communities respond to health risks. Community capacity can be strengthened by national and international NGOs who provide common resources e.g., training or reports, and funding;

Businesses who have a strategic role in supplying essential goods and services to protect people outside the formal healthcare system and, as employers, have a stake in promoting healthy lifestyles and protecting their workers from climate risks. Larger businesses can support the model by developing and scaling new products that can support prevention and resilience such as personal cooling, wearable devices and virtual care;

Formal healthcare providers who are among the most trusted sources of public information, can reduce costs by supporting broad-based, preventative models of healthcare, collaborate in emergency response, community education and awareness campaigns, and invest in healthcare resilience;

Research organisations – have a key enabling role, which can be enhanced through partnership with cities and other stakeholders in this list to improve data on climate and health risks and the efficacy of solutions in particular contexts;

Investors and multilateral agencies – external finance from investors such as development banks can support city objectives, especially in contexts of limited city resources, while concessionary and philanthropic capital can crowd-in capital from private investors and insurers;

National governments who can support cities by adapting funding models to advance this agenda, in a manner that improves the value for money of healthcare spending and promotes economic growth. **Multilateral initiatives** such as the WHO's Alliance for Transformative Action on Climate and Health (ATACH) network can underpin this by disseminating international best practices.

29 cities

19 countries

The *Resilient Cities, Reimagining Health* programme is partnering with 29 cities to develop tools required to implement this model. This report marks the first output of the programme, a multi-year partnership between the Sustainable Markets Initiative (SMI) and the Resilient Cities Network, led by Reckitt and Bupa, with support from the Yale School of Public Health, Mode Economics, and Sanofi. Engaging collaboratively with municipalities in a dedicated 'Community of Practice' across 19 countries, the programme foregrounds cities' priorities, identifying the barriers they face, and giving them with the practical resources needed to embrace this new approach. These resources include:

Health assessment tools to understand the magnitude and drivers of current and future health risks, tailored to individual city contexts.

Decision-making tools to develop the economic case for adopting packages of interventions. Economic appraisal tools can help identify and shape best-value approaches, accounting for co-benefits, and inform approaches to financing that combine public and private sources.

Playbooks to drive implementation including step-by-step guides to designing and implementing strategies, with archetypal partnership and financing models.

The next step for the programme will be to develop these resources and apply them to priority challenges faced by member cities.

Acknowledgements

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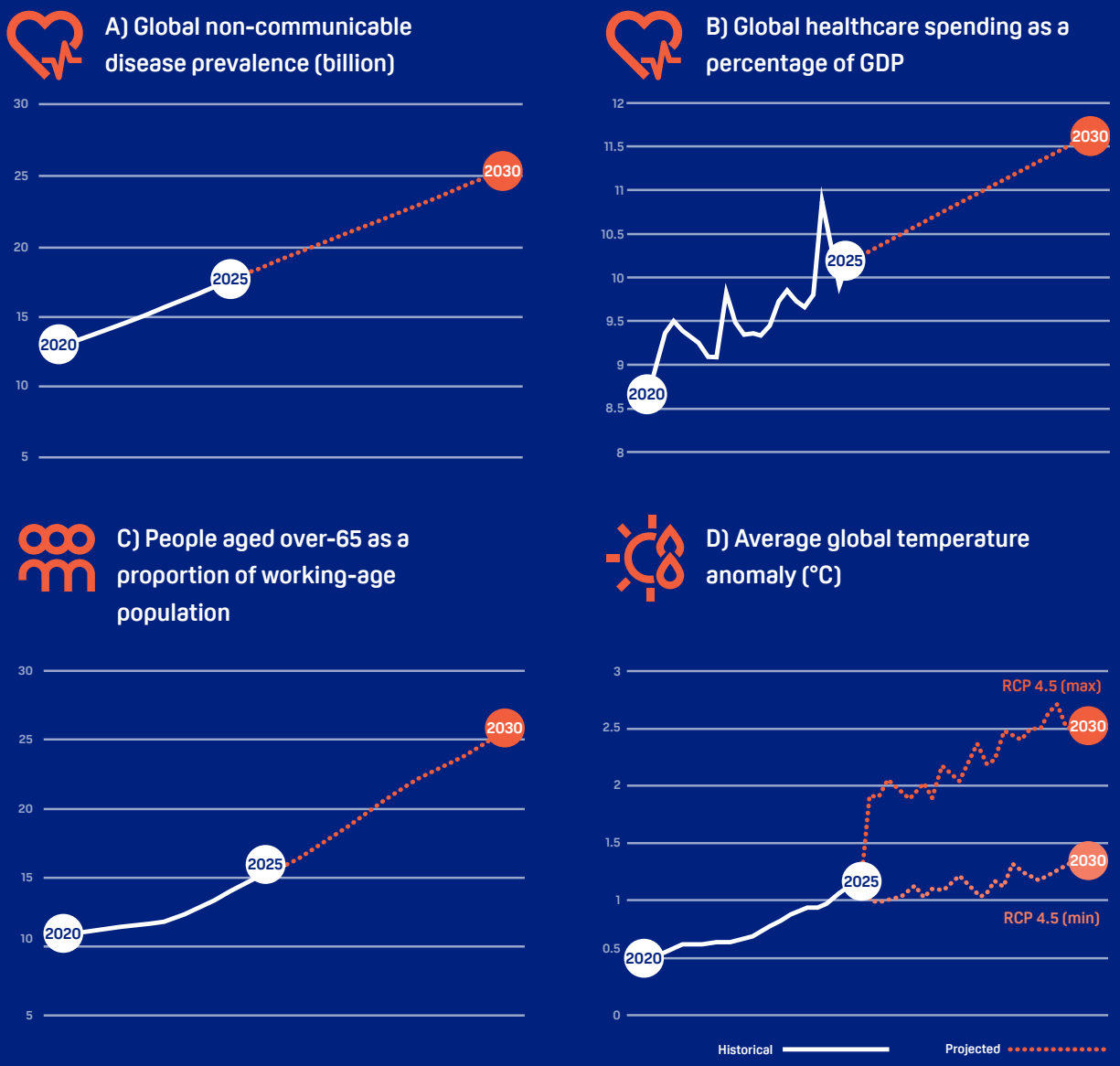
We would also like to extend our thanks to our Community of Practice – the 29 cities whose experiences and insights at the nexus of climate and health have shaped the direction of this work. Our member cities at publication are: Rio de Janeiro, Brazil; Mexico City, Mexico; Lagos, Nigeria; Greater Manchester, UK; Berkeley, United States; Broward County, United States; Buenos Aires, Argentina; Cape Town, South Africa; Christchurch, New Zealand; Ciudad Juarez, Mexico; Colima, Mexico; Glasgow, UK; Guadalajara, Mexico; London, UK; Medellin, Colombia; Monterrey, Mexico; Montevideo, Uruguay; Melbourne, Australia; Nairobi, Kenya; Penang, Malaysia; Porto Alegre, Brazil; Ramallah, Palestine; Salvador, Brazil; Santa Fe, Argentina; Santiago, Chile; Semarang, Indonesia; Surat, India; Sydney, Australia; Quezon City, Philippines.

Introduction

The current healthcare model is under severe strain, with rising costs and persistent unmet needs. While the global burden of communicable, maternal, neonatal, and nutritional disease is falling, the burden of non-communicable disease is growing steadily with ageing and growing populations, lifestyle changes, climate change, and uneven access to healthcare (Figure 1A).[10] Growing demands on health systems have increasingly been met through higher spending, with global healthcare spending passing 10% of GDP in 2020 (Figure 1B).[11] Despite these significant increases, 130 countries' healthcare spending still falls short of the WHO's unofficial benchmark (7% of GDP), leaving health needs unmet.[12] Further, higher spending has not always translated into better health coverage and outcomes: reductions in out-of-pocket health spending have stalled, persistent inequities in access leave 4.5 billion people globally without secure access to healthcare, and life expectancy has even declined in some high-income countries.[13,14,15]

Figure 1: Key global trends in climate-health risks



Source: Mode Economics

Accelerating climate and demographic change will exert additional strain on health systems going forward, while public finances to combat this are increasingly strained. Demographic trends will continue to drive increases in health burdens while reducing the relative size of the working age population that is needed to generate public funds – by 2050, one-in-six people will be over 65 years of age and each over 65 will be supported by only three people of working age (Figure 1C).[16,17] Accelerating climate change will put additional pressure on healthcare systems, increasing the total and volatility of demand for care while disrupting access through damage to healthcare facilities and supply chains (Figure 1D).[18,19] Healthcare systems must find ways to meet new climate-driven needs and adapt to climate change while also reducing their contributions towards it, with healthcare currently representing approximately 4.5% of global emissions.[20]

Cities are on the front line of these challenges. Home to over half of the global population, a share that is expected to pass 70% by 2050, cities are at the forefront of trends in global disease burdens.[21] Urbanisation has helped drive higher incomes and improved access to and quality of care for many (but not all) residents — but is also associated with increasingly sedentary lifestyles, social isolation, and exposure to heightened environmental risks such as air pollution, water stress, and urban heat islands. As hubs of learning and excellence across research, private, and public sectors, urban areas will also play a crucial role in how health systems respond to mounting challenges.

A growing movement seeks to elevate the climate health agenda. Of particular note is the Belém Health Action Plan, which aims to build momentum among UNFCCC member states towards a climate-health commitment at COP30. The plan identifies three priority action areas for resilient climate-health:

1. **Strengthen health surveillance and monitoring** – to detect, prevent, and respond to climate health risks
2. **Evidence-based policy and capacity building** – to accelerate the use of scientific evidence in decision-making and fostering cooperation between diverse stakeholders
3. **Innovation** – to deliver new technologies to meet population health needs.[22]

These action areas are underscored by a commitment to improve equity in health access and outcomes, and to accountability, transparency, and broad participation.

130+
countries below WHO healthcare spending benchmark (7% of GDP)

4.5%
of current global emissions arise from healthcare

1:3
ratio - each over 65 supported by only three working age people by 2050

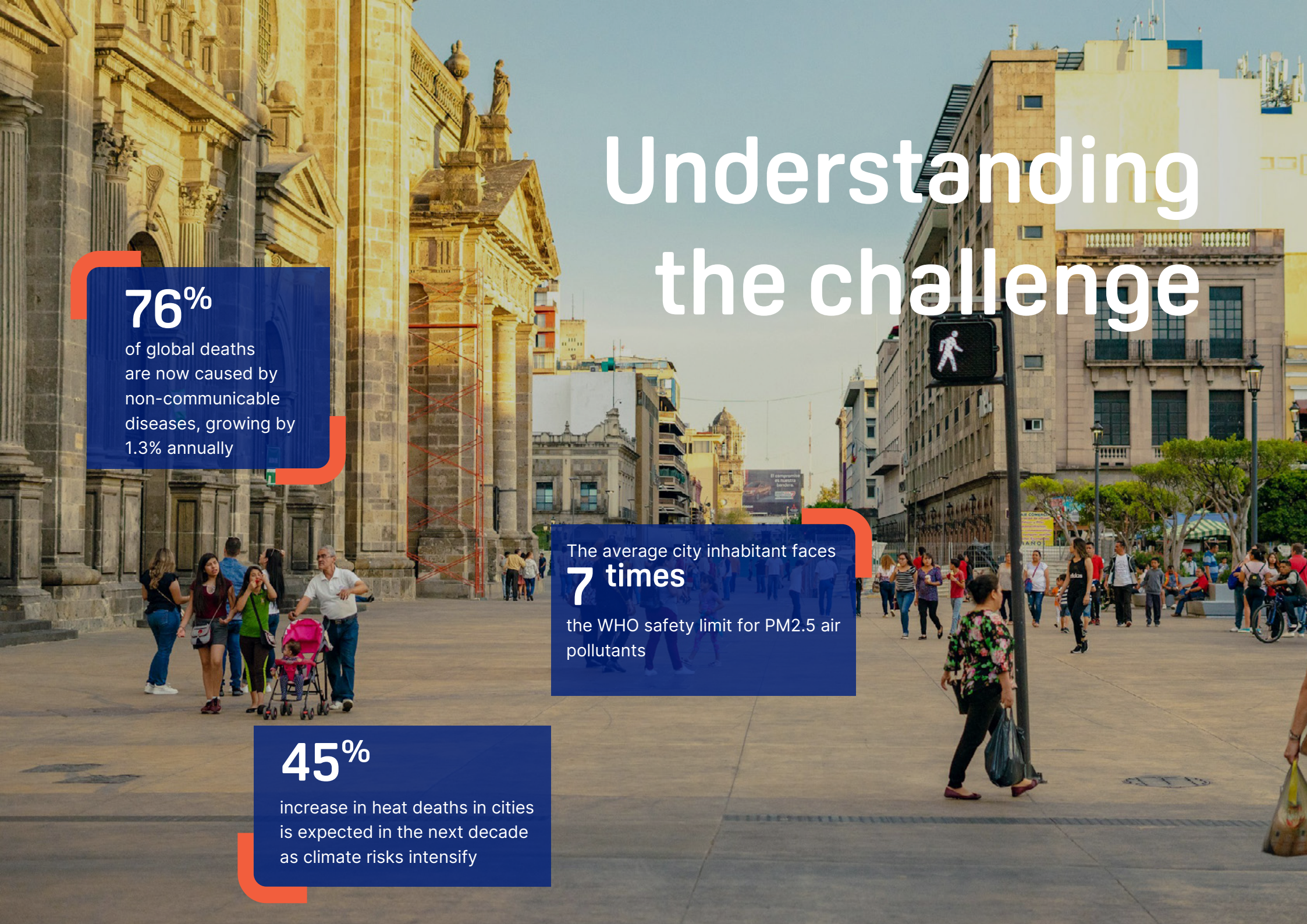
In this context, this report sets out the case for a new approach to managing health risks in urban settings – one that places a much greater focus on preventative, place-based interventions. Preventative health is not a new concept – but its application to cities at the nexus of climate change and equity, bringing in a broad range of stakeholders, has not been done at scale. This report presents the case for following such a transition across various contexts and how it could be affected. It considers how a more preventative, place-based approach to public health can:

- → **Lead to improved health outcomes & equity,** as well as a reduction in pressures on healthcare systems and associated costs and emissions
- → **Be adopted across a variety of urban contexts,** considering common challenges between cities while accounting for the local specificity of health risks and needs
- → **Empower wider stakeholders,** to support and instigate actions, shaping new, inclusive, local delivery models and creating new markets for health-promoting products and services to scale impact
- → **Facilitate evidence-based decision-making,** using tools and resources to help cities make the economic case for interventions, and ensure effective implementation

Building on existing literature on climate, health and urban planning, the report presents a new synthesis of how climate, urban and health pressures compound across various settings, a new analysis of the prospective impact of some of the relevant solutions, and charts a new framework for city-led adoption and implementation of the model.

It considers this new approach through the lens of climate change adaptation rather than mitigation. However, effective and holistic planning and implementation can ensure that adaptation measures support climate change mitigation. This includes climate change mitigation in the healthcare sector and in the wider urban economy. For example, public transport improves air quality, which reduces healthcare emissions from treating patients while simultaneously driving substantial emissions reductions in urban transport.

Finally, the report forms a foundation for the next phase of the programme, which will support cities in adopting the model. Cities have requested guidance to help them move from theory to implementation, supported by tools to enable evidence-based, transparent decision making. To support this, this report starts by outlining the compounding challenges faced by cities at the nexus of climate and health, before considering how a preventative, place-based approach to urban health can address these. It then presents original analysis of the potential health, emissions, and equity impacts of a discrete set of preventative interventions, which support cities in building the economic case for this new approach to urban health. In this new approach, cities and wider stakeholders must consider how they can adapt their roles, responsibilities, and ways of operating to drive effective, lasting change. This report lays the foundations for the next phase of the programme, which will work alongside cities to co-create technical tools to support the realisation of resilient, healthy cities.



Understanding the challenge

76%
of global deaths are now caused by non-communicable diseases, growing by 1.3% annually

The average city inhabitant faces
7 times
the WHO safety limit for PM2.5 air pollutants

45%
increase in heat deaths in cities is expected in the next decade as climate risks intensify

Urban health under pressure from compounding risks

This report focuses on how persistent trends in health, urban, and climate factors present a growing threat to public health. While health systems around the world face a host of challenges, ranging from productivity and digital security to trust and funding, the report focuses on health, urban, and climate factors that will have significant, and avoidable, medium- to long-term effects on health outcomes. Urban, health, and climate factors interact and compound each other in ways that intensify risk. For example, Figure 2 describes how climate change leads to direct and knock-on stresses on human health, the impacts of which are shaped by the urban environment, with resultant impacts on disease burden, healthcare capacity, and access.

Urban characteristics play a key role in shaping health and resilience to climate risks. Urban growth has important benefits – it drives productivity and helps people access higher incomes and public services. However, urbanisation also presents unique health challenges – urban areas can promote sedentary lifestyles, drive social isolation, stress, and anxiety, and have pioneered transport systems that prioritise individual convenience over air quality and safety. For example, the average urban inhabitant is exposed to 7 times the WHO limit for PM2.5 air pollutants.[23] Urban environments can also exacerbate climate hazards, for example through urban heat islands – in New York City, the built environment increases temperatures by over 5°C.[24] Health risks are especially salient where high rates of urban growth are concentrated in informal settlements, where low quality or poorly located housing, sanitation, and other infrastructure create new vulnerabilities. For example, settlements on highly exposed flood plains increased by 122% globally between 1985 and 2015.[25] Poor urban and transport planning can lock in risk exposure and behavioural patterns that can be expensive and difficult to change in future, shaping adverse health outcomes for current and future generations.

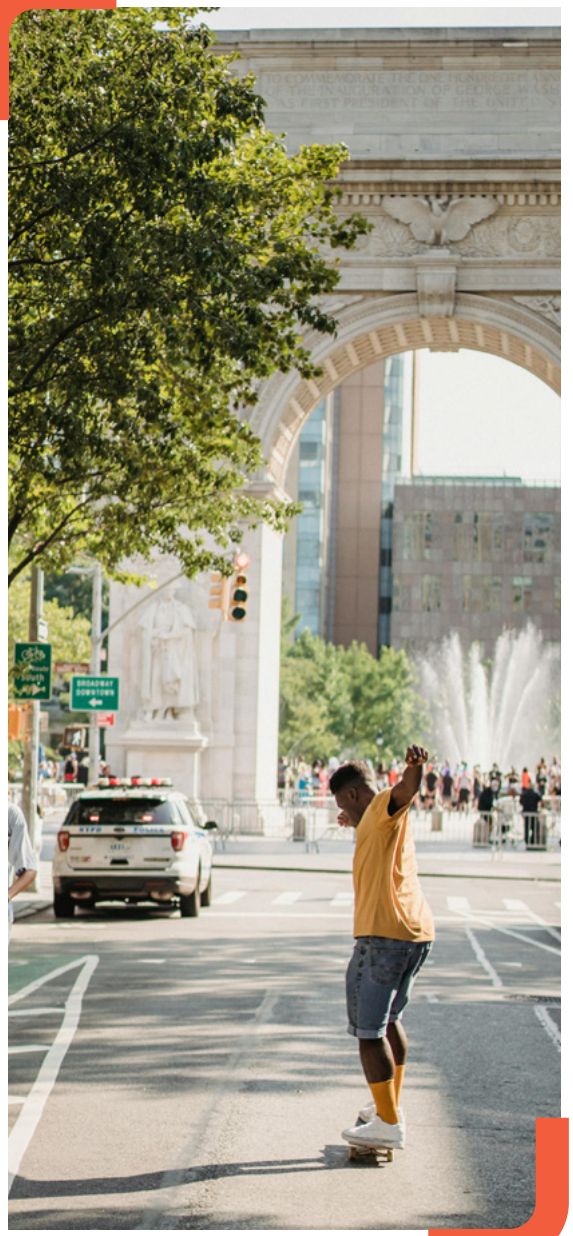
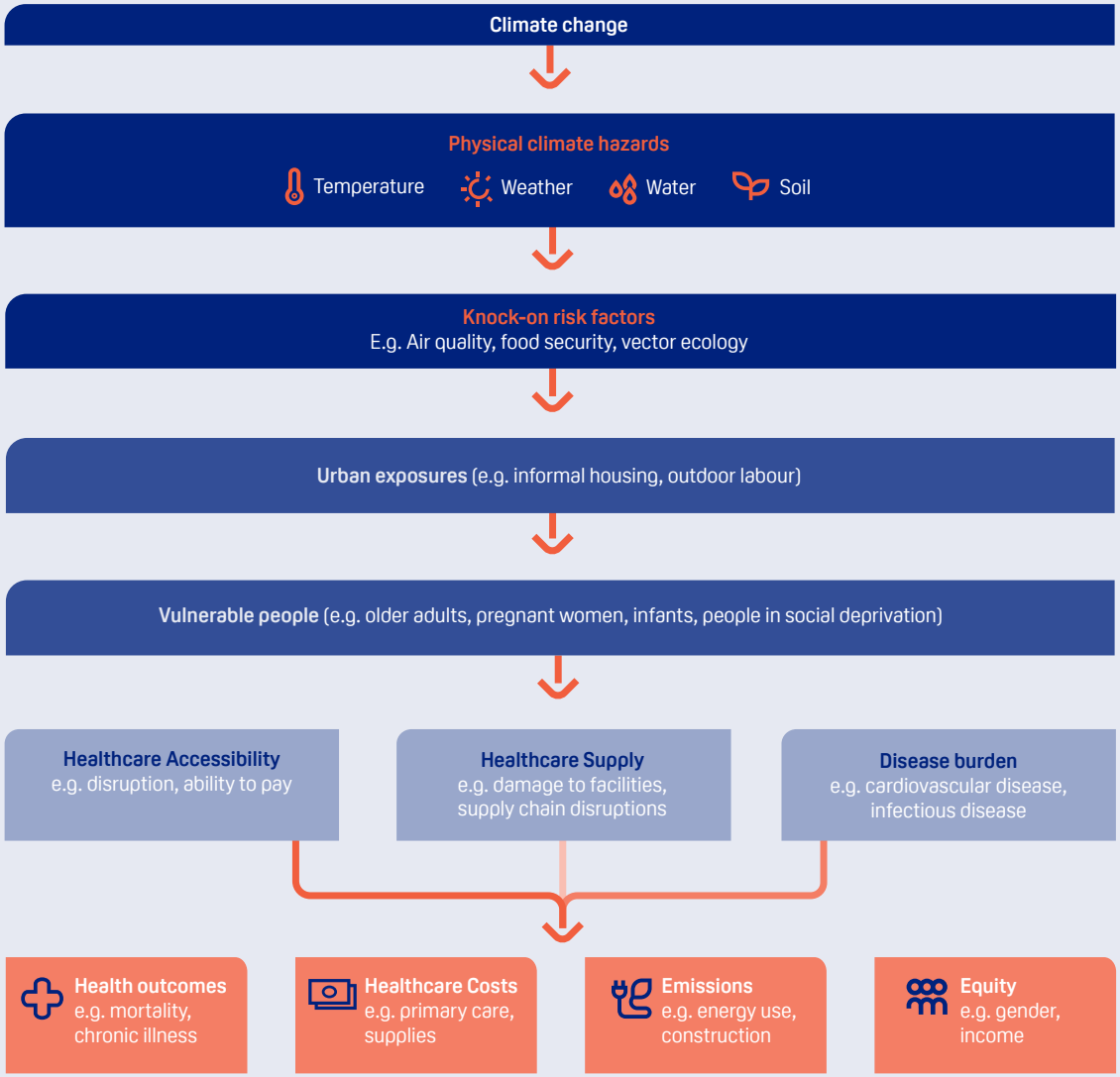
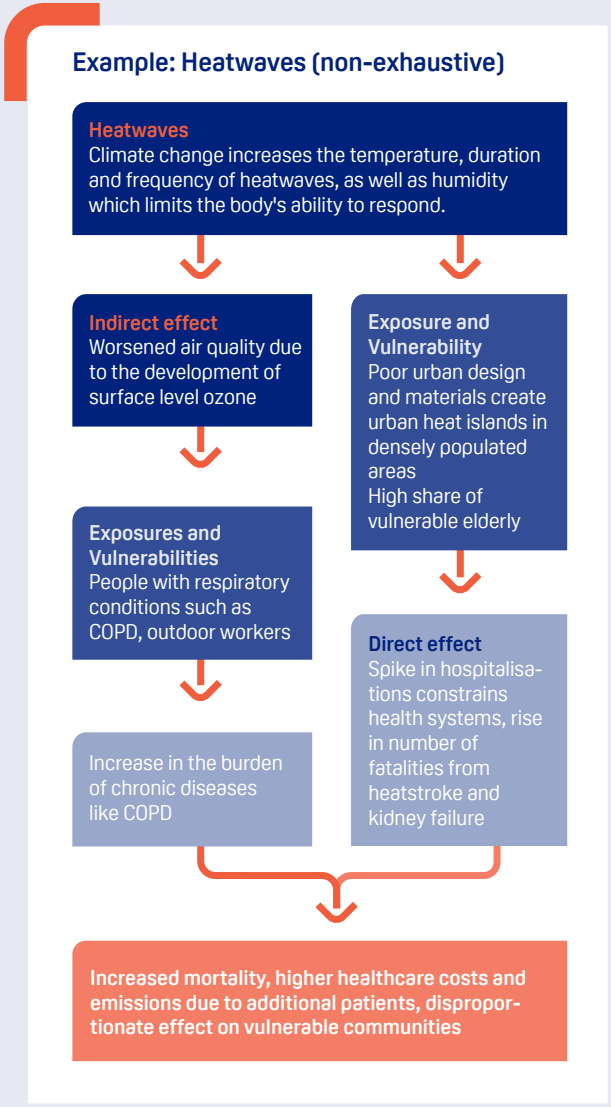


Figure 2: Risks cascade and compound to increase threats to people

Climate hazards and their **knock-on impacts** can be amplified by the **characteristics of the urban environment.** This further stresses **health systems**, and results in worse **healthcare outcomes, increased costs and emissions and worsened equity**

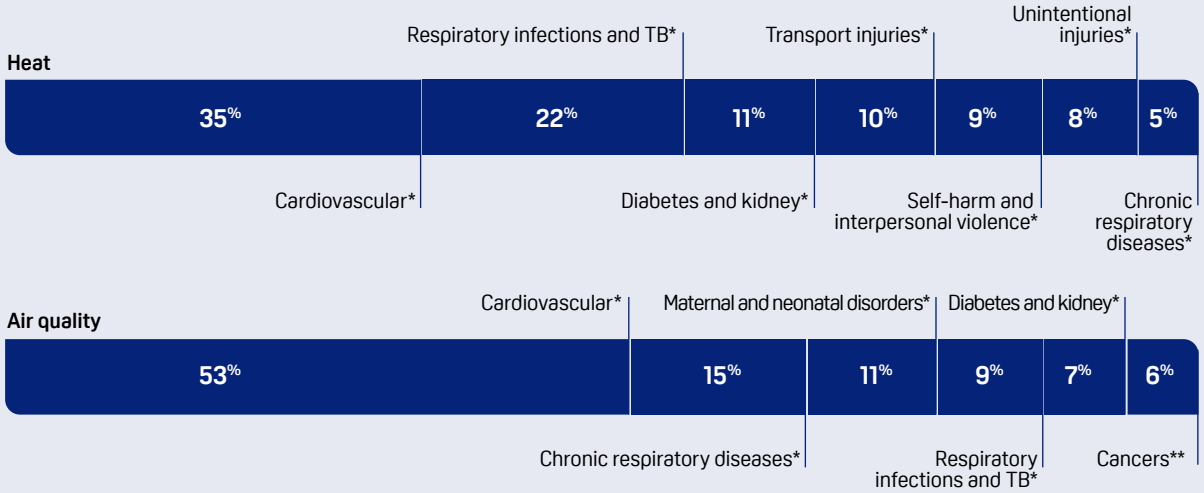




Source: Mode Economics

Trends in public health, particularly increases in non-communicable diseases (NCDs), tend to heighten vulnerability to climate risks. NCDs are now responsible for 76% of global deaths, growing by 1.3%.[26] This is largely driven by lifestyle changes and ageing populations. Figure 3 shows the breakdown of Disability-Adjusted Life Years (DALYs), a measure of disease burden, caused by air pollution and heat: over half of DALYs from air pollution are caused by cardiovascular disease and almost a quarter are caused by respiratory disease and infections. Rising burdens of NCDs like cardiovascular disease will make populations more vulnerable to air pollution and heat, increasing deaths and disability. Ageing has also contributed to rising NCD burdens and is a driver of vulnerability in itself – for example, over 65-year-olds have a 6x higher mortality rate for heat, relative to 15-64s.[27] Analysis of global health, climate, and urban datasets suggests that heat and air pollution deaths in cities will increase significantly, with heat deaths increasing by 45% in just a decade (Figure 4).

Figure 3: Heat and air quality Disability-Adjusted Life Years (DALYs) in cities, by cause.



*Highly climate sensitive

**Less climate sensitive

Source: Mode Economics from IHME, 2021

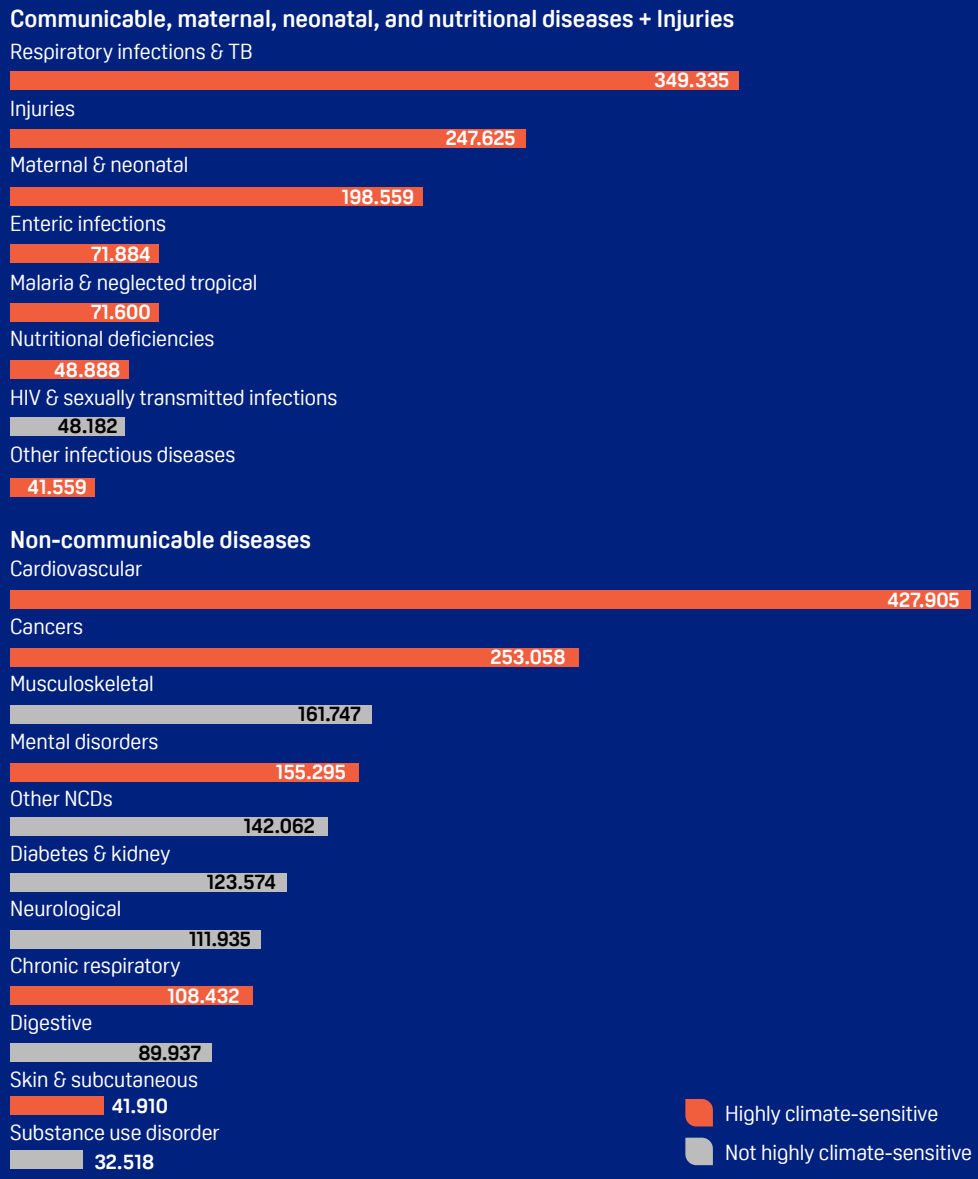
Figure 4: Heat and air quality annual deaths in cities (thousands)

Source: Mode Economics modelling based on IHME GBD 2021

Climate change can increase disease burdens in turn. Figure 5 details how major disease burdens are poised to increase in severity because they are sensitive to climate change.[28] For example, warmer temperatures and changing precipitation patterns will expand the range of some vector species, including into previously unaffected areas, increasing transmission of vector-borne diseases such as dengue, malaria, Zika, chikungunya, and West Nile virus.[29] Malaria deaths alone could increase by over 500,000 a year by 2050.[30] Water-borne disease outbreaks can be triggered by floods as sanitation facilities are overwhelmed and the presence of some water-borne parasites increases 2-3 times following extreme weather events.[31] Extreme weather events also directly damage healthcare facilities – incurring costs for providers, disrupting treatment, and reducing access. Disrupted access to healthcare facilities and other forms of care will worsen outcomes for chronic disease and mental health patients (Box 1). For example, one UK study found that every unit increase in the flood index was associated with a 6.7% increase in all-cause mortality over the following six years.[32]

Climate risks also compound each other. For example, flood events are more likely to trigger outbreaks of infectious diseases when they are preceded by droughts, as pathogens, resistant strains of bacteria, and other contaminants are concentrated in soil and in smaller bodies of water.[33] In recognition of this, heavy rainfall following a drought is sometimes referred to as the "first flush" – when water quality is at its worst.[34] Droughts make wildfire more likely, which presents direct risk of injury and also worsens air quality. Climate risks can also co-occur to drive poor health outcomes – one study suggests that co-exposure to air pollution and extreme heat can increase mortality risk by 21%, almost double the sum of risk from air pollution alone (5%) and extreme heat alone (6%).[35]

Figure 5: Global DALYs by disease burden in 2021 (thousands)



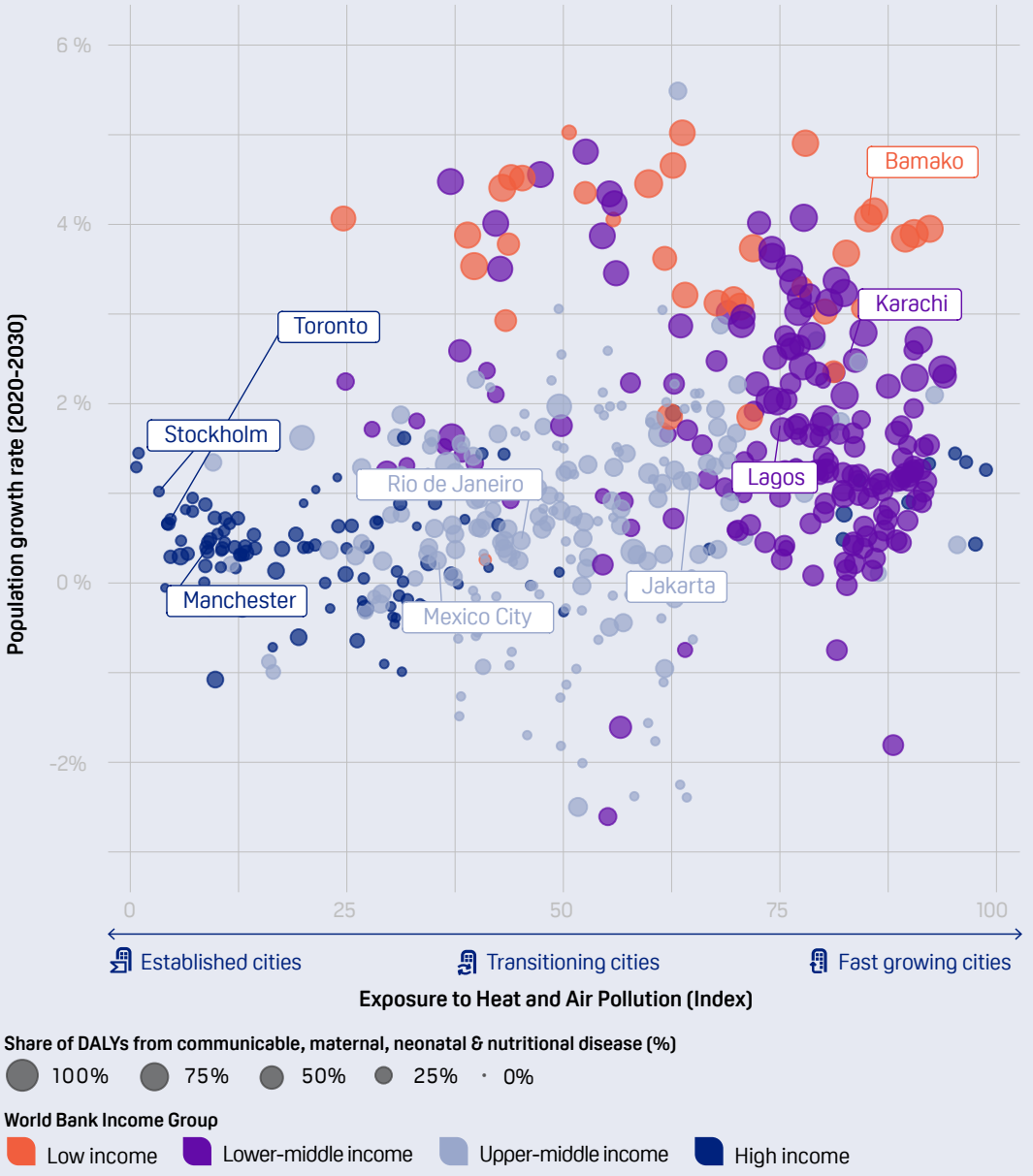
Source: Mode Economics from IHME 2021

Understanding urban contexts

City challenges are locally specific, shaped by their unique health, urban, and climate contexts, but common issues emerge across cities. Risks unfold in a highly localised manner in cities – for example, the extent of urban heat islands will be determined by the amount of green and blue space, urban density, and existence of wind tunnels, which will vary within and between cities. Cities will have varying levels of vulnerability to this additional heat, with some having older age profiles or more effective risk communication. However, many characteristics are common to cities – for example, many cities share high burdens of cardiovascular disease, air pollution that exceeds health recommendations, and under-provision of mental health services.

These climate, urban, and health characteristics are correlated in ways that allow us to group cities into archetypes. Despite the localised aspects of risk, archetypes help cities and other stakeholders identify shared challenges and learn from each other. There are no clear boundaries between the archetypes put forward in this paper: rather, they delineate points on a spectrum. These archetypes are described in Figure 6, with details on the trends within each archetype to follow.

Figure 6: Correlation between health, urban, and climate characteristics.



Source: Mode Economics

Fast growing cities

tend to have relatively high rates of population growth, but higher exposure to climate risks and lower income per capita. These cities can face challenges related to ensuring universal coverage of basic healthcare services and public health infrastructure, in the context of high communicable, maternal, neonatal, and nutritional disease burdens.

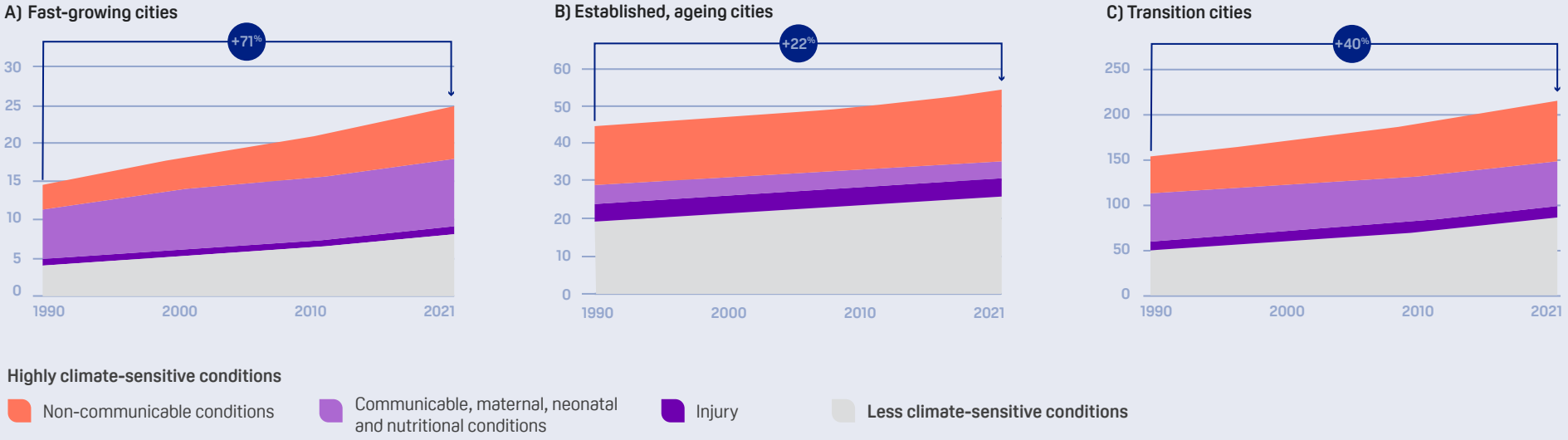
Established, ageing cities

tend to have a higher income per head and less exposure to climate risks. These cities can face high and growing NCD burdens, especially in mental health, and funding challenges as populations age and older infrastructure requires retrofitting.

Transitioning cities

fall somewhere in between these two extremes both in terms of income and exposure, albeit with great variation. These cities can face challenges common to both other archetypes – a dual burden of high communicable disease within rising NCDs, and the need to both expand and retrofit infrastructure systems.

Figure 7: DALYs by disease category in:



Source: Mode Economics from IHME 2021

Trends in Fast growing cities:

- **Health burden:** Fast growing cities have seen a 71% increase in disease prevalence from 1990-2021, with stubborn levels of communicable diseases and a growing NCD burden Figure 7A.[36]
- **Health access:** Health burdens are exacerbated by coverage challenges, with significant populations unable to access healthcare facilities or adequate preventative measures such as Water, Sanitation, and Hygiene (WASH). Accessing healthcare may incur unaffordable costs, driving households into or further into poverty.
- **Informal settlements:** Access issues are compounded where fast growth rates lead to widespread informal settlements. Informality increases the vulnerability of communities to climate risks, as poor quality housing and other infrastructure can increase exposure to events such as extreme heat, while flood events can overwhelm more rudimentary sanitation facilities, triggering water-borne disease outbreaks. Informal settlements also represent concentrations of low-income households, who have fewer resources with which to adapt.
- **Climate sensitivity:** Fast-growing cities face high exposure to climate hazards such as heat and flooding – and tend to face more severe knock-on consequences for health, such as the spread of water-borne diseases after flood events, impacts on food security, or climate-driven in-migration.[37]

Trends in Established, ageing cities:

→ **Demographic change:** Ageing populations, the result of higher incomes, improved life expectancy, and falling birth-rates, place a costly, long-term burden of care on health systems through higher NCDs (Figure 7B). Although the average age of urban inhabitants is typically lower than for rural areas, national trends in ageing will result in a higher proportion and higher absolute numbers of vulnerable people in cities. Many European countries' old-age populations already exceed 30% of working age populations, with this number exceeding 50% in Japan.[38]

→ **Funding constraints:** Ageing populations also mean that the relative size of the working-age population, whose tax revenues or insurance premia often support public health systems, is shrinking relative to older populations.

→ **Rising mental health burden:** Historical funding constraints have left growing mental health needs unmet. Stringent and well-observed COVID lockdowns exacerbated already accelerating rates of mental ill-health – the WHO reports that the global prevalence of anxiety and depression increased by 25% in the first year of the pandemic.[39]

→ **Health inequities:** Despite universal health coverage in many established cities, health inequities remain stark: in Australia for example, chronic disease deaths are 2-3 times higher in the poorest neighbourhoods relative to the wealthiest.[40]

Trends in Transitioning cities:

→ **Dual disease burden:** Transitioning cities can experience a "dual burden" of high but stable levels of communicable, maternal, neonatal, and nutritional disease, combined with rising levels of NCDs Figure 7C. NCDs are related to persistent trends in lifestyles and ageing, similar to those in established cities.

→ **Acute climate risks:** Transitioning cities can be characterised by particularly acute air pollution, with average PM2.5 concentrations over seven times the WHO safety limit (GHSL). These risks can be most acute in low-income households that are more likely to be located in polluted areas.

→ **Gaps in healthcare access:** Many transitioning cities are undertaking significant infrastructure upgrades and expansion in access to healthcare, but inequities leave large pockets without access and vulnerable to climate risks, particularly in informal settlements. For example, 65% of informal street vendors surveyed in Hanoi reported symptoms of heat exhaustion.[41]

Meeting the challenge: choosing the right interventions

5.5%

of healthcare spending is allocated to preventative measures on average in EU countries

50%

reduction in vector populations achieved through community-led programs in Indonesia

3x the impact

preventative measures can have on Quality-Adjusted Life Years (QALY) per dollar spent versus reactive treatment

Motivating preventative, place-based models of care

Today, the prevailing approach to healthcare is reactive and largely dependent on hospitals and other traditional healthcare settings for care delivery. This has contributed to steadily rising healthcare costs as a percentage of GDP, increasing healthcare emissions, and persistent unmet needs as capacity fails to keep up with demands. This reactive approach to healthcare provision is the norm, and is ill-suited to respond to the rising challenges outlined in the previous section. For example, EU countries allocate an average of only 5.5% of healthcare spending to preventative measures.[42]

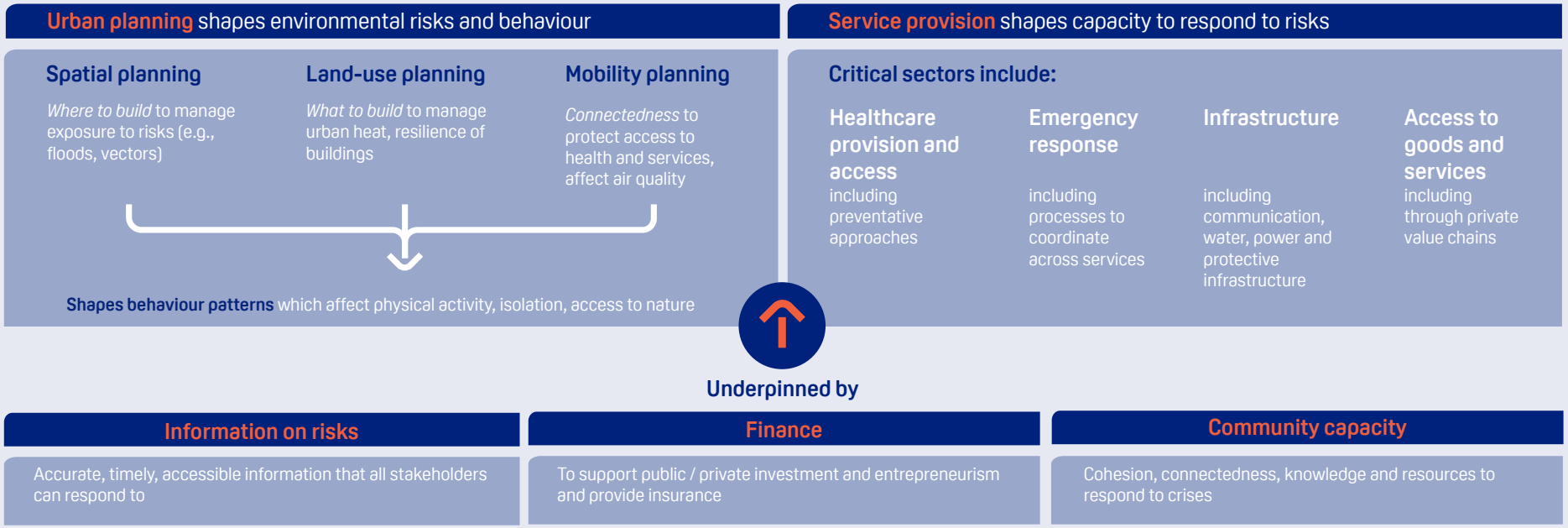
Moving from reactive to preventative models of healthcare and public health promises to reduce disease before it occurs, alleviating pressures on healthcare systems. Reactive, in-hospital treatment will always play an essential role in healthcare systems. However, evidence suggests that placing more emphasis on preventative measures outside of traditional healthcare settings can reduce overall healthcare demands and produce significant cost and emissions savings in the process. For example, one study suggests preventative measures could have three times the Quality-Adjusted Life Year (QALY) impact of reactive treatment per cost.[43] (Box 1) outlines how preventative measures can still take place within conventional healthcare settings, but simply better anticipate and adapt to disruptions to care.

Box 1: Early treatment and drug delivery

Climate hazards can interrupt treatment of chronic conditions by damaging healthcare facilities or preventing patients and staff from accessing them, leading to poorer health outcomes. This is especially pertinent with chronic kidney disease, which can require regular visits to health facilities for dialysis. For example Hurricane Sandy, which struck the Caribbean and the coastal Mid-Atlantic USA in 2012, has been described as “kidney failure disaster” in the USA as dialysis facilities closed before, during, and following the storm, leaving many patients unable to access dialysis facilities. To combat this, some health facilities conducted dialysis and drug deliveries in advance of the storm, reducing disruptions to care. In New York and New Jersey during Hurricane Sandy, early dialysis reduced hospitalisations by 21% and 30-day mortality by 28%.[44] This approach can also reduce patient stress and anxiety associated with having care interrupted, and prevents patients having to travel long distances in unsafe conditions to access care.

Addressing overreliance on traditional health providers and settings can ensure more people receive timely preventative care. This broader base of care is essential to advance prevention, as healthcare systems alone typically have limited access to patients before they seek care, and limited levers with which to encourage long-term risk reduction. Broader based approaches are particularly important in reaching vulnerable, lower-income communities. For example, expanding tuberculosis testing to private pharmacies in Pakistan has alleviated demands on formal health testing facilities while catching cases that may otherwise have gone undiagnosed.[45] Similarly, community-led vector control and education programmes in Indonesia have helped reduce vector populations by over 50%, and could represent better value for money than centralised vector control programmes.[46] (Box 2) outlines how engaging the wider stakeholders in preventative health measures can lead to drastic improvements in health outcomes.

Figure 8: A holistic model of resilience integrates urban planning levers with investment and service provision by public and private sectors



Source: Mode Economics

Broader-based case systems mean a broader range of levers can be pulled to affect change. Figure 8 outlines the domain of activities that can support preventive, place-based approaches: it includes urban planning levers to shape environmental risk profiles and population behaviours; the provision of goods and services from a range of public and private sources, including healthcare from formal and less traditional sources; and enabling by access to information on risk, finance, and the capacity of communities to respond to crises. The role of cities and broader stakeholders section describes in greater detail how different stakeholders can work together across these domains.

Box 2: Heat Action Plans

Ahmedabad created South Asia's first Heat Action Plan in 2013. The city established early warning systems and a response plan that raises public awareness of health risks and preventative measures, increases healthcare response capacity in advance of heat waves, promotes city-wide adaptive measures such as building codes, and identifies and targets response towards at-risk communities. The plan is triggered when a 7-day weather forecast indicates an imminent extreme heat event, with actions proportionate to the magnitude of the event.[47] In Ahmedabad, the plan reduced heat-related mortality by 13%.[48] The effectiveness of Heat Action Plans varies widely between settings. For example, Benmarhnia et al. (2016) find relatively small effects in Canada (6% reduction in deaths), while other studies report significantly larger effects, such as Fouillet et al. (2008) in France.[49,50] These differences likely reflect variation in both heat exposure and population vulnerability, as well as the scope, quality, and implementation of the plans themselves (as well as methodological differences in the studies). The importance of Heat Action Plans will only increase over time as heat events become more severe and present risks to cities that are not used to high temperatures.

Designing preventative, place-based models of care

This broader-based, preventative approach can manage cascading and compounding risks in a variety of complementary ways. Figure 9 outlines the different types of interventions available to cities, across: provision of risk information, risk reduction, transfer of risks (e.g., through insurance), and enablers. It also details how interventions can target different stages of the risk formation process, with earlier interventions helping to stop risks from cascading. Interventions can aim to:

- → **Reduce climate pressures**, which limits the exposure of communities to climate hazards and their indirect impacts – for example, interventions to reduce air pollution address the risk at source, reducing climate hazard and underlying disease burden;
- → **Improve the resilience of the built environment** – for example, zoning laws that prevent development on floodplains reduce the number of people exposed to dangerous flooding;
- → **Reduce community vulnerability**, changing behaviours and shielding households from excessive losses – for example, index-based social protection payments can ensure that disruption and damages from extreme events do not push households into poverty;
- → **Reduce the underlying disease burden** – for example, improving cardiovascular health through active transport, described in (Box 3), reduces susceptibility to heat-related illness.

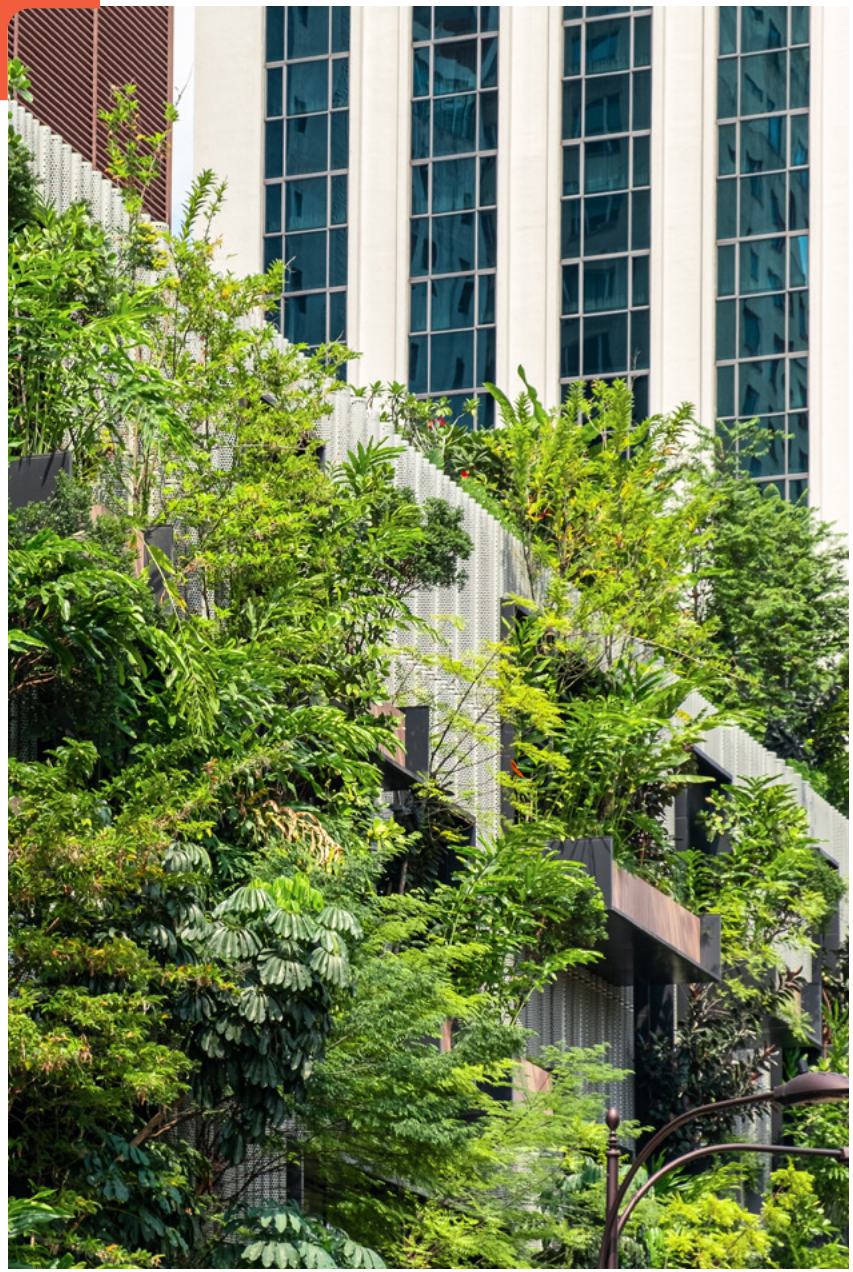
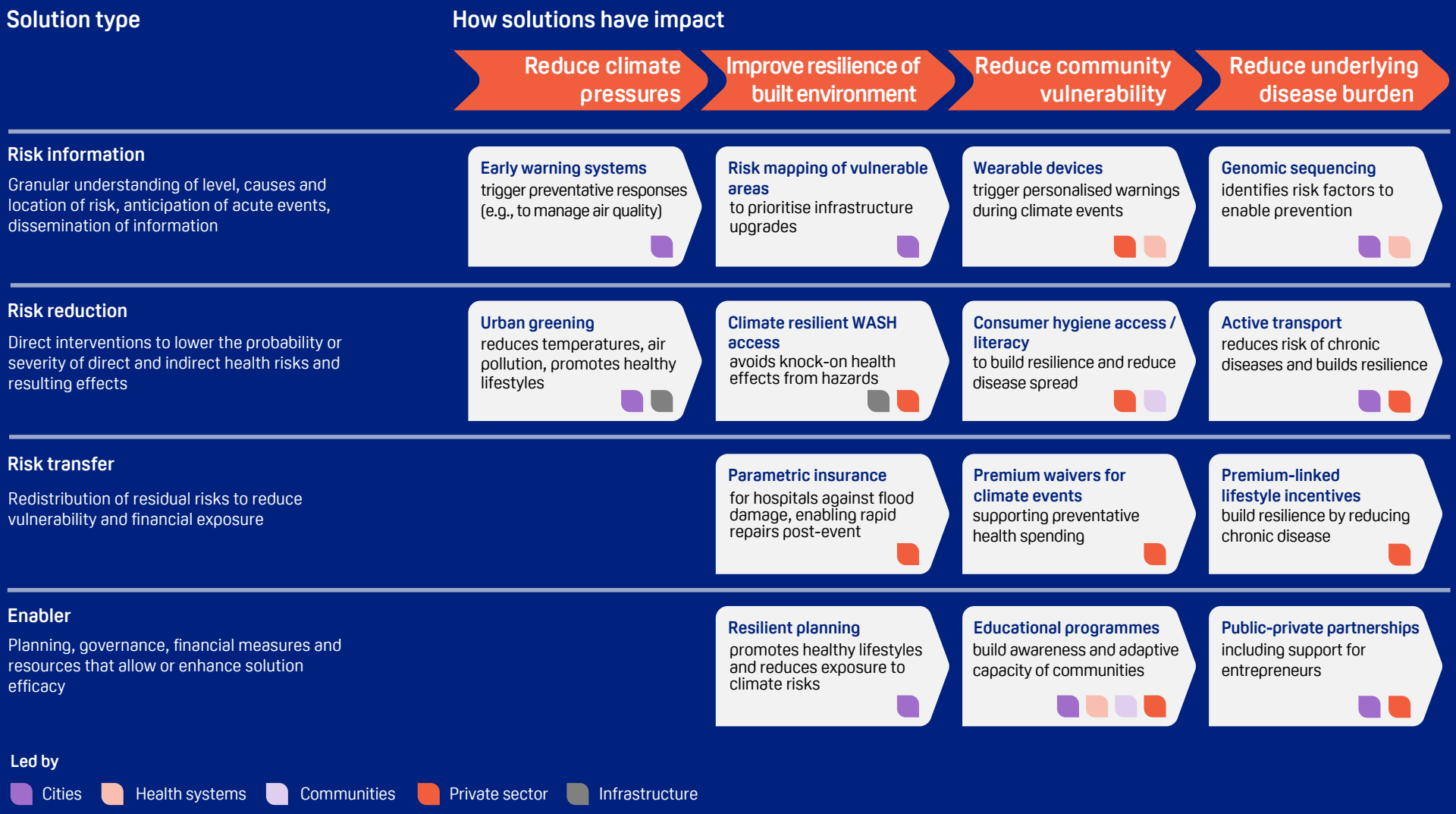


Figure 9: Intervention options along the risk formation process



Source: Mode Economics

There are a significant number of well-evidenced, mature interventions available to cities today. A long-list of interventions is included in Figure 14, a subset of which is described in (Boxes 1-6) and modelled in Quantifying the impact. Neither of these lists are intended to be exhaustive or universally applicable; they are instead illustrative of the efficacy of a set of preventative interventions that are available to cities. A small subset of interventions are modelled in the next section in order to provide evidence on the potential scale and efficacy of different packages of urban health interventions.

Box 3: Public and active transport

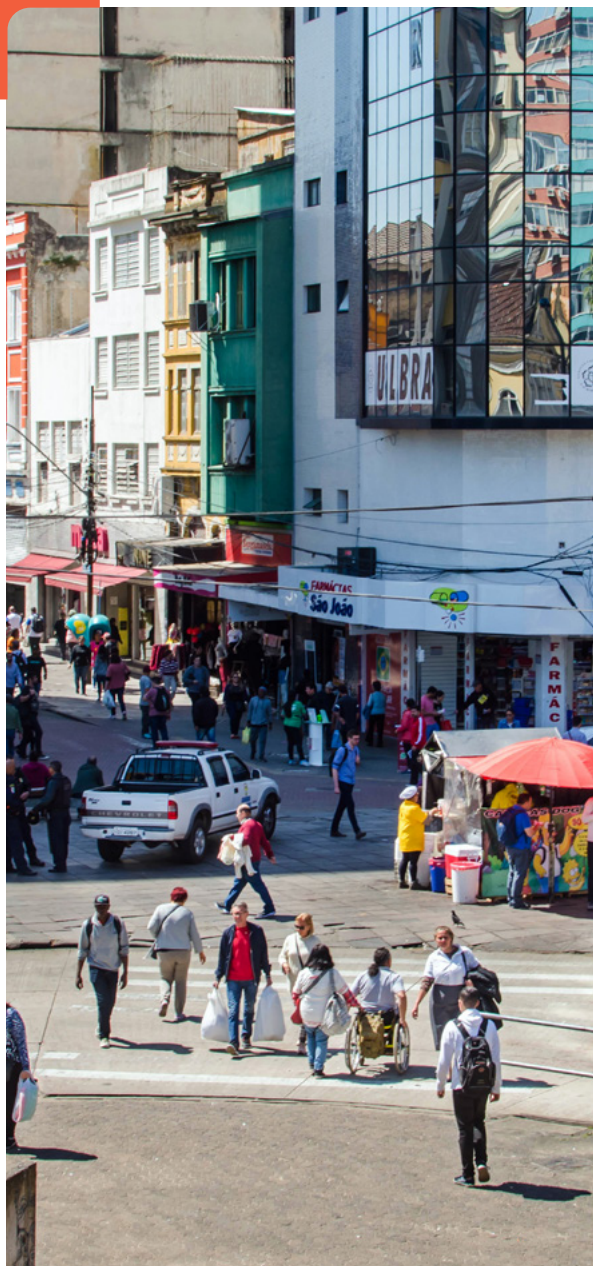
This includes any measures that encourage people to shift away from private cars and towards modes of public and active transport. As with heat action plans, this is best implemented as a bundle of complementary actions that can include area-based car restrictions or payments (e.g., congestion charges), subsidised public transport, cycling infrastructure, and pedestrianisation. Public transport supports health outcomes by reducing air pollution (relative to private car transport) and improving road safety. Active transport has these benefits plus the additional benefit of increasing physical activity levels: someone could meet WHO-recommended physical activity levels through five moderate-intensity, 30-minute cycle journeys per week alone.[51] In Paris, city authorities have implemented a series of ambitious transport policies to boost public and active travel. For example, the cycle lane network increased by over 50% between 2019 and 2023 alone to 4,000km, and the city is removing 70,000 on-street parking spaces (half of its total number) to make room for more cycling and pedestrian infrastructure and urban greening.[52,53] PM2.5 emissions in Paris have fallen by 55% since 2005, with premature deaths from air pollution falling by a third between 2010-19.[54] Active transport schemes in particular typically have very high benefit-to-cost ratios (BCR) due to low infrastructure costs and wide benefits for health and economic productivity – a UK-wide study suggested that UK cycling investments had a BCR of 5.5:1 ($5.50 in benefits for every $1 invested).[55] Public and active transport are closely linked to urban planning, with higher-density, more compact urban areas more viable for low-cost public transport and more feasible for active travellers.

Selecting combinations of interventions

Place-based, preventative interventions often promote a range of objectives, which can be considered holistically. These include:

- → **Economic development:** a key co-benefit for cities from these approaches is economic development – a healthier urban population means a more productive workforce that is able to work for longer. Transport systems that deliver for health can also reduce journey times and costs, which supports labour market efficiency. In turn, economic development can drive further improvements in health outcomes through enabling private spending that supports health, such as safer housing, and fund public health interventions such as public transport.
- → **Inclusivity:** place-based interventions in cities can generate broad benefits. Cleaner air improves health for all residents while also delivering disproportionate gains for populations that face vulnerabilities. For example, reducing urban heat can most improve outcomes for older adults, children, and low-income households. To be truly inclusive, however, such interventions must be deliberately designed and governed to ensure that benefits are equitably distributed and do not inadvertently exacerbate existing inequalities.
- → **Environment:** cities that are healthy for humans are typically healthy for nature – evidence suggests that access to a healthy natural environment is conducive to improved physical and mental health.[56] For example, urban green space can reduce extreme heat deaths, improve mental health, and provide benefits for biodiversity simultaneously.

Conducting holistic assessments across city priorities can help to formulate the best-value package of interventions. For example, by selecting native trees that are high-shading, effective at reducing air pollution, adapted to future changes in climate, and that support biodiversity. This approach also helps overcome siloed thinking – for example, (Box 3) describes how active transport can simultaneously target improvements across transport safety, travel time, physical health,



air pollution, and greenhouse gas emissions. Putting active transport into only one of these siloes would obscure many of its benefits.

Implementing portfolios of interventions can deliver superior value-for-money than individual interventions. Due to biophysical,[57] economic, and social factors, implementing a suite of interventions can have a greater impact and lower cost than individual interventions. For example, planting trees alongside a body of water (a "green-blue corridor") can cool waterfront temperatures by over 3°C more than the sum of individual interventions alone.[58] Similarly, bundling WASH improvements together with child nutrition measures can increase height-for-age scores by more than their combined individual effects.[59] The mechanics of these synergies can be straightforward even where not quantified, for example early warning systems are more likely to be effective when public education campaigns ensure that the public knows how to respond to warnings appropriately. Similarly, car congestion pricing is likely to be much more effective in encouraging cycling if it is accompanied by cycling infrastructure that makes cyclists feel safer on the road. Portfolios that can identify and leverage these synergies stand to benefit from improved impact and cost-effectiveness of interventions. (Box 4) describes how targeted mass vaccinations implemented alongside WASH interventions can be effective in bringing cholera outbreaks under control.

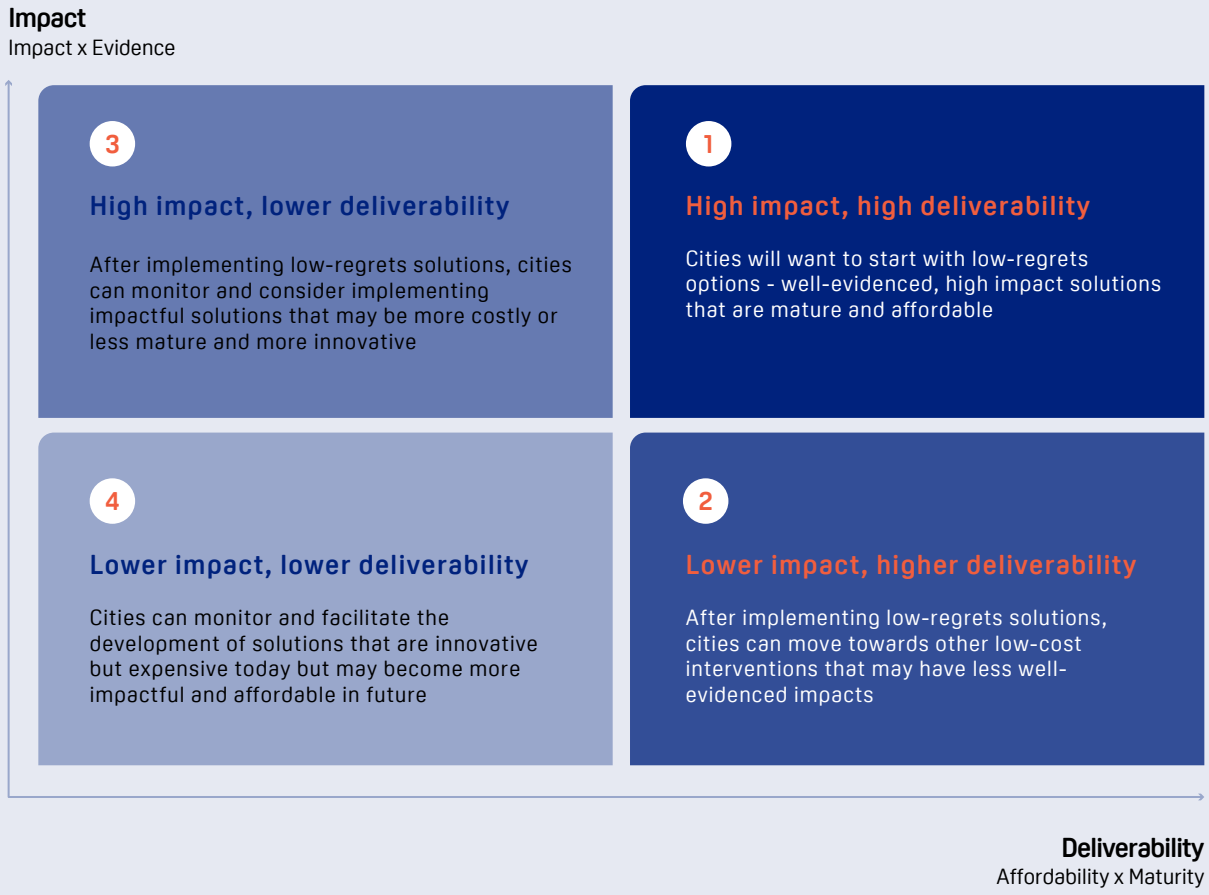
> **We need stronger packaging and management of programs of action, particularly when it comes to prioritization and funding applications, as well as economic studies to evaluate investments and guide decision-making among competing interests.**
>
> Director of Resilience, African City

Box 4: Targeted mass vaccinations

Vaccinating whole populations can be logistically challenging and prohibitively expensive in some contexts. Instead, if communicable disease outbreaks are identified early, targeted mass vaccinations can reduce transmission in targeted populations. This is especially effective where disease outbreaks disproportionately affect or are concentrated in particular areas, such as migrant camps and other informal settlements. For example, floods in Malawi in 2015 left many internally displaced peoples living in migrant camps, which were then subject to a major cholera outbreak. A targeted oral cholera vaccine (OCV) programme, accompanied by promotion of WASH practices in the camps, meant that outbreaks in some camps at the epicentre of the outbreak were controlled within two weeks of the second OCV dose.[60] Data from Zimbabwe, India, and Tanzania suggests that targeted vaccination programmes following the first 400 cases can reduce cholera deaths by 40%.[61] Applying this efficacy rate to global cholera deaths suggests that between 8,000 and 55,000 cholera deaths a year could be prevented by targeted mass vaccinations.[62] The cost per Disability-Adjusted Life Year (DALY) averted is estimated at between $700 and $1000.[63] Targeted mass vaccinations do, however, require fast and precise early warnings of disease outbreaks and sufficient stockpiling of vaccines and other resources to in order to mobilise quickly.

Identifying and selecting low-regret options would support value-for-money for cities and help build momentum for further action. Figure 10 describes how interventions could be placed on a spectrum between evidenced impact on one axis and deliverability on the other. Cities in the early stages of their efforts to improve urban-climate-health outcomes may want to start with low-cost, mature interventions they know to have well-evidenced, high impact on health (position 1 in Figure 10). These would be considered low-regret options – while not risk-free, these measures are unlikely to have significant negative consequences, even if the outcome is not as intended. See (Box 2) for an example of a low-regret option.

Figure 10: Matrix of intervention impact and deliverability



Source: Mode Economics

Cities that have implemented lower risk options may prioritise mature interventions more uncertain impacts (position 2) next, while also working to cultivate higher-cost, less mature interventions (positions 3&4) for the long-term, for example through funding research and pilot programmes. (Box 5) describes one of these interventions – personal wearable devices – that may remain expensive in some contexts today but could be more accessible in future.

Box 5: Personal wearable devices

These are devices like smartwatches that enable continuous monitoring of physiological measurements such as heart rate and blood oxygen, and also measure physical activity levels. These can support preventative health measures in two key ways. First, wearables could be used to communicate health alert (such as extreme heat) to users, while continuous monitoring of physiological measurements can help identify when users are presenting signs of stress (such as lower blood oxygen) and suggest response options (such as rest and hydration). Second, wearables can also encourage and monitor physical activity levels.[64] Granting access of physical activity levels to health insurers could incentivise physical activity levels by offering lower premiums for customers with higher activity levels. Wearables are an emerging technology with mixed measurement quality and limited data on efficacy, however an estimated 37% of the UK population are already using wearable devices, which suggests they may have helpful coverage in more established cities.[65] In countries with lower uptake of wearable devices, alerts can instead be issued through mobile phones, although phones are not able to perform physiological measurements.

Quantifying the impact

15.6 $MtCO_2e$

in healthcare emissions could be saved annually by 2030

725,000

deaths a year could be avoided by 2030

$70bn

in healthcare costs could be saved a year by 2030

Approach

This section presents original modelling evidence that supports the case for preventative, place-based approaches. It considers how, for a subset of the drivers of ill-health reviewed here, a subset of relatively low-cost interventions could, if applied at scale, materially improve health outcomes, save costs and emissions, and support health equity. We do not attempt to model the full impact of adopting preventative, place-based approaches, which would include many more interventions and sources of health risks. Nor do we set out the case for adopting interventions in any given city context: as the next section explains, this requires more bespoke tools that account for each city's specific urban, health, and climate profile.

The analysis focuses on four determinants of climate-related health risk that are shaped by the urban context: extreme heat, air quality, WASH, and lifestyle. These risks were selected due to their:

→ **Significance in determining health outcomes** – e.g., air pollution is responsible for 1 in 8 deaths worldwide[66]

→ **Relevance to cities** – e.g., extreme heat affects rural areas too but is most pronounced in cities, where urban heat islands elevate temperatures

→ **Sensitivity to climate change** – e.g., cancer is a major disease burden globally but is not considered to be highly sensitive to climate change (see Figure 13)

→ **Applicability to global-level modelling** – e.g., mental health is a major and rapidly growing urban health risk, but has complex drivers and insufficient data to account for in a global modelling exercise.

The four health risks modelled here are by no means the only or most severe climate-sensitive health risks that cities should be monitoring – vector-borne diseases, nutrition (beyond obesity), and mental health, for example, are not modelled but constitute substantial and growing risks. The modelling results should not be interpreted as the full picture of climate-health impacts – they are conservative estimates that reflect what can be reliably modelled at the city level.

These four key health risks are sensitive to climate change, but in contrasting ways. The link between climate change to extreme heat is clear and well-evidenced – climate change means warmer temperatures and more extreme weather, increasing the number and severity of heatwave days. For air quality and WASH, the direct drivers are not climate but baseline deficits – deficit of air quality as a result of air pollution, and deficit of WASH due to infrastructure gaps and inequity. Rather than being caused by climate change, air quality and WASH risks are instead made more severe by it – high temperatures and extreme weather increase air quality risks, and extreme weather can interrupt WASH access and lead to outbreaks of infectious disease. Lifestyle risks are less directly caused or worsened by climate change, but are instead a major factor underlying other climate-health risks. For example, cardiovascular disease is the cause of over half of air pollution deaths.

This section provides an overview of the approach and findings. Further technical detail is provided in Technical Methods: Data, Assumptions, and Computation.

Intervention packages

The analysis considers place-based, preventative interventions that have well-evidenced impact on health. A long-list of possible interventions, limited to lower-cost, scalable measures accessible to most cities, was developed. For example, large infrastructure upgrades are out of scope for this analysis, while digital network monitoring would be in scope due to its low relative cost and high scalability. Scalable and place-based are not mutually exclusive – interventions should demonstrate broad applicability to different cities, but still require catering to specific city contexts when implemented. A long (though still non-exhaustive) list of possible interventions is included in Figure 14. Interventions were selected for modelling based on the quality of evidence for their:

- → Efficacy
- → Magnitude of their impact
- → Appropriateness in being applied to cities globally, and
- → Compatibility with global health data.

For example, providing health training for clinical staff could be an effective intervention but its efficacy is not well-evidenced in real-world studies, while the impact of early pre-disaster treatment for chronic care patients has robust evidence but is applicable in select circumstances (see Box 1) that make it less suitable for application globally.

The modelling makes broadly applicable assumptions about the scale at which interventions are implemented. Cities face physical, fiscal, and political constraints in the scale at which they can implement interventions, and this will vary from city-to-city. However, some of these interventions are effective only when implemented at scale. For example, piecemeal measures to increase active transport will likely not be sufficient to change social norms around travel. The assumptions on the scale of uptake of solutions aim to be realistic (e.g., increasing the coverage of cool roofs and green space by 5% of the urban area) while also being of sufficient magnitude to ensure they can demonstrate impact.

The combined effect of representative packages of interventions are considered. This reflects the fact that interventions are often implemented as portfolios or packages of interventions (see (Selecting combinations of interventions) section). The packages are not intended to be recommendations on specific packages of interventions or the scale at which they should be implemented; instead, they simply highlight the impact that these kinds of interventions could credibly have. In limiting the analysis to the four key health drivers identified above, this necessarily overlooks some of the wider health benefits of these interventions – for example, measures to reduce congestion would likely reduce transport injuries and improve mental health.

Heat

High temperatures impede the body's ability to regulate temperature, and cause dehydration and inflammation. These can trigger underlying health conditions, such as cardiovascular disease, respiratory diseases and infections, diabetes, and kidney disease. Heat can also impair daily activities and alter behaviours – heat is associated with increased transport injuries and increased incidence of interpersonal violence.[67] This analysis suggests that extreme heat causes a total of 196,000 deaths in cities every year. Intervention packages are grouped under the following headings:

→ **Reduce urban temperatures:** urban planning and design interventions such as cool roofs, urban greening, reflective paints, and building standards that can reduce urban temperatures. The modelling assesses the impact of increasing the coverage of cool roofs and green space by 5% of the urban area.

→ **Reduce underlying disease burden:** efforts to increase physical activity and / or reduce obesity mitigates the risk extreme heat poses to populations, as these interventions decrease the underlying health burden. The specific impacts of these interventions on heat vulnerability are not modelled, but their broader impact is considered under lifestyle risks.

Air quality

Poor air quality increases the risk of cardiovascular disease and irritates the respiratory system, increasing the risk of chronic respiratory diseases. Air quality can also particularly affect maternal and neonatal health by increasing the risk of adverse pregnancy outcomes. Air quality can be made worse by extreme heat, which emphasises the importance of tackling multiple overlapping health risks. Air quality is a major contributor to disease burdens, causing a total of 2.1 million deaths in cities every year. Interventions to improve air quality risks can aim to:

→ **Reduce air pollution:** urban planning and transport interventions such as urban greening, public and active transport, area-based congestion measures, and restrictions on traditional heating and cooking equipment can all help to reduce air pollution in cities. The impact of area-based congestion schemes that reduce PM2.5 levels by 18.25% are modelled here.

→ **Reduce underlying disease burden:** as noted above, measures to reduce obesity and increase physical exercise reduces a population's vulnerability to poor air quality. The specific impacts of these on air quality risks are not modelled, but their broader impact is considered under lifestyle risks.

WASH

Lack of access to sufficient water, sanitation, and hygiene facilities increases the risk of enteric infections, other infections, and comorbidities such as malnutrition. WASH access is a major driver of global disease burdens in its own right, and brings wider social costs – time spent travelling to collect water reduces (predominantly female) incomes and education, and is associated with increased incidence of violence against women.[68] WASH access also interacts with climate change as extreme weather events, such as drought and flooding, can damage WASH facilities and trigger water-borne disease outbreaks such as cholera. Interventions to improve WASH access can include state-funded infrastructure upgrades, distribution of point-of-use products, or micro-finance for household facilities (see Box 6). WASH-related deaths are predominantly located in rural areas, but WASH access remains a significant challenge in cities, causing 718,000 deaths a year.[69] Interventions to reduce WASH risks can aim to:

→ **Improve infrastructure access:** the modelling considers how, through a set of plausible infrastructure upgrades, increasing access to piped drinking water for up to 10% of the population that is previously not connected can improve health outcomes. These infrastructure upgrades are also assumed to increase access to handwashing facilities for up to 2.5% of the population who are previously not connected.

→ **Reduce community vulnerability:** interventions that empower communities to change behaviours, especially during acute events such as flood-induced water-borne disease outbreaks, could directly reduce WASH deaths. The modelling considers the health impacts of improved access to sanitation for up to 10% of the population that is previously not connected. It also assumes that these measures provide an additional improvement in handwashing practices for up to 2.5% of the population.

Lifestyle

Lifestyle is a major determinant of health outcomes in cities and underlies growing health risks related to climate. Most notably, lifestyle choices characterised by poor diets and low physical activity are a major driver of growing rates of cardiovascular disease, which in turn is the leading cause of both heat-related and air quality deaths globally.[71] Low physical activity and high BMI today cause 2 million deaths in cities. Interventions to reduce lifestyle-related risks can aim to:

→ **Reduce underlying disease burden:** reversing trends towards lower physical activity and higher BMI in cities can include a wide range of interventions including education campaigns, food taxes and subsidies, advertisement bans, personalised diet and exercise plans, social prescribing, and active transport. The modelling considers the impact of personalised prevention plans on physical activity levels and BMI. Green and social prescribing interventions, which place emphasis on physical activities done outdoors and in social groups, can have significant benefits for mental health outcomes, which are not captured here.[70]

Results

The set of interventions modelled could prevent more than 725,000 deaths a year if adopted at scale. These low-cost, inclusive urban interventions are only a subset of options available to cities, and so represent a highly conservative estimate of the total impact that could result from the adoption of the broader approach this paper endorses. This is broken down as follows in Table 1.

Across heat, air quality, WASH, and lifestyles, the interventions considered could almost reverse expected increases in deaths to 2030 (e.g., see Figure 11). The interventions considered therefore offer cities a powerful means of halting continued rises in climate-health disease burdens.

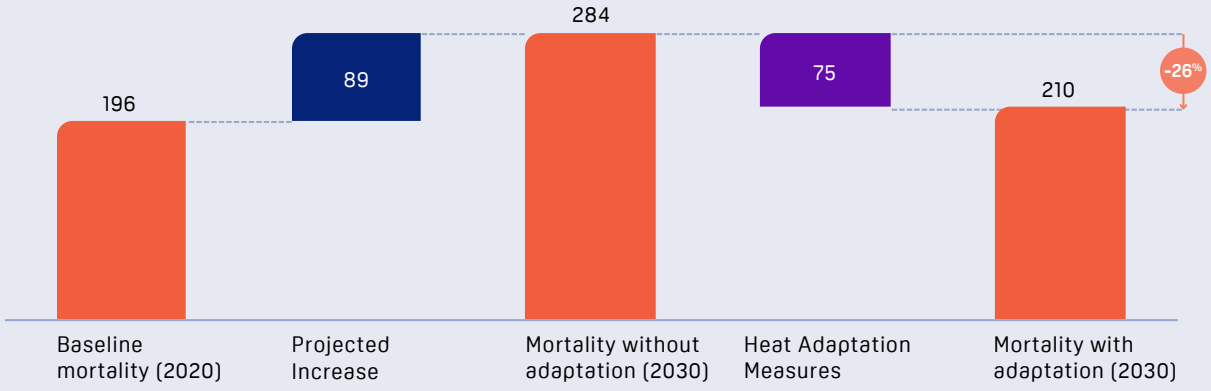
The most vulnerable populations stand to gain the most from these interventions. Some of the most vulnerable groups – those of older age, young children, and low-income groups – bear the greatest climate-health burdens, and therefore stand to benefit most from its reduction. For example, over 65s have 16x higher mortality rate from PM2.5

Table 1: Intervention modelling results

Climate-health risk	Intervention package	Deaths avoided in 2030
Heat	Reduce urban temperatures	**74,500** heat deaths a year, a **26%** reduction relative to a no-intervention scenario
Air quality	Reduce air pollution	**354,000** air quality deaths a year, a **14%** reduction relative to a no-intervention scenario
WASH	Improve infrastructure access	**109,000** WASH deaths a year by 2030, an **11%** reduction relative to a no-intervention scenario
	Reduce community vulnerability	**57,000** WASH deaths a year by 2030, a **6%** reduction relative to a no-intervention scenario
Lifestyle	Reduce underlying disease burden	**131,000** deaths a year by 2030, a **6%** reduction relative to a no-intervention scenario (for obesity and physical activity-related lifestyle deaths only)

Source: Mode Economics

Figure 11: Annual urban heat deaths, 2021-2030 (Thousands)

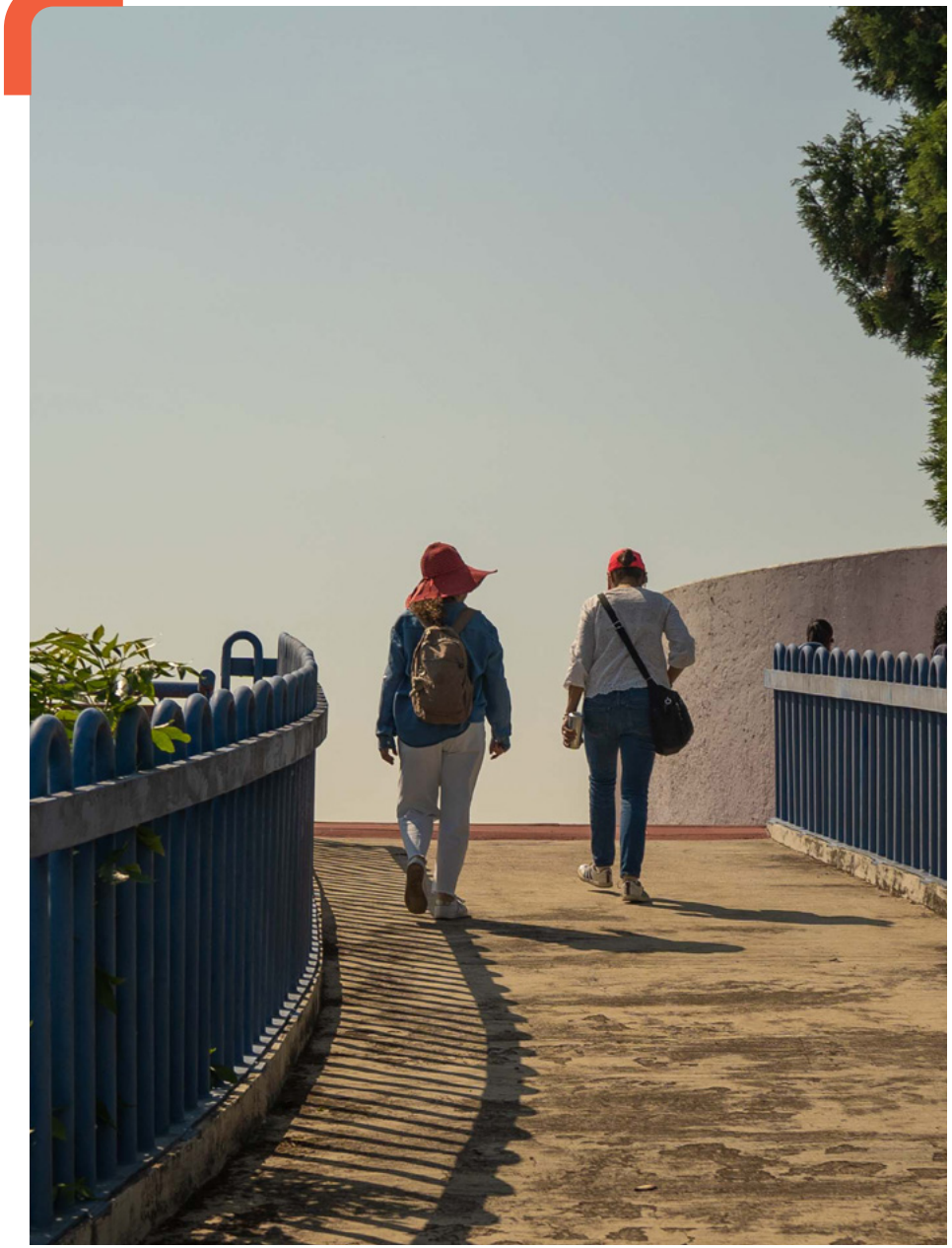


Source: Mode Economics

air pollution, 6x higher mortality rate from heat, and 5x higher WASH-related mortality rate. Under 5s have a 10% higher mortality rate from heat and 4x higher WASH-related mortality rate.[72] Women have an 8% higher risk of death from heatwaves and 72% increased risk of needing to access medical care.[73] Low-income groups have a 13% higher risk of death from PM2.5 air pollution, while 80% of people exposed to unsafe PM2.5 levels live in low- and middle-income countries.[74,75] Low-income groups also have a 3x higher mortality rate from lack of access to handwashing, 2.5x from unsafe water, and 1.5x from unsafe sanitation.[76] Shielding low-income groups from health risks also protects their livelihoods – low-income people are more likely to be pushed into poverty by loss of income and out-of-pocket healthcare spending.

> **There are already programs providing quality water and services for people vulnerable to heat, but these often remain inaccessible to people experiencing homelessness. These services need to be extended to everyone.**
>
> – NGO Director, Latin American City

The interventions could together save $70bn in healthcare costs and 15.6 $MtCO_2$ in emissions from healthcare provision every year by 2030. This emissions figure represents just under 1% of global healthcare emissions, equivalent to the annual CO_2 emissions of Prague emissions of Prague, or Accra.[77] Beyond this, the interventions can reduce emissions outside the health sector. Most notably, public and active transport programmes can substantially reduce urban transport emissions. For example, one estimate suggests that urban



transport policies could reduce urban transport emissions by 22% worldwide – equivalent to ~2% of global annual emissions.[78] Similarly, urban greening programmes will sequester carbon, although the size of this emissions impact will be substantially smaller than for transport, given the low land footprint of urban areas.

While modelling assumes a defined scale of implementation for each intervention, it is up to cities to consider the appropriate scale of intervention required for their specific context. The interventions modelled here are also a subset, and should therefore not be seen as the only options available to cities. For example, fast-growing cities may choose to focus on expanding access to basic services, empowering communities to take actions that reduce risk of infectious and nutrition-related disease, and ensuring that future patterns of growth (e.g., through major infrastructure investments) do not lock-in vulnerability and poor health. Established, ageing cities may instead focus on retrofitting urban infrastructure in response to increasing climate risk, and adopting preventative strategies to improve mental and physical health. Transitioning cities may focus on a combination of these, in addition to improving air quality and hygiene, and developing strategies to protect vulnerable groups such as those in informal settlements.

It is up to cities to consider which risks are most salient to them and to begin to prioritise interventions. In order to do so, cities require frameworks and tools for identifying risks, and prioritising and implementing interventions, which the following section will consider.

The role of cities and broader stakeholders

29 cities

are part of the Resilient Cities, Reimagining Health Community of Practice

19 countries

represented by the cities in the Community of Practice

Cities have a natural leadership role in pioneering preventative, place-based approaches to public health that support economic development. Economic development is central to a city authority's remit, and has a mutually reinforcing relationship with urban health – healthy cities are more productive. Cities' broad remits allow them to undertake holistic assessments of risks and opportunities to take advantage of intersecting economic development and health goals. For example, Medellin's Climate Action Plan aims to deliver carbon neutrality and adaptation through integrated action across transport, buildings, waste management, green infrastructure, and community approaches.[79] Holistic planning helps the identification of synergies, and reduces the chance of maladaptation, for example, by supporting expansion of social housing that does not account for heat risks or support active transport. Resilient Cities Network's City Resilience Framework can help cities to prioritise, implement, and communicate portfolios of interventions in a holistic and integrated manner.[80]

Cities can directly influence health through their control of critical levers. While specific responsibilities vary between institutional contexts, cities typically shape the urban environment through control of urban planning levers, coordinate emergency response, and may provide or tender essential services such as public transport or social care. This gives them direct influence over population health and resilience to climate risks. Cities also have access to expertise and data spanning a broad range of services, enabling the strategic identification of place-based needs and targeted implementation of interventions.

> **We must prioritize urban cooling and carefully manage the trade-off between energy efficiency and how housing responds to extreme heat. Over-insulating homes can create risks if they cannot be cooled during heatwaves.**
>
> Senior Policy Advisor, European City

Cities also have a unique ability to convene and coordinate other stakeholders who have a role to play. Cities play a pivotal role in guiding, supporting, and convening wider stakeholders from across communities, local businesses, formal healthcare providers, finance and research organisations, and national government. Cities can initiate convenings around key city goals or events, and help orientate external stakeholders around goals or new market creation. Alternatively, cities could choose to support initiatives instigated by wider stakeholders. An example of this is Sustainable Markets Initiative Camden Breathing Better Charter, supported by major Camden employers including Bupa, Reckitt, and GSK, which commits signatory organisations to reduce harmful emissions and support employee health and wellbeing.[81] Cities can also support external initiatives by convening and providing expertise, data, and funding. External stakeholders in turn can enhance city initiatives through contributing expertise, delivery capacity, and public coverage. (Box 6) outlines an example of how civil society and private sector organisations can instigate public health improvements, which city authorities may wish to support.

Box 6: Micro-financing for WASH

The efficacy of quality Water, Sanitation, and Hygiene (WASH) practices is well-established – for example, point-of-use water filtration devices can reduce the risk of diarrhoea by over 60%.[82] WASH improvements can result from infrastructure upgrades, changes in personal habits and practices, or household and point-of-use facilities and products. Despite high efficacy and an established evidence base, WASH coverage remains a challenge, even in urban areas, with 2.2 billion people globally without safely managed drinking water, 4.2 billion without safely managed sanitation facilities, and 3 billion lacking basic handwashing facilities.[83] One of the biggest challenges to achieve universal access is the funding gap, estimated at $140bn annually. Innovative financing solutions like micro-financing are proving transformative in expanding access to adequate WASH, particularly in underserved communities. Organisations like Water.org provide micro-loans to empower households to install water taps and toilets in their homes.[84] 90% of these loans go to women with a repayment rate of 98%, creating a self-sustaining cycle of impact: every repaid loan is reinvested into the model, multiplying reach and impact. Through this approach, water.org has helped mobilise more than $6.8 billion in capital to support access to safe water and sanitation for almost 80 million people.

Within this framework of city leadership and coordination, there is an opportunity for other stakeholders to contribute much more. See Figure 12 for an example on how cities can coordinate a broad set of actors to achieve health resilience, alongside work on synergistic goals on climate and the economy. Key stakeholder groups include:

Community groups and NGOs – including community networks, local community associations, and local and international NGOs. Communities contribute highly localised knowledge (such as locating at-risk households) and delivery capacity (targeted outreach and education) that are essential in developing and implementing plans, and shaping how communities respond to health risks. National and international NGOs can enable locally-led action by empowering communities with funding and expertise. For example, Start Network channels financing to locally-led disaster preparedness and response programmes.[85] NGOs can also leverage their expertise and capacity to strategically fill in institutional gaps – for example, where there is an absence of well-resourced agencies promoting urban public health.

Businesses – have a strategic role in supplying essential goods and services to help people protect their health and wellbeing. As employers, they have a stake in promoting healthy lifestyles and protecting their workers from climate risks. Larger private sector organisations could go further in supporting the model, creating new markets and products and designing infrastructure that promotes health and considers how climate change will affect needs. For example, personal cooling and hydration products can be a scalable means of reducing exposure to heat, while personal wearable devices and accompanying software can encourage physical activity.

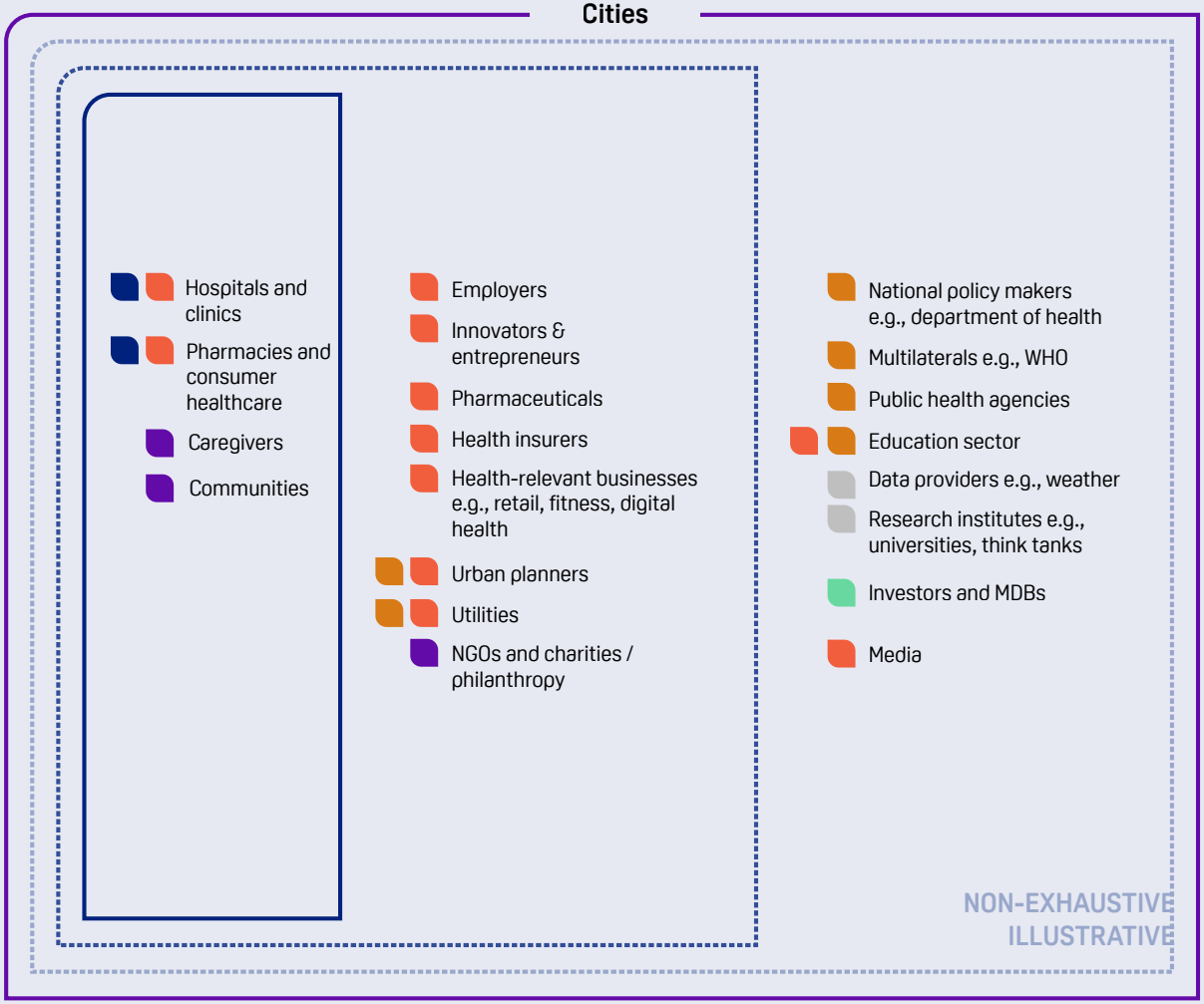
Formal healthcare providers – can reduce costs by supporting broad-based, preventative models of care, collaborate in emergency response, community education and awareness campaigns, and invest in care resilience. Under a more ambitious model, healthcare providers could leverage healthcare professionals' trusted status to help educate the public on climate-health risks and preventative and reactive behavioural responses. Healthcare facilities could similarly be reimagined as resources rather than recipients of patients during acute climate hazards – hospitals with on-site electricity generation and water purification can act as resilience hubs for the local community. For example, following devastating hurricanes, St George's Hospital in St Vincent & the Grenadines was able to provide access to potable water for patients and the wider community, while Peebles hospital in the British Virgin Islands was the only facility able to host government meetings following the event.[86]

Research organisations – have a key enabling role, which can be enhanced through partnership with cities to understand their specific needs and develop appropriate solutions. Research organisations can play an active role in active monitoring and evaluation of public health goals, filling gaps often left by city authorities even in established, ageing cities. For example, Breathe London is a university-based network that seeks to improve the coverage of air pollution monitoring in London, given significant gaps and deficiencies in the public network.[87]

Investors and development banks – investment by development banks and other public interest investors can support city objectives, especially in contexts of limited city resources. Concessionary and philanthropic capital can crowd-in capital from private investors and insurers. For example, CRA and SEWA have developed micro-insurance products that support informal sector women's health and livelihoods during extreme heat events.[88] Financing arrangements also play a role in formalising cooperation and sharing of expertise between different public and private institutions.

National governments and multilateral agencies – can support cities by providing technical expertise and more flexible financing to support preventative health models and promote economic growth. Under such a model, public sector organisations could responsibly ease centralised control on health resources, to place a greater emphasis on providing the tools, funding, and sharing and learning procedures to empower local actors to design and deliver place-based interventions. For example, decentralisation has allowed Greater Manchester to develop its own integrated transport network.[89] Where gaps exist in local capacity and expertise, national governments and multilateral agencies can help fill these. For example, WHO provide technical assistance, finance, and health monitoring to member states through the ATACH programme.[90]

Figure 12: Cities can coordinate a broad set of actors to achieve health resilience, with synergistic goals on climate and the economy



Roles in building health resilience

Healthcare provision
The first line of defence implementing both treatment-based and preventative healthcare

Health supporting
Actors directly supporting healthcare provision by providing goods, services, infrastructure, and incentives for preventative healthcare

Enabling
Actors who have no direct relationship with healthcare, but enable the other actors through data provision, information, research, regulation, policy, and finance for health and wellbeing

Coordinating for health and broader sustainability objectives
Cities play a key role in coordinating health resilience delivery across actors, with synergistic work on other policy goals including climate and economic growth

Stakeholder groups building resilience*
- Formal healthcare providers
- Businesses
- Community groups and NGOs
- Governments and multilaterals
- Investors and banks
- Research organisations

*Some organisations may perform multiple roles, here for simplicity they have been mapped against their primary role

Source: Mode Economics

Together with wider stakeholders, cities can work to identify and secure funding sources from beyond their own tax base. While cities themselves often lack the jurisdiction to raise finance independently, they can, in their convening capacity, bring investors and projects together, such as by aggregating pipelines of investable opportunities. For example, the EBRD Green Cities programme helps cities identify environmental challenges and stimulate private investment in infrastructure such as water, urban transport, and solid waste.[91] Financing arrangements require cities to become comfortable working closely with the private sector, and financing arrangements can assist by formalising the required cooperation between stakeholders. Non-public funding sources can help to stretch limited public funds further and can help formalise cooperation between cities and other stakeholders. Table 2 outlines some potential funding sources and mechanisms available to cities.

To implement impactful and cost-effective programmes of interventions, cities and broader stakeholders require frameworks for decision-making and lasting partnerships. The capacity and institutional context of every city is different, but there are broadly applicable steps that cities can follow to develop and implement interventions. (Box 7) outlines the Resilient Cities Network's 5-step action framework that cities can follow to adopt place-based, preventative approaches to urban health in collaboration with a network of stakeholders.

Table 2: Financing partnerships for cities

	Role for Cities	Role for other Stakeholders	Use Cases	Examples
Public and Donor Funding	Financing from Municipal budgets and intergovernmental transfers	Development and philanthropic grants from philanthropic community	Core services, pilot programs, equity-driven interventions	Infrastructure budget, research and innovation funds
Blended and Market Finance	Concessionary financing from municipal budgets and intergovernmental transfers	Private financing from DFIs, ESG investors, private firms	Scalable infrastructure	Performance-based delivery, public-private partnership schemes
Insurance and Risk Transfer	Purchase and co-design of insurance products; premium subsidies	Design of insurance, purchase of reinsurance	Disaster recovery, epidemic response, acute climate risks	Catastrophe bonds, parametric insurance, regional risk pools, epidemic risk coverage
Community and Innovation	Convene community and other initiatives, bringing projects together with investors and aggregating projects	Local NGOs, civic platforms, tech firms, academic institutions	Local adaptation, grassroots initiatives, digital enablement	Community savings schemes, participatory budgeting, crowdfunding, data-for-health partnerships

Source: Mode Economics

Box 7: The 5-step Action Framework, adapted from Resilient Cities Network (2024)[92]

Assess:

Hold structured discussions to clarify high level objectives, assign governance roles, and map all relevant city stakeholders and institutions; collect baseline data, analyse who and what is affected by which risks, and match evidence based interventions

- → **Stakeholders:** city resilience team officers, public health department, initiative steering members, city expert group, technical support
- → **Outcomes:** agreed objectives or goals, steering group set up, and comprehensive stakeholder mapping; data-driven risk profile and long list of matched interventions.

Prioritise:

Screen out infeasible options, integrate equity considerations, and capture stakeholder enthusiasm; conduct rapid multicriteria analysis for prioritisation and initial economic and cost-benefit valuation of most promising interventions.

- → **Stakeholders:** city expert group, wider stakeholder panel, technical support, economic analysts, delivery partners
- → **Outcomes:** shortlist of feasible interventions aligned with stakeholder appetite; draft strategy and headline business case

Design:

Draft interventions, allocate responsibilities, establish governance, funding, and monitoring and evaluation plan; gather community input, revise and adapt the strategy accordingly, build trust and legitimacy, and identify delivery risks and mitigation actions

- → **Stakeholders:** working groups, city leadership, funding partners; community representatives, technical support
- → **Outcomes:** preliminary strategy framework and implementation blueprint; strategy refined with community feedback and risk mitigation measures.

Engage:

Increase plan detail, negotiate procurement, secure financing; validate detailed plan with community, adapt as needed, strengthen legitimacy, and confirm delivery risk mitigation.

- → **Stakeholders:** working groups, procurement, and finance teams; community representatives
- → **Outcomes:** implementation ready design and procurement packages; public endorsement, final adjustments, and confirmed risk mitigation.

Implement:

Launch and begin actively delivering interventions; ongoing monitoring of performance, adapt interventions as necessary, and report results.

- → **Stakeholders:** implementation partners, delivery team; monitoring and evaluation team, steering group
- → **Outcomes:** interventions deployed for city residents; evidence of effectiveness, lessons for scaling, and adaptive improvements.

Moving forward

1 in 4

cities' climate resilience plans consider both climate and health risks

30 -year

delay between some preventative health interventions and their impact, complicating policy appraisal

Despite strong evidence of the impact of preventative, place-based approaches, cities have identified a number of challenges in moving towards adoption. Through our work with 29 cities from around the world in our Community of Practice (CoP), we know that:

Cities lack granular data for understanding the problem – assessing and prioritising climate-health risks in urban areas requires granular data on the interaction between different climate, urban, and health factors. For example, risk from heatwaves is mediated by a range of factors that will vary across a city, such as housing quality, work occupation, and population age profile. Targeted interventions are not possible without understanding these factors at a granular level. Many cities lack this information or robust data on related mortality or health demand, making it difficult to understand the scale of the challenge, integrate data into decision-making, or monitor progress. To help fill this gap, UN Habitat has developed a Global Urban Monitoring Framework, which harmonizes existing urban indices and tools into one universal framework to help cities monitor progress towards Sustainable Development Goals, although health outcomes are not considered in a standalone domain.[93]

Cities lack tools to support effective decision-making – cities often lack the practical tools to be able to identify and appraise different climate-health interventions, which can undermine consistent and transparent decision-making. Specifically, many cities cited difficulties in quantifying the health impacts of heat, given that heat can be "invisible" in health databases. Another key challenge relates to articulating the broader case for interventions in supporting inclusive economic development, which can be particularly important to attract funding. (Box 8) outlines the importance of economic appraisal of costs of benefits of interventions in support of effective decision-making. Cities also cite the importance of being able to demonstrate impacts over short-time periods, reflecting the political reality of short election cycles.

Cities struggle to develop joined up responses, including effective partnership models with stakeholder groups – tackling climate-related health challenges required joined-up action, but coordination between city departments and with wider stakeholders remains challenging for cities. This can lead to siloed thinking and action. For example, only one-in-four cities' climate resilience plans consider both climate and health risks.[94] This lack of coherence within cities can forestall effective engagement outside, including work with community groups to understand needs and formulate responses. Lack of granular data has implications for partnerships too: cities identified that lack of data can make it difficult to define the problem, while data inconsistences between departments can make coordination more challenging.

Cities need access to new mechanisms for financing – cities can face barriers accessing finance, with many lacking fiscal independence and debt-raising capacity, leaving them dependent on central government grants. Cities can instead look to identify, secure, and coordinate funding sources from beyond their own tax base. Cities noted that data gaps make it difficult to build the investment cases needed to attract public and private sources of financing, while lack of evidence on the efficacy of different interventions can make it difficult to secure political support for funding.

Next phase

The next phase of the programme will work with cities to develop tools and resources to address these challenges. This report has articulated the general case for preventative, place-based health approaches and considered how such models could be implemented through coordinated action across the healthcare sector and the wider stakeholders, spearheaded by strategic city leadership. Working closely with the leading members of the CoP, this programme will co-create resources for cities including:

- → This report, which provides a foundation for the programme and develops the evidence base for rethinking urban health, quantifying the climate impacts on health systems and impact of interventions that reduce emissions, costs, and health inequities
- → Decision support tools for cities to understand the magnitude and drivers of current and future risks and to appraise the economic, social and health impact of solutions
- → A playbook to support cities in formulating, financing and implementing preventative strategies across a variety of institutional contexts

> **Precise, up-to-date data and technical research is essential to justify and inform actions in support of public health and mitigation of climate risks, disseminate information and inform training around prevention of accidents and illnesses caused by climate change**

Director of Metropolitan Development, Latin American City

Box 8: Cost-benefit analysis

Economic appraisal of the costs and benefits of interventions is crucial for evidence-based decision-making. Economic analysis allows consistent comparison between interventions and ensures transparency in use of public funds. Cost-effectiveness analysis (CEA) and cost-benefit analysis (CBA) are the leading approaches to economic appraisal in health. CEA is valuable as it assesses effectiveness in terms of clinical health outcomes (e.g., "cost per cardiovascular event averted"). This provides a clear point of comparison, and can be especially helpful when it is difficult or contentious to place a monetary value on health outcomes. However, CEA does not accommodate or place a monetary value on non-health benefits, which makes it less useful in deciding whether an intervention is socially worthwhile or not.

CBA supports cities in prioritising and selecting between different health interventions. It allows consistent comparison between different interventions by expressing both costs and benefits in monetary terms. Crucially, and unlike CEA, it includes non-health benefits such as economic productivity and time savings, which can help decision-makers assess whether an intervention is socially worthwhile and thus justifies public spending. CBA can distinguish between monetisable and non-monetisable benefits, which can help to identify sources of funding (Figure 12). For example, some private sector companies may wish to help fund initiatives that they know they will directly benefit from. Costs and benefits are expressed in a ratio, for example a cost-benefit ratio of 1:3 means that every £1 spent yields £3 in benefits. Costs and benefits are composed of different constituent parts:

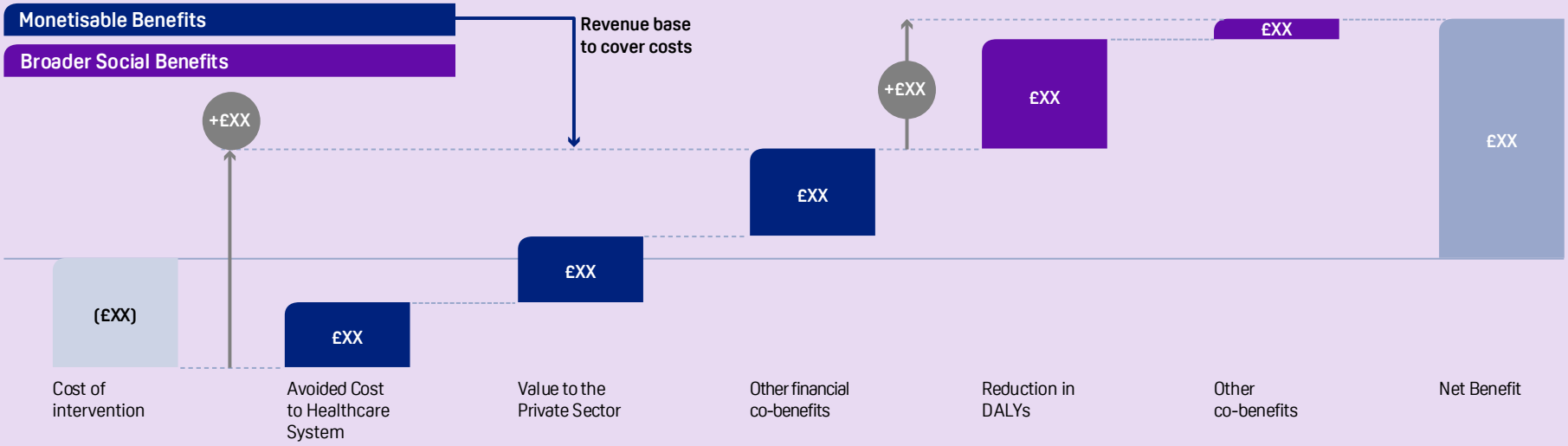
Costs – these can include capital costs such as investments in infrastructure or equipment, operating costs such as ongoing staffing costs and maintenance, and other costs such as financing costs.

Benefits – these typically accrue over a defined time period and are composed of both:

- **Health benefits** – the effect of the intervention on health outcomes (often expressed as DALYs), with a monetary value assigned to each DALY. Assigning monetary values to health outcomes can be seen to be contentious, but can be roughly approximated by assuming one DALY to be equal to average GDP per capita for that country or region. Health benefits expressed in DALYs are typically not considered monetisable.

- **Non-health benefits** – these can include avoided healthcare costs from lower demand for treatment, enhanced economic productivity from a healthier workforce, reduced greenhouse gas emissions, improved wellbeing, or reduced commuting time. Non-health benefits can be monetisable (avoided healthcare costs) or non-monetisable (reduced commuting time). Non-monetisable benefits can be more challenging to assign values for and can require an assessment of people's willingness to pay for, for example, shorter commute times.

Figure 13: Cost-benefit analysis can help to distinguish between monetisable and non-monetisable benefits for financing streams



Source: Mode Economics

While cost-benefit analysis is a well-established approach to assessing and comparing policies, cities should note that preventative interventions can present some unique methodological challenges. Health outcomes may take decades to be realised, which means some benefits may be outside of the timescales of the model. For example, improvements to cardiovascular health in 20-year-olds through active transport may take 30 years to translate into reductions in cardiovascular deaths. Health outcomes are influenced by multiple factors, which can make it difficult to isolate the impact of a single intervention. Many cities face a lack of granular urban health data, which makes it difficult account for highly localised health contexts. Climate risk is also highly place-specific, and preventative interventions tend to lack real counterfactual data (given that they prevent impacts occurring in the first place). Urban systems are dynamic and complex, so an intervention in one city may not induce the same effect in another city. These effects will also likely be non-linear – each marginal expansion of cycle lane networks may be increasingly effective up to a point and then decreasingly effective after another. Evidence of efficacy may not account for complex spatial or design considerations, such as how integrated or how well-designed a cycle network is. Cities can also face challenges in bringing diverse evidence sources together when there is limited data integration between different city departments. A full list of challenges is included in Figure 15.

Summaries for decision-makers

Fast-growing cities

These cities are characterised by relatively high burdens of communicable disease, high population growth rates, high exposure to climate risks and low levels of income per capita.

Critical challenges

- Fast-growing, young cities face high and rising disease burdens and uneven health coverage, with high urban growth rates having led to the expansion of informal housing.
  - **These cities have seen a 71% increase in disease prevalence from 1990-2021, with stubborn levels of communicable diseases and a growing NCD burden.**
- Fast-growing cities tend to be located in parts of the world that are highly exposed to climate risks – hotter, more humid, and more susceptible to extreme weather.
- These cities often lack resilient infrastructure, leaving them vulnerable to knock-on impacts from climate risks, for example water-borne disease outbreaks following flood events, impacts on food-security, or climate-driven migration.

Focal solutions

- In the short-term, city leaders can focus on low-cost measures to support communities in protecting themselves from climate-related threats to health, for example through early warning systems, emergency response planning, and improvements in hygiene practices. Case study evidence highlights significant potential short-term impacts:
  - **Early warning systems could reduce heat deaths by 13%.**
  - **Improvements in handwashing could reduce WASH deaths by 6%.**
- In the medium-term, investment in infrastructure will be needed to, aiming to promote economic growth and avoid locking in high vulnerability to climate-health risks.
  - **Upgrades to sanitation infrastructure could reduce WASH deaths by 11%.**

Next steps

- Understand the main climate and health challenges in your city, and where vulnerable groups are located through improved collection and use of spatial data.
- Assess how climate and health challenges will evolve over time within your city, and integrate these insights into urban planning decision-making.
- Work with international funders to develop efficient, scalable, and flexible financing models that support locally-led solutions.

Transitioning cities

These cities are usually in middle-income per capita settings and fall in the middle both with both climate risk exposure as well as population growth, albeit with great variation.

Critical challenges

- Transitioning cities face challenges common to both other archetypes – a dual burden of high but stable communicable, maternal, neonatal, and nutritional disease, combined with rising levels of NCDs.
  - **The total disease burden has risen by 40% from 1990-2021; these cities have on average over 7 times the WHO safety limit for air pollution.**
- Rapid rural-urban migration can lead to an expansion of informal settlements and employment – this makes cities more vulnerable to direct climate-health risks and knock-on impacts.

Focal solutions

- In the short-term, city leaders can focus on improving the emergency response across healthcare and other sectors to ensure a coordinated response during acute events such as heatwaves.
- Implementing targeted urban greening can moderate expected rises in air quality- and heat-related deaths in the short-term, representing a low-cost option with multiple co-benefits.
- In the medium-term, increasing the resilience of the healthcare system, e.g., through installing electricity generators or emergency water supply, can support the wider community in the event of an extreme event.

Next steps

- Improve data availability and access on climate and health risks across departments and integrate the insights into emergency response and broader public health and urban planning.
- Develop an evidence-based pipeline of projects responding to climate-health risks in your communities, based on transparent economic appraisal of costs and benefits.
- Develop more flexible financing models that suit the project types and timelines in your city, including locally-led approaches.

Established, ageing cities

These cities tend to have high-income per capita, but a slow or stagnant population growth, and lower than average exposure to climate risks.

Critical challenges

- Established cities face high and growing NCD burdens and associated funding challenges as populations age.
  - **For example, in many European countries the old-age population already exceeds 30% of the working age population, with this number exceeding 50% in Japan.**
- Health inequalities, especially those related to income, remain stark despite near-universal health coverage.
  - **For example, chronic disease deaths in Australia are 2-3 times higher in the poorest neighbourhoods than in the richer ones.**

Focal solutions

- Several low-cost options can mitigate climate-health risks in the short term while promoting wider wellbeing and economic growth – examples include active transport and urban greening
- Social support mechanisms, rooted in community groups and linked to early-warning systems, can be targeted more effectively to ensure the most vulnerable communities are protected from the impacts of extreme climate-health events.
- In the medium-term, cities can develop programmes to encourage public health with new technologies that can help citizens manage their own risks, for example through personal wearable devices and genomic sequencing for health monitoring.

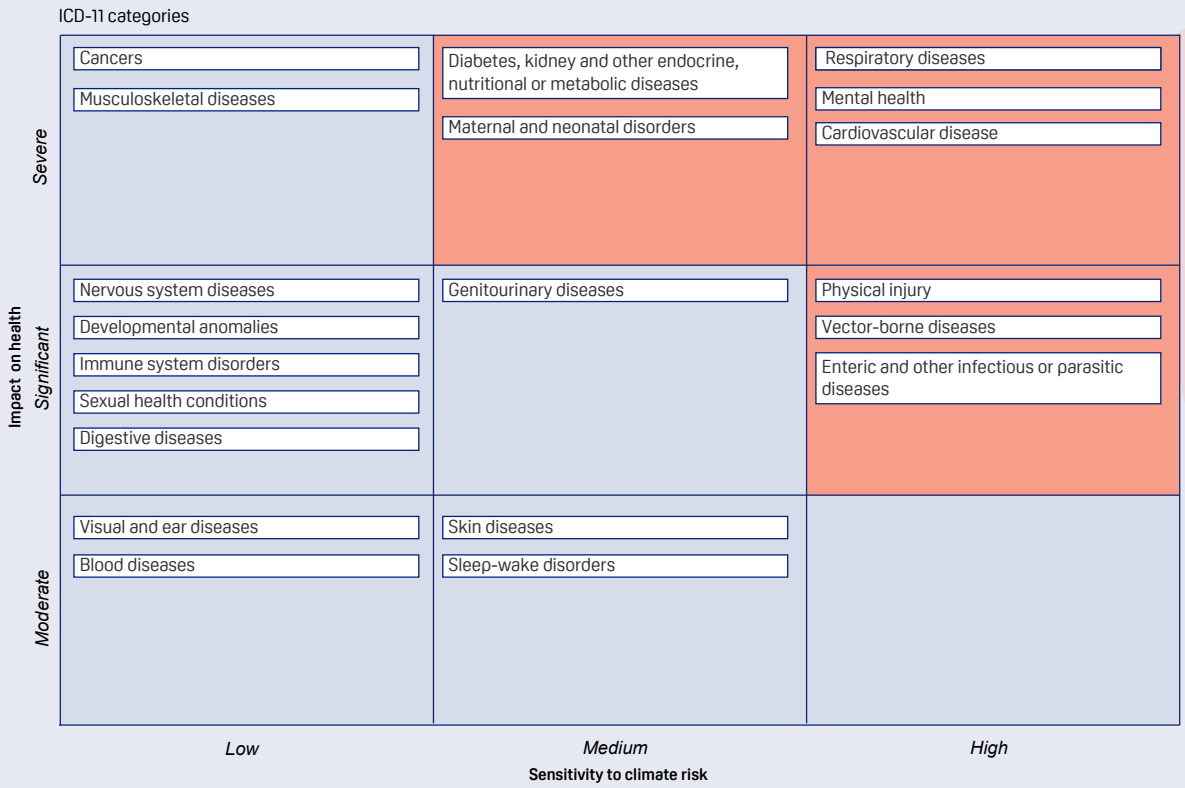
Next steps

- Invest in systems to understand how climate risks shape health and economic conditions, with a focus on vulnerable groups.
- Develop novel and sustainable funding models that channel healthcare savings from implemented initiatives towards further city-led prevention.
- Monitor and evaluate the impact of climate-health interventions, and share your findings to inform other cities' activities.


Appendix

Additional Figures

Figure 14: Matrix of IHME disease categories by impact on health and sensitivity to climate change



Key climate drivers per condition

Respiratory diseases	Air quality Heatwaves Wildfires
Vector-borne diseases	Heatwaves Flooding, water quality
Mental, behavioural or neurodevelopmental disorders	Heatwaves Flooding Air quality
Circulatory diseases	Air quality Heatwaves
Pregnancy, childbirth	Air quality Heatwaves
Food and water borne diseases	Flooding, water quality
Injury or other external causes	Flooding Storms, landslides

Based on expert analysis – Impact on health based on composite analysis of disease incidence and severity, climate sensitivity based on magnitude, frequency, exposure and vulnerability for relevant risks

Source: Mode Economics

Figure 15: Long-listed preventative health interventions for cities; impact approximates for efficacy in addressing health risks

NON_EXHAUSTIVE Deep-dives in report

	Example preventative solutions available to cities	Hazard addressed	Health condition addressed	Co-benefit	High → Low: Impact, Evidence Maturity, Affordability
Risk reduction: Public health	**Microfinance for WASH** catalyses implementation of WASH services and infrastructure	Water quality	Water-borne, infectious	**Equity:** reach people in informal WASH systems	
	Reactive mass vaccinations reduce susceptibility to disease in target populations and reduces spread	Water quality, migration, vector	Water quality, migration, vector	**Equity:** target most vulnerable groups	
	Climate health training for clinical staff to provide education to patients about preventative measures	Heat, flooding, air quality, vector	Injury, respiratory, cardiovascular	**Equity:** can reach groups with low trust	
Risk reduction: Healthcare systems	**Early treatment and drug delivery** for patients whose care is at risk of being disrupted by natural disasters	All acute events	All chronic conditions	**Equity:** reduce long trips to seek care	
	Pre-planned appointment changes for chronic care patients at risk of disruption from natural disasters	All acute events	All chronic conditions	**Equity:** reduce long trips to seek care	
	Genomics-enabled screening can improve efficacy of care through early diagnosis and personalisation	Heat, air pollution	All chronic conditions	**Equity:** can help cater care to at-risk people	
	Personal wearable devices can help identify symptoms, monitor health, and encourage behaviours	Heat, air pollution	All chronic conditions	**Equity:** can help identify at-risk groups	
	At-home testing including blood and other tests that can be perform at home instead of in health facilities	All acute events	All chronic conditions	**Equity:** can improve access to earlier testing	

Note: (1) Impact approximates for efficacy in addressing health risks; healthcare systems and tertiary public health are out of city scope but can be enhanced by other measures when deployed synergistically, e.g., with early warning systems. (2) Deep dives selected based on a) impact, b) available evidence, c) variations in maturity to include innovative solutions

Source: Mode Economics

NON_EXHAUSTIVE Deep-dives in report

	Example preventative solutions available to cities	Hazard addressed	Health condition addressed	Co-benefit	High → Low: Impact, Evidence, Affordability, Maturity
Enablers	**Urban planning** can prevent development in hazard-prone areas and ensure ample green space	Flooding, heat, air quality	Injury, water-borne, respiratory	**Equity:** from rules on access to green space	
Enablers	**Anticipatory financing mechanisms** to release funds at short notice in response to early warning	All acute events	Injury	**Economic growth:** from reduced volatility	
Enablers	**Fiscal autonomy** for city authorities, such as ability to raise debt, can enable necessary interventions	All acute events	All conditions	**Economic growth:** from decentralisation*	
Risk information	Heat action plans outline preparation and response to extreme heat events, supported by early warning	Heat	Injury, cardiovascular	**Equity:** identification of vulnerable people	
Risk information	**Early Warning Systems** for range of hazards can enable preventative actions or temporary migration	Flooding, heat, vector	Injury, vector, cardiovascular	**Equity:** reach people with limited comms	
Risk information	**Digital network monitoring** can identify leaks in water infrastructure to reduce water loss	Water scarcity, water quality	Injury, water-borne	**Equity:** fewer leaks protects water prices	
Risk transfer	**Index-based / parametric insurance** provides funds to those likely to be affected by extreme events	Flooding, heat	Injury, cardiovascular	**Equity:** sponsorship can increase coverage	

*Provided sufficient capacity for informed and effective local decision-making

Note: Deep dives selected based on a) impact, b) available evidence, c) variations in maturity to include innovative solutions

Source: Mode Economics

NON_EXHAUSTIVE Deep-dives in report

	Example preventative solutions available to cities	Hazard addressed	Health condition addressed	Co-benefit	Evidence Impact (High → Low)	Maturity Affordability (High → Low)
Risk reduction: Built environment	**On-site health infrastructure** such as energy and water supply and treatment in major health facilities	Flooding, water quality, heat	All treated diseases	**Equity:** health facilities can distribute water		
	Building design measures can promote practices that reduce ambient and indoor air temperatures	Heat, vector	Cardiovascular, vector	**Climate:** less need for energy-intensive tools		
	Public and active transport reduce air pollution (car use) and improves personal health (physical activity)	Air quality	Cardiovascular, respiratory	**Climate:** reduced transport emissions		
	Car and bus fleet electrification reduces air pollution and can reduce urban heat islands	Air quality, heat	Injury, respiratory, cardiovascular	**Climate:** lower transport emissions		
	Green and blue space including permeable surfaces reduce flooding and heat, and improve air quality	Flooding, heat, air quality	Injury, water-borne, chronic	**Nature:** from connected green and blue habitat		
	Traditional burning replacement reduces ambient air pollution and exposure to indoor air pollution	Air quality	Cardiovascular, respiratory	**Equity:** lower running costs from efficiency		
Risk reduction: Community	**Community health literacy** can increase awareness of symptoms and behaviour adaptations	Flood, heat, air & water quality	Injury, mental	**Equity:** knowledge held in community		
	Community vector training can reduce the spread of disease vectors through household practices	Vector	Vector	**Equity:** knowledge held in community		
	Rainwater harvesting in residential properties can reduce water scarcity and flood risk	Water scarcity, flooding	Injury	**Equity:** lower water use protects water prices		

Deep-dive to follow in report

Note: Deep dives selected based on a) impact, b) available evidence, c) variations in maturity to include innovative solutions

Source: Mode Economics

Figure 16: Common challenges in cost-benefit analysis approaches to appraising preventative health interventions

	Challenge	Example	Response options
Health	**Health outcomes may take decades to be realised,** which means some benefits may be outside the timescales of the model	Active travel may take years to reduce cardiac deaths	Time horizon includes impacts, use social discount rate
	Interventions can have direct and indirect health benefits, which can make it difficult to make a holistic outcome assessment	Green space effect on inclusion, knock-on impacts	Include co-benefits and non-health benefits in CBA
	Health outcomes are influenced by many factors, which makes it difficult to isolate the impact of a single intervention in studies	Reducing heat deaths requires many interventions	Perform a sensitivity analysis using a range of impact sizes
	Lack of granular urban health data can make it harder to account for and target the most vulnerable communities	Water-borne disease can be geographically concentrated	Use risk assessment tools (see next slide)
Climate	**Climate risk is highly place-specific,** which can make it difficult to calculate the benefits of reducing risks in specific cities or districts	Green cover or urban density can vary significantly	Use evidence from cities with similar climate or urban contexts
	Preventative measures lack real counterfactuals in studies, as it is difficult to quantify the impacts of something that didn't happen	It can be difficult to value the costs of a flood prevented	Use scenario-based and probabilistic modelling
Urban	**Urban systems are dynamic and complex,** which means an intervention in one city may not induce the same effect in another	Transport habits may be harder to change in some cities	Use range of evidence sources for basis of CBA
	Impacts of interventions may be non-linear, as the efficacy of an intervention may change as its uptake increases	Each additional km of cycle lane may be less effective	Use a range of evidence and sensitivities in model
	Limited data integration between departments can make it difficult to bring together evidence in one comprehensive analysis	Health and urban data may be held by different bodies	Early stakeholder consultation prior to risk assessment

Source: Mode Economics

Technical Methods: Data, Assumptions, and Computation

This appendix explains the methods used to estimate how urban interventions could reduce deaths, Disability-Adjusted Life Years (DALYs), healthcare costs, and emissions across approximately 11,000 cities worldwide. The analysis focuses on four key health risk factors: heat exposure, air quality, water, sanitation and hygiene (WASH), and lifestyle factors.

Overview of Approach

Our analysis follows four main steps, each discussed in turn below:

1. **Establishing Baseline and Projected Deaths and DALYs:** We determine current deaths and DALYs in cities worldwide for each risk factor and project how these will change by 2030, 2040, and 2050
2. **Defining Intervention Packages and Health Impacts:** We identify evidence-based urban interventions for each risk factor and specify the magnitude of risk reduction they can achieve
3. **Calculating Health Outcomes with Adaptation:** We apply epidemiological relative risk curves to quantify how risk reductions translate into prevented deaths and DALYs
4. **Estimating Broader Impacts:** We calculate healthcare cost savings, emission reductions, and benefits for vulnerable groups.

Establishing Baseline and Projected Deaths and DALYs

Quantifying Current Urban Health Burdens

The analysis uses country-level health data from the Institute for Health Metrics and Evaluation's (IHME) Global Burden of Disease (GBD) study 2021. This provides total deaths and DALYs for each country, broken down by cause (e.g. Ischemic Heart Disease, Lower Respiratory Infections, etc.) and specific risk factors. For risk factors, the analysis focuses on:

- → "High Temperature" to evaluate the health impacts of heat,
- → "Ambient Particulate Matter Pollution" for air quality,
- → "Unsafe Water Source", "Unsafe Sanitation", and "No Access to Handwashing Facilities" for WASH-related conditions, and
- → "Low Physical Activity" and "High Body-Mass Index" for lifestyle factors.

National totals are then downscaled to urban areas of individual cities. The underlying city data are from the Global Human Settlement Layer (GHSL) "Stats in the City" database (2023 release), which includes more than 11,422 cities with over 50,000 inhabitants and represents a total of 3.68 billion people (45% of the world's population).

Deaths and DALYs were allocated to cities based on their share of the national population, assuming the same disease prevalence in urban and rural areas. This assumption was made due to data limitations on relative urban-rural disease prevalence and makes the estimates conservative, as climate-related health impacts tend to be more prevalent in urban than rural areas (e.g. due to urban heat island effects or accumulation of air pollution in cities).

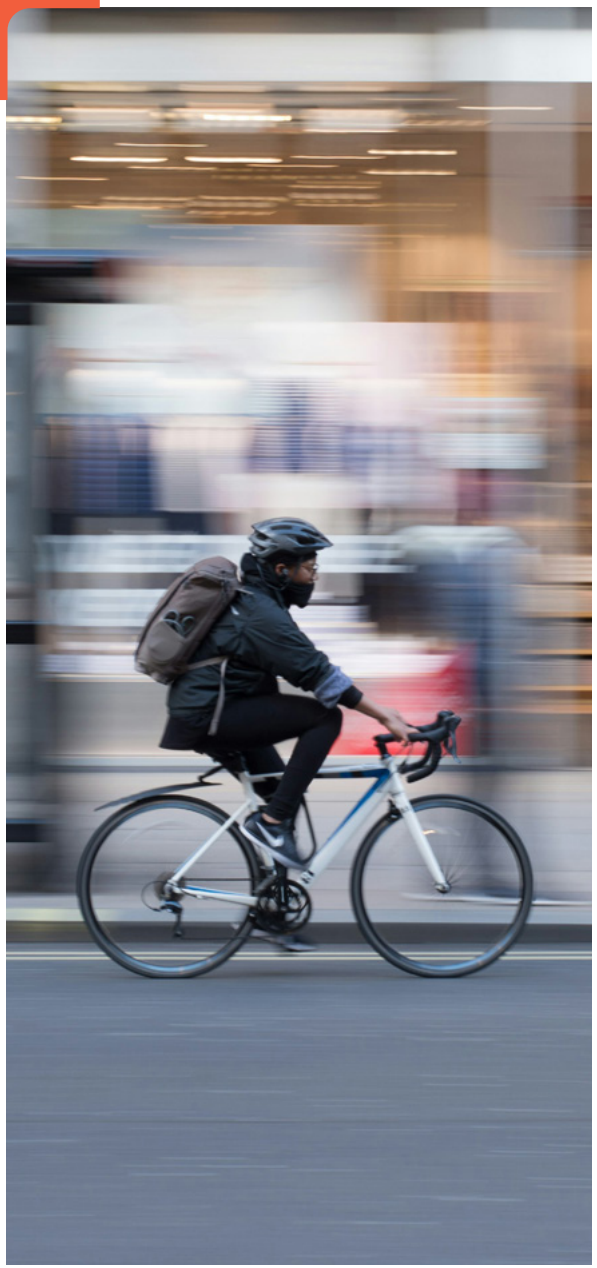
Projecting Future Health Impacts

For projecting city populations to 2030, 2040 and 2050, each country's urban population growth rate from the UN World Urbanisation Prospects was applied to current city populations from GHSL. Death and DALYs are assumed to grow proportionally with population for air quality, WASH and lifestyle factors.

Heat-related health impacts were further adjusted based on temperature projections. Each city's temperature distribution was modelled using its mean and standard deviation from GHSL, assuming a normal distribution truncated at ±4 standard deviations to exclude extreme outliers. This distribution captures the full range of temperatures a city experiences throughout the year. These temperature distributions are then projected forward under two climate scenarios: RCP4.5 (moderate emissions) and RCP8.5 (high emissions). City-level temperature statistics for 2030 come from the GHSL database. For 2040 and 2050, the temperature increases from CMIP6 global climate projections are applied to the 2030 values. While mean temperatures increase over time according to climate projections, standard deviations are held constant at 2030 levels. Temperature-mortality relationships (detailed in the next section) are then applied to estimate additional deaths from warming.

Defining Intervention Packages and Health Impacts

For each risk factor, a realistic bundle of urban interventions is modelled based on successful real-world examples. Rather than prescribing specific measures, the analysis simulates the overall health improvement that cities could achieve if they reduced risk factors by a magnitude specified in the bundle. The analysis is not intended to prescribe specific packages of interventions for cities: different combinations of interventions will be appropriate for different cities depending on their context, environmental exposure, existing infrastructure, and demographics. Instead, the analysis quantifies realistic magnitudes of risk reduction that can be achieved, based on evidence from some specific interventions.



Key Drivers and Interventions

HEAT

Driver: Ambient urban temperatures affecting heat-related mortality

Intervention: The cooling effect of increasing tree cover by 5 percentage points of the city area and adding cool roofs to 5% of the roofed surface.

Temperature reductions vary by climate zone and existing green cover. The analysis uses cooling coefficients from Zhao et al. (2023), who modelled temperature cooling effects (TCE) for 806 cities worldwide at different levels of urban greening, expressed as percentages of city area. For each of the 11,000+ cities, TCE values are assigned from the geographically closest city in Zhao et al., assuming similar tree species and climate conditions.

To calculate city-specific cooling effects, each city's existing urban green cover is determined using global 100m land cover share maps from Copernicus Global Land Service (2020). This baseline is crucial because the cooling impact of additional greening depends on current green cover levels. Each city's temperature distribution is then analysed to identify the number of days above various temperature thresholds, as cooling effectiveness varies with ambient temperature conditions. Finally, the 5 percentage point increase in urban green cover is applied to these city-specific conditions to determine the temperature reduction.

AIR QUALITY

Driver: Annual average PM2.5 concentration (population-weighted)

Intervention: An 18.25% reduction in PM2.5 levels is modelled. This is a conservative estimate of observed impacts from comprehensive traffic management measures, such as London's congestion charge combined with ultra-low emission zones, which was found to reduce PM2.5 levels by 31% in outer London (Greater London Authority, 2025).

WASH

Driver: Population lacking access to safe water, sanitation, and handwashing facilities

Intervention: Improvements in WASH access are modelled through two complementary pathways. The community intervention upgrades up to 10% of the population from unimproved to improved sanitation services, or the entire unimproved population if less than 10% currently lack improved access. The infrastructure intervention upgrades up to 10% of the population from improved to piped drinking water services, or all those with improved services if less than 10% of the population. Data on current access levels comes from the WHO/UNICEF Joint Monitoring Programme.

LIFESTYLE

Driver: Average body mass index (BMI) and average minutes of physical activity

Intervention: Improvements are consistent with successful behaviour change programmes reported in medical literature. These include personalized prevention programmes that combine dietary counselling, exercise promotion, and health monitoring. Evidence on the impact of personalised nutrition guidance on a healthy eating index are taken from Celis-Morales et al. 2016, and the subsequent impact of the index on BMI is taken from Tsuzaki et al. 2024. Evidence for the impact of personalised physical activity plans are taken from Keller-Varady et al., 2023, which suggests that moderate-to-vigorous physical activity levels can be increased by 108.5 mins per week.

Calculating Health Outcomes with Adaptation

Changes in risk factors are translated to health impacts using relative risk (RR) curves from epidemiological research.

→ **Heat:** Temperature-mortality relationships are used from Burkart et al. (2021), who provide relative risk (RR) curves that vary by climate zone to reflect local physiological responses and humidity effects. Using these curves, heat-related mortality can be calculated through several steps.

Appropriate RR curves are selected for each city based on its climate zone. Minimum mortality temperature (MMT) are then identified – this is the temperature with the lowest relative risk on the curve. For all temperatures above this MMT, the number of days above the MMT are counted and grouped into incremental 0.5°C categories. A weighted average risk score is then calculated across all these temperature categories, giving an overall heat risk for the city.

This calculation is performed for three scenarios: baseline conditions, future conditions without intervention, and future conditions with intervention. By comparing the relative risk between these scenarios, the proportional change in heat-related mortality is determined. Specifically, the analysis calculates the ratio of future risk (with intervention) to baseline risk, and the ratio of future risk (without intervention) to baseline risk. These ratios indicate how much heat-related deaths will increase or decrease. These proportional changes are applied to the baseline mortality and DALY estimates to project future health impacts.

→ **Air Quality:** Relative risk (RR) curves for PM2.5 are taken from GBD 2021, which show how overall mortality risk changes at different PM2.5 concentration levels.

Each city's current position on the RR curve are established using baseline PM2.5 concentrations provided in the GHSL database. The 18.25% reduction in PM2.5 is then applied to determine the new concentration level and find the corresponding risk level on the RR curve. The difference between these two points gives the change in relative risk, which is then applied to baseline mortality and DALY counts to calculate health benefits from adaptation.

→ **WASH:** Relative risk values for unsafe water, sanitation, and hygiene are taken from GBD 2021, which shows how mortality risk changes across different WASH access categories. To determine baseline shares of people with different levels of access to water, sanitation and handwashing facilities, data is taken from the WHO/UNICEF Joint Monitoring Programme. National-level urban estimates are used where available, otherwise national-level total estimates combining urban and rural populations.

As described in the intervention section above, population-weighted average risk is calculated before and after upgrading up to 10% of the population to better service levels through both community and infrastructure interventions. The change in average risk determines the reduction in WASH-related deaths and DALYs.

→ **Lifestyle:** Relative risk curves are used again but for high BMI and low physical activity (measured in average minutes exercised weekly) from GBD 2021. To determine baseline conditions, different approaches are used for each risk factor.

For BMI, national-level data is taken from the NCD Risk Factor Collaboration and applied to each city to determine the current prevalence of people with BMI greater than 25.

For physical activity, usable baseline data was not found to be available. Current activity levels are derived using a reverse calculation from observed mortality. GHM's relative risk curve for physical activity, where the asymptote represents the minimum risk (equivalent to zero deaths from physical inactivity) are used for this. Each city's current position on the curve is determined by identifying the point where the relative risk is proportionally higher than the asymptote, with the proportion determined by the share of low physical activity deaths out of total deaths from related conditions at the city level.

The change in relative risk is applied from increased exercise minutes and decreased BMI to the baseline deaths and DALYs to calculate health benefits.

Estimating Broader Impacts

Healthcare Costs

Healthcare savings are estimated using a top-down approach. First, country-level health expenditure per DALY is estimated by dividing total health spending (WHO data on health expenditure as percentage of GDP, multiplied by World Bank GDP figures) by total DALYs from IHME. DALYs prevented through interventions are multiplied by this cost-per-DALY ratio.

This approach assumes that DALYs from all health conditions have the same healthcare costs associated with them. This is a limiting assumption which is made in the absence of both condition-specific cost data and the share of fixed and variable costs associated with care.

Healthcare Emissions

Healthcare systems generate substantial carbon emissions through energy use, supply chains, and waste. Emission reductions are derived from preventing disease, using data on healthcare sector emissions for OECD countries (Braithwaite et al., 2025). For countries without OECD data, the average of available OECD countries is used. An emissions-per-DALY intensity is used and multiplied by DALYs prevented.

Note: This is a conservative estimate because it only captures emission reductions from preventing disease (reduced hospital visits, medications, etc.), not from the intervention itself such as reduced transport emissions from air quality interventions, or carbon sequestration from increased urban tree cover.

Impacts on Vulnerable Groups

Different populations face varying health risks. Using IHME data on age- and sex-specific mortality rates, "equity multipliers" are calculated, i.e. the ratio of a group's mortality rate to the general population rate. Three vulnerable groups are considered:

- → Children under 5 years
- → Adults 65 years and older
- → Women (all ages)

In addition to this, economically disadvantaged groups were considered. Assuming those with the worst access across the different WASH categories considered are within the bottom income quintile, the RR for this group is compared with the average population to generate a similar "equity multiplier".

These multipliers indicate which groups bear disproportionate health burdens and would benefit most from interventions.

Quality Assurance

Several validation steps were performed as part of the quality assurance process:

- → Verified all cities have valid baseline data
- → Confirmed city populations sum to national urban totals
- → Applied conservative rules for missing data (using lower-bound estimates)
- → Cross-checked intervention effects against published studies.

Limitations

Several important limitations shape the interpretation of the results:

- → **Representative interventions:** Illustrative intervention packages are modelled based on well-evidenced measures. Cities could achieve similar health gains through different combinations of interventions.
- → **Aggregated risk functions:** Risk relationships are sourced from large, multi-study analyses. Local conditions may create variations not captured in global averages.
- → **Data constraints:** The analysis inherits any limitations in the underlying IHME, WHO, and UN datasets.
- → **Cost and emission estimates:** These provide order-of-magnitude estimates based on national averages. Detailed local assessments would be needed for budget planning or carbon accounting.
- → **Conservative estimates:** The focus is on well-established interventions with strong evidence bases. Emerging innovations or combined intervention effects could yield greater benefits.

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