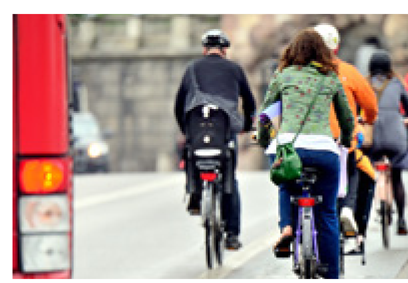
International Transport Forum | CPB Corporate Partnership Board

Health Impacts of Low-carbon Transport in Cities

Evidence for Better Policies



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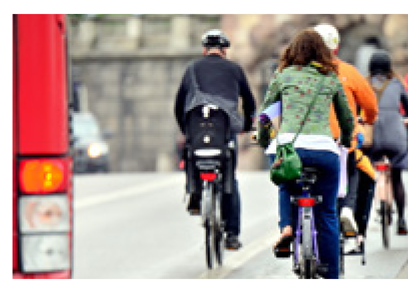

Corporate Partnership Board Report

The International Transport Forum

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Key messages

Low-carbon mobility is healthy and cost-effective

Transitioning to low-carbon transport reduces greenhouse gas emissions and also significantly improves public health, for example, by encouraging active mobility and lowering air pollution levels. These improvements contribute to decreased health-care expenditures, with the potential to balance investment costs in the long run.

Urgent need for integrated, cross-sectoral policies

Health and transport sectors need more integrated strategies to support healthier, low-carbon urban mobility solutions. Coordinated actions can achieve better health outcomes while meeting climate targets.

Equity and inclusion cannot be an afterthought for healthy mobility planning

Vulnerable groups, including women, older adults, and low-income households often experience higher exposure to urban health risks and barriers to mobility. Addressing these disparities is critical to creating healthy, inclusive, liveable, low-carbon cities.

Main findings

Transport activity is a leading source of air pollution in most urban environments, contributing significantly to poor health outcomes such as respiratory diseases and premature deaths. Fine particulate matter (PM2.5) and nitrogen dioxide (NO_2) from vehicles are primary pollutants exacerbating chronic health conditions, especially in densely populated urban areas. The most vulnerable, including children, the elderly, and low-income communities, are often disproportionately impacted. Transport and health cross-sectoral modelling underscores the severe health risks associated with current urban transport systems and highlights the potential for more holistic policy evaluation that includes both emissions and health outcomes. This integrated approach reveals that ambitious transport policies could significantly enhance public health by reducing pollutant emissions and promoting active mobility, thereby addressing both climate targets and health goals simultaneously.

The current reliance on motorised transport based on internal combustion engine technologies continues to generate soaring greenhouse gas emissions, undermining efforts to combat climate change. In parallel, transport-related health costs are rising, with increasing evidence linking traffic emissions to long-term health issues like asthma, heart disease, dementia and stroke. Urban mobility systems dominated by private vehicles also lead to sedentary lifestyles, contributing to the rise of non-communicable diseases such as diabetes, chronic kidney disease and chronic obstructive pulmonary disease. However, the High Ambition scenario defined in this study, envisions a future where proactive policies are implemented to significantly decarbonise the transport sector, producing significant health benefits. An estimated 13 trillion life years are saved between 2022 and 2050, and 21.5 trillion Disability-Adjusted Life Years (DALYs) saved, for OECD countries, the People's Republic of China, India and major countries in Latin American and the Caribbeans. Putting this into perspective, 13 trillion life years saved is equivalent to creating 130 billion centenarians over this period, approximately 4.5 billion centenarians per year. This figure is roughly equivalent to the combined populations (relevant to 2024) of China, India, the European Union, and the

United States living to 100 years old annually. The 21.5 trillion DALYs saved represents not only an increase in lifespan but also significant improvements in quality of life, reducing the years people would otherwise live with chronic diseases or disabilities.

These analogies highlight the profound human impact of ambitious low-carbon transport policies. A key insight is that the High Ambition scenario not only generates significant health benefits but also leads to substantial cost savings, with the potential to balance investments required for sustainable transport infrastructure in the long run. The projected savings in public health spending are estimated at approximately USD 875 billion annually, with the largest reductions seen in regions experiencing the most pronounced health improvements. These savings amount to between 0.1% and 2.0% of health-care expenditure under the Current Ambition scenario. In addition to the direct health cost savings, the High Ambition scenario delivers productivity gains equivalent to 860 000 Full-Time Equivalent (FTE) years, valued at almost USD 22 billion annually, comparable to the economic burden of air pollution-related premature deaths in New Delhi. The combined savings in health care and the increased workforce capacity demonstrate that investments in low-carbon mobility measures can be economically self-sustaining and may free budget for other public actions, disproving concerns about the high costs of sustainable transport transitions.

The findings also indicate significant regional disparities in health outcomes, driven by differences in urban density, economic development, and the pace of technological adoption. High-income regions are expected to see the greatest improvements in air quality and health due to strong vehicle electrification efforts. While electrification offers substantial benefits in reducing tailpipe emissions, it is important to note that it does not address non-exhaust emissions from braking and tyres, which are already significant and may even increase with heavier electric vehicles. Considering these factors could moderate some of the health benefits suggested by the modelling exercise.

Conversely, lower-income regions may struggle with persistent high pollutant levels due to the slower uptake of cleaner technologies and continued reliance on older, more polluting vehicles. However, this challenge also indicates a substantial opportunity to address inequitable health issues: low-and middle-income countries (LMICs) bear a disproportionate burden of noncommunicable diseases (NCDs), which are exacerbated by air pollution and inadequate mobility systems. These disparities underline the need for region-specific strategies and the importance of equity in urban transport planning for addressing context-specific challenges.

Finally, the study highlights the importance of promoting active mobility as a key component of healthier urban transport systems. While the High Ambition scenario shows an overall increase in active mobility, especially cycling, it also reveals that the benefits of active transport can vary significantly depending on local policies and infrastructure. For example, in China, urban densification and a focus on public transport have reduced walking by decreasing average trip distances and providing alternatives to trips previously made only with active modes. This suggests that while active mobility is crucial for improving public health, its promotion must be carefully tailored to the specific urban context to maximise benefits.

Top recommendations

Integrate health outcomes into urban policy planning to create healthier and sustainable cities

Policymakers must prioritise health as a key objective in urban transport policies. By evaluating the health impacts of all infrastructure projects, policymakers can address pressing public health issues such as air pollution, physical inactivity, chronic diseases, and road safety. Health Impact Assessments (HIA) should be conducted to understand the long-term effects of transportation systems on health and well-being. Health metrics must be integrated into planning and decision-making processes, using health outcomes as a benchmark for project success. This will help prevent diseases, reduce healthcare costs, and improve quality of life for urban populations.

Invest in active and public transport infrastructure to reduce emissions and improve health

Governments should significantly invest in safe, comfortable and accessible infrastructure for walking, cycling, and other forms of active transport, while also improving and expanding public transport services. This includes the expansion of protected bike lanes, well-maintained pedestrian pathways, designated car-free zones, and enhanced public transport networks in urban areas. Reliable, frequent, and affordable public transport is essential to complement active transport modes and reduce dependency on private vehicles. By creating safe and convenient alternatives to car use, cities can promote physical activity, reduce greenhouse gas emissions, improve air quality, and make streets safer for all users. Ensuring connectivity between public transport networks and active mobility routes further enhances the effectiveness of this approach. Investment in both active and public transport infrastructure should be paired with public campaigns to promote their use, fostering a shift away from car dependency.

Strengthen cross-sector collaboration for healthier cities

Collaboration between health, environment, urban planning, and transport sectors is crucial to creating healthier cities. Policymakers should establish cross-sectoral governance structures, such as the role of Healthy City Managers, to bridge sectoral knowledge gaps and encourage the integration of health into sustainable urban mobility plans and their equivalent. These actions would ensure that public health considerations are integrated into urban planning and transportation decisions. Regular cross-sectoral communication will improve the implementation of transport policies that support physical activity, reduce air pollution, and foster mental well-being. Involving research institutions and academia in these collaborations can provide evidence-based insights, ensuring that policy decisions are well-informed.

Adopt equitable urban planning approaches for more inclusive urban policy

Equity must be a cornerstone of urban planning, including urban transport planning. It is critical to ensure that all citizens, especially women and vulnerable groups such as low-income communities, persons with disabilities, and children, benefit from air quality improvements and measures that improve health outcomes. Citizen participation in urban planning should be inclusive and representative, considering the needs of all socio-economic groups. This can be achieved by creating platforms for diverse voices to be heard and by proactively engaging underrepresented groups and communities in consultations. Equitable urban planning will help address social inequalities while improving access to healthy environments for all.

Build capacity in public authorities for evidence-based decision-making

Cities can better plan for future growth, manage public health challenges, and create sustainable, livable environments for residents by embedding data-driven approaches into urban policy frameworks. It is critical to focus on building the capacity of public authorities to use evidence-based models for decision-making. This includes training and collaboration with research institutions and academia to better understand and use transport, health, and environmental models. These models can quantify the economic, social, and environmental impacts of urban policies, helping policymakers to make informed decisions. Effective use of these tools can also aid in monitoring the success of implemented policies over time.

Interconnectedness of transport, climate, and health

Cities are complex systems of built-infrastructure, human interactions and economic activities. At the start of the 20th century, only about 10% of the world's population lived in urban areas (Westenhöfer et al., 2023). By 2021, this percentage had increased to 56% and is predicted to reach 68% by 2050 (UN Habitat, 2022), with nearly 90% of this growth occurring in Asia and Africa (Cheshmehzangi and Butters, 2022; UN Habitat, 2022). This rapid growth in urban population and the interconnectedness of transport, climate and health makes achieving low-carbon transport goals a complex task. Vehicle-focused policies alone may inadvertently worsen health outcomes unless complemented by measures to address non-exhaust emissions and promote sustainable urban mobility systems.

Over the past two decades, research has increasingly highlighted the diverse health impacts of transport policy decisions, reinforcing environmental arguments, clarifying the costs and benefits, and emphasising health equity issues (Dora and Racioppi, 2003). Given the complex intersection of transport and health within urban planning, the challenges are multi-dimensional, interconnected and interdependent (Glazener et al., 2021). Therefore, it is fundamental to develop a holistic and systemic approach to gain a more accurate understanding of the situation and to better comprehend the diversity of solutions and potential impacts, in turn enabling informed policy decisions and appropriate allocation of investments.

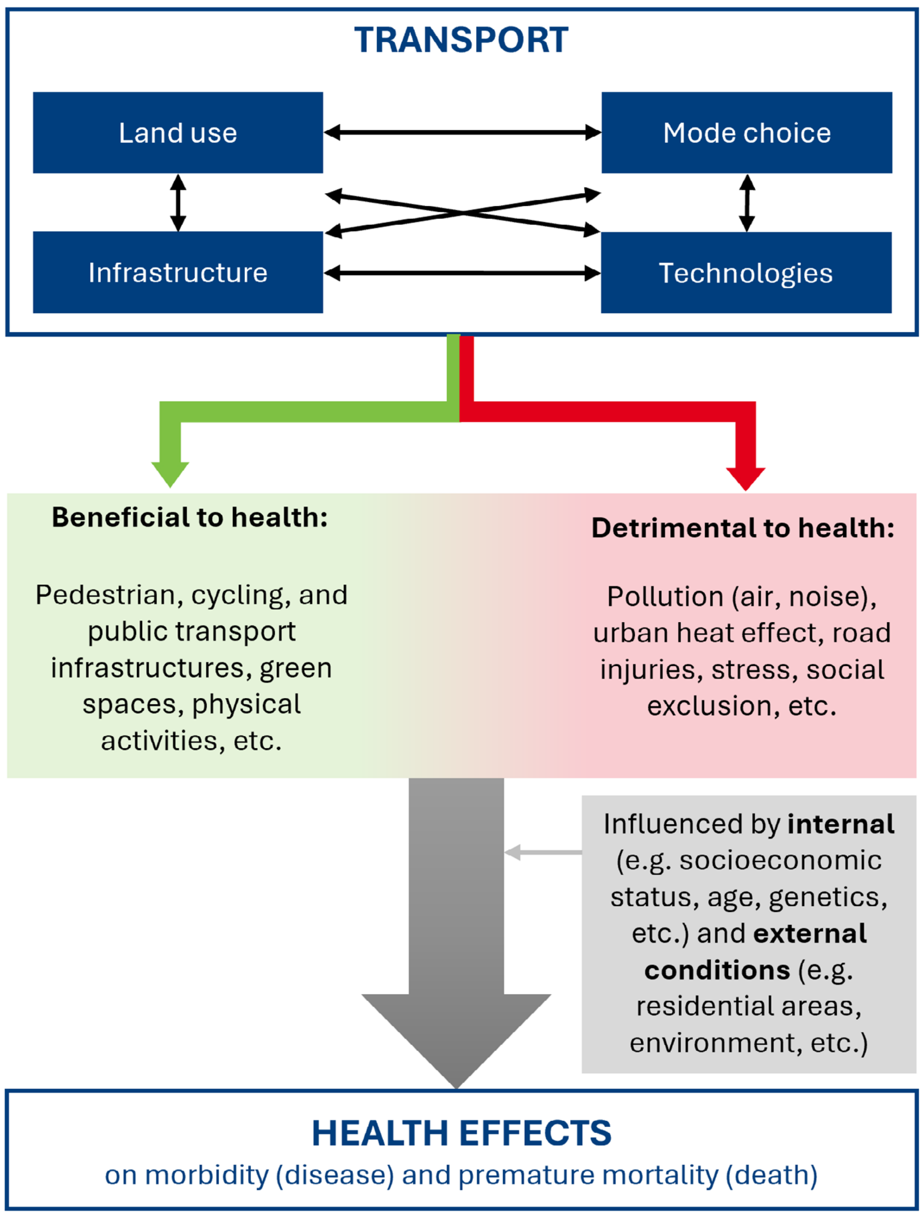
Transport is a major contributor to greenhouse gas emissions and significantly impacts public health, especially in cities (Khreis, May and Nieuwenhuijsen, 2017). In 2019, nearly the entire global population resided in areas failing to meet the World Health Organization (WHO) air quality guidelines. Outdoor air pollution, primarily from transport and other sectors, was responsible for an estimated 4.2 million premature deaths worldwide in the same year, posing significant challenges, especially in urban environments (WHO, 2022). At the same time, transport plays a central role in enabling full participation in society and ensuring access to labour, social activities, leisure opportunities, health care, and other essential services (ITF, 2023b).

Rising travel demand and inadequate public transport systems that fail to keep pace with urban expansion are likely to contribute to higher emissions from vehicles, particularly in regions where low-quality fuels and older vehicles are prevalent. However, in cities with lower income levels, transport may not be the primary source of air pollution; emissions often stem from stationary sources such as industry, home cooking, and heating. Over time, as incomes rise and emissions from stationary sources decline, mobile sources may account for a growing share of urban air pollution, highlighting the need for targeted interventions across multiple sectors. Consequently, the insufficiency and poor quality of public transport alternatives contributes to the ongoing trend of mass motorisation, characterised by growing dependence on motor vehicles (Khreis, May and Nieuwenhuijsen, 2017). This results in escalating traffic volumes, higher road crash rates, and elevated pollution levels, physical inactivity, increasing chronic diseases and death risks, representing significant societal costs (ITF, 2022b; Leroutier and Quirion, 2023; Thondoo et al., 2023).

It is also important to consider that air pollution does not solely originate from exhaust emissions due to incomplete fuel combustion. Non-exhaust emissions, such as fine particulate matter (PM2.5 and smaller) generated from tyre and brake wear, are a significant and often unregulated source of urban air pollution (Fussell et al., 2022). As regulations drive down exhaust emissions, non-exhaust sources may become an increasingly dominant contributor to poor air quality. Moreover, vehicle electrification, while beneficial for reducing tailpipe emissions, does not eliminate these pollutants and may even exacerbate them due to the heavier weight of electric vehicles (Lopez et al., 2023; Zhang et al., 2024).

The urban environment greatly affects individual well-being, including physical and mental health, happiness, and socio-cultural life (Smit et al., 2011; Tokay Argan, 2016). Thus, urban and transport planning are essential for ensuring sustainable transportation options that reduce air and noise pollution and combat heat island effects (Whitmee et al., 2024). This involves promoting active mobility, public transport availability and use, green spaces, increased physical activity, and safety while discouraging car use (Tran, 2016; Nieuwenhuijsen, 2020; Glazener et al., 2021; ITF, 2023b). The goal is to create healthier cities for all residents, recognising that urban transport planning significantly impacts public health (Figure 1).

Figure 1. Relationship between urban transport and health



Source: Adapted from Glazener et al. (2021).

The notion of co-benefits between sectoral policies

Many measures aimed at improving urban environments, encouraging active mobility, and increasing public transport efficiency and coverage, do not explicitly prioritise or even mention health impacts as their main objective. However, these measures frequently impact significantly upon health and quality of life (ITF, 2013, 2023b; Karlsson, Westling and Lindgren, 2023). In recent years, policymakers have increasingly considered the health effects of transport and urban policies as standalone objectives to improve. Often, these considerations remain limited to risk evaluations of transport and urban projects, rather than effectively and directly addressing the challenge of urban pollution and prioritising health as a primary objective (Khreis, May and Nieuwenhuijsen, 2017).

When health considerations are explicitly included as objectives in measures and policies, it enables the evaluation and measurement of health impacts. Highlighting the co-benefits of their inclusion in cross-sectoral policy making can also support the complex decision-making process and prioritisation of budget allocation, making the process more effective and efficient by addressing multiple issues through a single effort. In optimal modelling scenarios, integrating health impacts in policy making decisions has the potential to save lives and costs by preventing premature mortality, chronic pulmonary diseases, cardiovascular diseases and reducing road crashes accidents – and improve lives through increased physical activity and improved mental health. (ITF, 2013; ITF, 2023b; Khreis, May and Nieuwenhuijsen, 2017; Karlsson, Westling and Lindgren, 2023).

Health implications of low-carbon urban mobility

Low-carbon urban mobility is increasingly recognised for its significant impact on public health. This section explores how sustainable transport modes, such as walking, cycling, and public transport, contribute to healthier urban environments and the broader role that urban planning plays in creating environments that support both health and sustainability. Policies that promote active mobility and reduce reliance on private cars can address goals such as increasing physical activity, lowering air pollution, reducing traffic-related injuries, and ultimately enhancing well-being.

Linking health outcomes, active mobility and public transport

Walking and cycling have become increasingly recognised as solutions to improve both health and the urban environment (Glazener et al., 2021; ITF, 2023b). The benefits of physical activity far surpass the risks associated with air pollution and traffic incidents, except in rare cases of very high pollution levels (Clockston and Rojas-Rueda, 2021; ITF, 2023b).

Physical inactivity causes premature deaths and increases the risk of diabetes, heart diseases, obesity, chronic kidney disease, chronic obstructive pulmonary disease, cancer, and mental health issues, resulting in substantial health-care costs (Cao et al., 2022; ITF, 2023b; Mueller et al., 2017; Thondoo et al., 2023; WHO, 2019). Insufficiently active people have a 20% to 30% higher risk of premature death than sufficiently active people (WHO, 2024). The WHO recommends at least 150 minutes of moderate or 75 minutes of vigorous activity weekly for all adults. Nearly one-third of adults and 80% of adolescents do not meet these recommendations (Strain et al., 2024; WHO, 2024). Promoting active mobility and public transport usage is essential to combat sedentary lifestyles and its detrimental effects. Proper infrastructure, network continuity, and improving safety are pivotal to this happening.

Several policies have been successful in encouraging more active mobility in urban environments. Below are some examples:

- **The integration of several, if not most public transport services, including bike-sharing systems, facilitates multimodality trips and expands mobility options**. In Seoul, Korea, the Climate Ticket allows users to access both public transport and an extensive bike-sharing system (ITF, 2024; Kosmidis and Müller-Eie, 2024; Seoul Metropolitan Government, n.d.).
- **Bike parking facilities, especially near public transport stops or stations, facilitate combining public transport and cycling with private bikes**. In Denmark, a model showed that adding 100 bike parking spots increases the probability of cycling by about 2.5% (Halldórsdóttir, Nielsen and Prato, 2017; Kosmidis and Müller-Eie, 2024).
- **Allowing bikes on public transport supports intermodal trips**. In Vienna, Austria, all bikes are permitted on subways and city trains, but only folded bicycles are allowed on buses and trams (Wien, n.d.). Despite these limitations due to safety and space concerns, such policies enable cyclists to extend their reach by combining cycling with public transport.

In several cities, the Covid-19 pandemic has accelerated the shift from car-centric paradigms to prioritising active mobility (Nieuwenhuijsen, 2021; Ohlund et al., 2022; ITF, 2023a, 2023b). During the pandemic, walking and cycling were essential for ensuring people's everyday mobility and had the benefit of maintaining or increasing physical activity levels while maintaining social distancing. Cities like Paris and London saw an increase in bike and e-scooter ridership and expanded cycling infrastructures and slow-speed zones. Similarly, cities like Washington DC and Portland implemented lower speed limits in certain areas, making streets safer for cyclists and pedestrians (Ohlund et al., 2022; ITF, 2023a, 2023b).

Box 1. Pro-cycling societies

In several countries such as the Netherlands and Denmark, urban policymakers have implemented pro-cycling policies to encourage cycling at the local and regional levels, resulting in relatively high modal shares of active mobility. These efforts prioritised safety and convenience through the development of pro-cycling infrastructure and regulatory decision-making. Additionally, restrictive policies have been implemented to discourage car use by making it less convenient, particularly in city centres (Pucher and Buehler, 2008).

The Netherlands features over 38 000 km of cycle paths strictly reserved for bikes. Bicycles make up 28% of all trips and 55% of trips under 5 km. Between 2005 and 2016, bike usage increased by 12%. By 2022, 72% of the surveyed residents considered cycling a relaxing activity and associated it with improved health (Fishman et al., 2015; Harms and Maarten, 2018; de Haas and Kolkowski, 2023).

Denmark has more than 12 000 km of cycle paths. Cycling constitutes 21% of trips under 10 km and 15% of all trips. In Copenhagen, cyclists take 1.1 million fewer sick days each year than residents who don't cycle. Each kilometre cycled rather than driven generates EUR 1 in health benefits. Overall, cycling reduces national CO_2 emissions by about 20 000 tonnes annually (Cycling Embassy of Denmark, 2020).

Promoting active mobility and public transport usage while discouraging private motorised vehicle usage benefits the environment by reducing carbon emissions, local air pollution, and traffic noise. However, this requires combining multiple policy strategies aimed at promoting public transport and active modes, along with urban planning policies, to increase mobility access for all and create a healthier and more pleasant urban environment (Nieuwenhuijsen, 2020). Shifting policy focus from cars to public transport and active mobility can also free up spaces for safer walking and cycling (ITF, 2023b). This also enables leisure activities, strengthens social cohesion and generates a virtuous circle that makes urban life healthier, more environmentally friendly, and cities more closely aligned with climate goals (Nieuwenhuijsen, 2020; Ohlund et al., 2022; Chatziioannou et al., 2023).

It is important to recognise, however, that calls for increased walking and cycling are not uniformly applicable or appropriate across all global settings (ITF, 2023b). In regions where walking and cycling are inherently dangerous or poorly adapted to the urban scale, encouraging their uptake without implementing significant infrastructure and policy changes may achieve limited results. Moreover, for individuals walking or cycling primarily due to poverty, reducing reliance on these modes and increasing access to safer, more efficient transport options might lead to greater overall benefits. Such benefits include improved access to employment opportunities, education, healthcare, and essential services, as well as the ability to fully participate in social interactions, leisure activities, and community life. Enhanced transport options can also lead to time savings, greater comfort, and improved safety, particularly for vulnerable groups. Finally, the health advantages of active mobility are strongly correlated with baseline levels of physical activity. Marginal benefits are much greater in contexts where physical activity is low, highlighting the need for regionally tailored approaches to active mobility that consider local conditions and the diversity of user needs.

Re-thinking car-centric urban development for healthier cities

For decades, car-centric policies and their widespread adoption have physically transformed cities and how people engage in urban activities and spaces. These policies have facilitated travel over greater distances and contributed to the expansion of cities and urban sprawl. During this period, in many cities, owning cars became essential for residents to fully participate in society and access employment, social interactions, leisure activities, and other necessities (Khreis, May and Nieuwenhuijsen, 2017; ITF, 2023a).

In these car-dominated urban areas, pedestrians and cyclists typically experience more collisions with motor vehicles compared to pedestrians and cyclists in areas with fewer cars. In 2021, 1.2 million people died in road crashes globally, with 56% of these deaths being vulnerable road users, such as cyclists and pedestrians and 92% of these deaths occurred in low- and middle-income countries (WHO, n.d.a). In 2023, 1 635 deaths in EU cities resulted from collisions between cars and pedestrians, and 404 from collisions between cyclists and cars, compared to 581 fatal collisions between cars themselves (ITF, 2023b). According to the WHO (2023a), road traffic injuries are the leading cause of death for children and young adults aged 5–29 years.

Moving cities to prioritise active mobility and public transport requires shifting away from the dominant car-centric model of urban development. Such a transition in rethinking urban spaces is challenging and should be done gradually, with health and environment placed at the top of political agendas (ITF, 2023a; Thondoo et al., 2023). Additionally, a people-centric approach should be adopted, addressing concerns from various stakeholders (e.g., contextual, physical, aspirations, fear), ensuring mobility solutions meet diverse needs by transitioning from a segregated-use to a mixed-use model of public spaces with multimodal possibilities (Mehaffy et al., 2022; Chatziioannou et al., 2023; ITF, 2023a).

Enhancing health through sustainable urban design and increased proximity

Urban planning can reduce pollution by incorporating measures such as increasing green spaces (parks, gardens, and tree-lined areas that improve air quality and provide shade) and blue spaces (water bodies like rivers, lakes, and urban wetlands that help regulate temperature and manage stormwater). Additionally, urban planning can promote proximity to key destinations such as workplaces, schools, healthcare facilities, shops, and recreational areas through densification (concentrating development to reduce the need for long commutes) and mixed-land use (integrating residential, commercial, and recreational spaces within closer distances). These strategies create healthier urban environments, lower pollution levels, and enhance liveability.

Access to green spaces and overall greener environments in urban areas undeniably improves mental and physical health (de Vries et al., 2003; Markevych et al., 2017). Studies suggest that a 10% increase in green space correlates with a reduction in health symptoms equivalent to a five-year decrease in age, assuming a causal link (de Vries et al., 2003; Hunter et al., 2023). Although green spaces are known to benefit health, the optimal amount, location, and type are still uncertain. In addition, the benefits of green spaces are not evenly distributed across the city, and the quality of green spaces depends on the existing biodiversity (Hunter et al., 2023).

Densification, supported by measures and intervention to integrate multi-purpose land uses and reduce distances, promotes closer proximity. This approach encourages active mobility, reduces reliance on motor vehicles, and improves overall health (Smit et al., 2011; Pojani and Stead, 2015; Gil Solá and Vilhelmson, 2022). As part of this paradigm, Transit-Oriented Development (TOD) is an urban model that emphasises densifying cities through strategic land use and transport planning, and decision-making favouring connections to, and use of, public transport. By doing so, cities become more accessible, resilient, and less dependent on cars (Chatziioannou et al., 2023). For proximity to be effective, a range of essential services must be available to all urban residents within a close radius (OECD, 2021).

Dense and compact urban spaces often face challenges such as higher housing prices, congestion, air pollution, loss of privacy, and noise, resulting in some people favouring less dense urban areas (Zumelzu and Herrmann-Lunecke, 2021). Thus, high urban density delivers the most benefits when paired with high-quality urban design strategies and community participation (Lehmann, 2016). This means that high urban density policies should also be combined with measures to reduce car usage, facilitate public transport and access by active travel, and to increase recreational and green spaces as evenly as possible (Lehmann, 2016; Cheshmehzangi and Butters, 2022; Gil Solá and Vilhelmson, 2022). Optimal density levels vary across urban and cultural contexts: density must be monitored to avoid the potentially detrimental effects of excessive densification (Lehmann, 2016).

Evidence-based measures for promoting well-being through low-carbon mobility

Integrating robust evidence into urban planning and design is critical for tackling emissions from road transport, particularly private vehicles, while also promoting public health. However, improving urban well-being involves more than reducing transport-related CO_2 emissions; it requires a systematic approach that considers co-benefits and examines the interconnectedness of multiple factors influencing urban liveability. Research increasingly shows how land use, transport mode prioritisation, and environmental exposures, such as air pollution and noise, affect public health (Dyer et al., 2024). However, this knowledge is rarely incorporated into climate and transport policies, and public awareness of these issues remains limited (Khreis, May and Nieuwenhuijsen, 2017).

Policies that encourage physical activity, such as safe walking and cycling infrastructures, slow-speed zones, and reliable public transport, offer multiple benefits. They reduce pollution and CO_2 emissions, stress factors, and traffic risks, creating a healthier environment. Decision-making criteria that consider these co-benefits can strengthen the evidence base, reduce uncertainty, and better balance the costs and benefits of urban transport strategies (Karlsson, Westling and Lindgren, 2023).

Directly linking health outcomes to environmental factors like pollution can be challenging. This is due to the sensitive nature of health data and the influence of various factors, such as travel conditions and lifestyles. However, developing a body of evidence that connects policy, environmental, economic, and social factors to health outcomes is essential for informing evidence-based policymaking, prioritising interventions with the highest health benefits, and fostering cross-sectoral collaboration to address complex urban challenges. Given the wide variability in environmental exposures such as air pollution, noise, temperature, and green space across cities, collecting relevant data at multiple scales is key to building localised evidence that can inform targeted, effective policy making.

Challenges in data collection and capacity building for evidence-based policy making

Good decision-making relies on accurate information, which requires the collection of relevant datasets. Data may take multiple shapes: quantitative (e.g. big data from sensors, surveys) or qualitative (e.g. interviews), spatial or temporal, real-time or historical, among other types. Quality and scale differ. The evolving role of data in policy making highlights the need for rigorous data management, quality assessment, and privacy preservation to maintain the integrity of decision-making processes. Developing a standardised data catalogue ensures comparability and accurate measurement.

Policymakers often face challenges in collecting high-quality data, determining what to collect and how, analysing diverse data sources, interpreting results accurately, and ensuring comparability and generalisability (Ramirez-Rubio et al., 2019; Le and Poom, 2024). By using models adapted to their needs, urban authorities can be guided in collecting relevant datasets. However, it may require specific technical skills such as programming (e.g. cleaning datasets, data management) and big data handling, data analysing (e.g. understanding statistical significance), which are areas where additional training and capacity building may be beneficial for municipal employees (Le and Poom, 2024).

Adequate resources should be allocated to capacity building, fostering a data-driven culture within urban authorities and developing long-term urban and transport strategies. Academia can serve as a key partner, advancing data literacy and assisting policymakers with dataset analysis to support the creation of evidence-based policies.

Maximising data resources for better urban planning

In resource-rich environments, the availability of abundant, high-quality quantitative as well as qualitative data can lead to better-informed decisions. Strengthening public sector capacities is crucial for improving decision-making processes. Implementing cost-effective data collection methods can keep costs low, reduce reliance on private consultants, and maintain continuity of vision. It is also important to expand data collection beyond the transport sector to better understand urban complexity and the interplay of various factors influencing mobility and well-being.

Policymakers should also regularly review and enhance the data collection process. Establishing a performance management framework tailored to the local context will enable the integration of data into decision-making processes and allow for ongoing evaluations of the effectiveness of interventions and policies (Vandervalk, 2012). This will ensure that urban mobility strategies remain adaptable, data-driven, and responsive to changing needs (ITF, 2022a).

Leveraging models for strategic policy making

Models serve as simplified representations of real-world systems, highlighting the relationships between various factors. They can show how changes in one variable (e.g., an increase in air pollution) affect another (e.g., public health outcomes). By offering insights into these connections, models enable the design of more effective, adaptive, equitable policies. This systematic approach allows policymakers to evaluate the economic, environmental, health, and social impacts of different actions, making it possible to integrate these factors across sectors.

Developed by academic institutions, researchers, and public agencies, models offer valuable tools for quantifying, comparing, and evaluating the impacts of policies, scenarios, and interventions, including their distributive impacts. When assessing health impacts, models can be used for scenario analysis, predictions, health risk assessments, and cost-effectiveness evaluations. They quantify both tangible effects, such as reductions in hospital admissions or premature deaths, and intangible effects, such as Disability-Adjusted Life Years (DALYs), the burden of diseases or economic losses, making health outcomes more concrete and easier to compare (Tran, 2016; Ramirez-Rubio et al., 2019). They can help prioritise interventions by identifying those that deliver the greatest benefits relative to their costs.

When used ethically and transparently, models also strengthen the legitimacy of decision-making. By clearly outlining potential risks and outcomes, they help build public trust and acceptance of policies (Human Impact Partners, 2011). Continuous improvements in risk assessment and modelling processes allow researchers to offer refined recommendations. By incorporating these models into comprehensive transport assessments, policymakers can make better-informed decisions that anticipate consequences, mitigate negative impacts, and optimise positive outcomes, ultimately improving health and resource allocation (Kahlmeier et al., 2023).

What is required to effectively use models?

Using models effectively in policy making requires careful consideration of several key factors. Models differ in assumptions, methodologies, datasets, and objectives, from risk estimation to scenario analysis and trend prediction. They also differ in the costs to develop and maintain them, including the cost of attracting and retaining skilled staff. Policymakers must select the most appropriate model based on their specific goals and ensure they meet essential criteria such as reliability, transparency, and comprehensive documentation. It is also important to understand a model's limitations, as no model accounts for all factors.

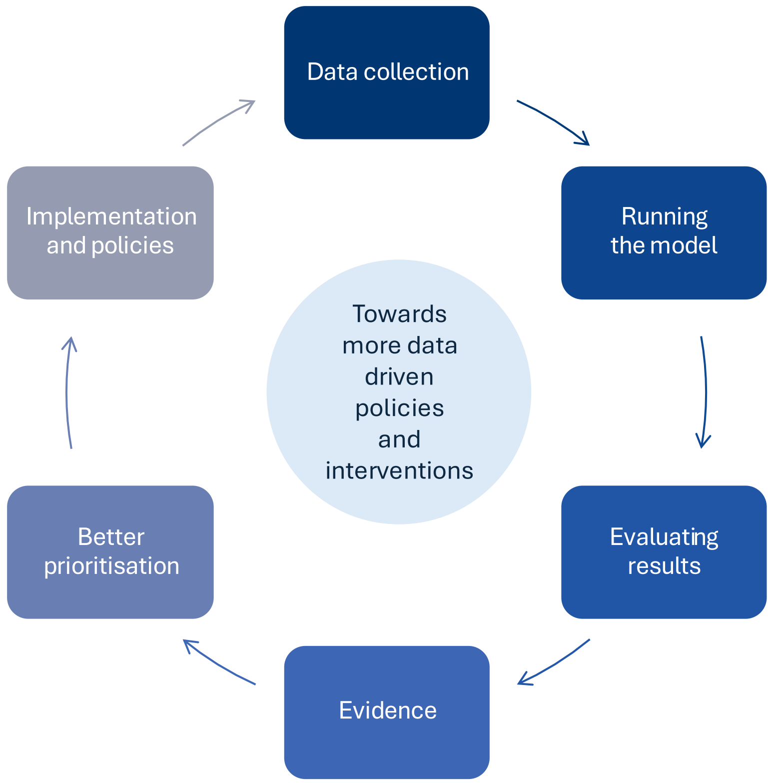
High-quality data is critical to a model’s accuracy, and collecting or processing reliable data is essential. Models may sometimes be chosen based on existing datasets to minimise costs, but this requires access to sufficient, relevant data. Data validation and standardised collection methods further ensure consistency and comparability.

Collaboration with other public agencies, private entities, or NGOs can provide additional datasets and enhance the model's accuracy. Building the necessary skills for data management within public authorities, through training and funding, is vital for long-term success. Developing the skills needed for data collection and management is another essential factor. Public authorities may need to invest in specific training to ensure employees can handle complex data tasks, which requires adequate funding. Without these investments, maintaining data quality over time can be difficult.

Consistency in model usage is also key. Once a model has been used, it should continue to be applied consistently across different areas and times to track progress and evaluate the effectiveness of policies. Regular monitoring allows for timely adjustments to strategies. Although models may need to be adapted over time, these changes should not undermine consistency in the evaluation process.

Cross-agency co-operation is often necessary for managing and sharing data. Clear roles and responsibilities, overseen by a lead agency, can prevent complications and improve co-ordination. Finally, securing continuous funding for data collection, equipment, and skilled personnel is essential for maintaining the quality and reliability of evaluations, ultimately leading to more informed, evidence-based policy decisions.

Figure 2. Using models for evidence-based policy making



Transport, health, climate action, and urban measures

Transport-related policy can be implemented that contributes to healthier urban environments by either increasing physical activity or reducing air and noise pollution, directly or indirectly. Expanding bicycle and pedestrian networks, optimising public transport, managing speed, and developing shared-mobility options encourage more active lifestyles, leading to better physical health and reduced risks of chronic diseases. Meanwhile, vehicle-restriction schemes, slow-speed zones, land-use policies, and teleworking can decrease reliance on cars, cutting down on emissions that contribute to respiratory issues and other health problems. Finally, increasing green spaces not only provides more areas for physical activity but also improves mental health by providing cleaner air and more recreational areas.

These measures also hold positive implications for freight transport in cities. Restricting private vehicle use and optimising road space can improve the efficiency of urban logistics by reducing congestion, enabling faster and more reliable deliveries. Additionally, policies that promote clean vehicle technologies and designate low-emission zones can incentivise the adoption of electric or alternative fuel freight vehicles, further cutting down pollutants. Together, these strategies improve public health outcomes while fostering sustainable urban living.

The ITF Global Urban Passenger model assesses several measures to reduce CO_2 emissions from the urban transport sector. Out of these, thirteen measures, listed in Figure 3, have a significant impact on health outcomes, beyond the reduction in emissions. Each measure is explained below with details on its health impacts, associated costs, and relevant notes or examples.

Figure 3. Transport decarbonisation measures that impact health outcomes in urban areas

Transport infrastructure enhancements	Transport service improvements	Regulatory interventions	Complementary urban enhancements
• The expansion of bicycle and pedestrian networks • The development and expansion of public transport systems, and express lanes for buses	• Public transport service optimisation • Shared-mobility incentives • Carpooling policies • Support for Mobility as a Service	• Urban vehicle-restriction schemes • Speed management • Parking restrictions • Urban vehicle-restriction schemes	• Multiplying green spaces • Teleworking • Land-use policies and transit-oriented development

Source: Adapted from ITF (2023c).

The ITF Global Urban Passenger model includes other measures that are not listed here as they do not directly relate to health impacts. These economic instruments including carbon pricing, road pricing and parking pricing are gradually set up or enhanced worldwide.

Category 1: Transport infrastructure enhancements

Transport infrastructure improvements, such as expanding bicycle and pedestrian networks and promoting carpooling, have significant potential to enhance public health by encouraging active modes of transport and reducing vehicular emissions. By reallocating urban spaces to favour walking and cycling over car use, cities can create environments that promote physical activity, helping to mitigate risks associated with chronic diseases like obesity, heart disease and premature death (Mueller et al., 2018). These measures also improve air quality by reducing the number of vehicles on the road, leading to decreased exposure to harmful pollutants (Chatziioannou et al., 2023; Mehaffy et al., 2022). Expanding public transport networks not only lowers emissions by reducing private vehicle use but also promotes walking, as people tend to walk more when using buses, trams, or trains. This helps improve cardiovascular health and air quality (ITF, 2023b; Moreno and de Miguel, 2018). Additionally, reducing the number of motorised vehicles on the road, including cars and goods vehicles, enhances safety for vulnerable road users such as cyclists and pedestrians, contributing to fewer fatal and serious incidents.

Table 1. Transport infrastructure enhancement measures

Measure	Description	Health impacts	Costs	Notes/Examples
Expansion of bicycle and pedestrian networks	Reallocate or create urban spaces for walking and cycling infrastructure (e.g. bike lanes, bike parking, walkways).	Increased physical activity, improved air quality, reduced chronic disease risk, reduced premature deaths and improved mental health.	Low – Involves constructing segregated lanes, bike racks, and walkways.	Encouraging active transport has positive health outcomes. Initiatives like Barcelona's superblock model promotes cycling and walking (Mehaffy et al., 2022; Chatziioannou et al., 2023).
Development and expansion of public transport systems, and express lanes for buses	Build and improve public transport systems (e.g. metro, buses), including express lanes for buses.	Reduces use of cars, increases walking, and decreases emissions. May lead to increased exposure to suspended particulate matter inside of vehicles and stations compared to private car use.	High – Includes land acquisition, construction, and operational costs.	In Seoul, installing air purifiers on metro platforms reduced pollutant levels, improving public health (Moreno and de Miguel, 2018).

Boxes 2 and 3 below, provide three examples of recent initiatives that show a commitment to improving well-being and quality of life by encouraging active and public transport use over private vehicles.

Box 2. Open Streets initiatives

In 2019, the Open Streets initiative, known as Ciclovía Recreativas, was implemented in 77 Latin American cities, involving the temporary repurposing of at least 1 km of urban roads into car-free spaces for several hours, typically once a week (Velázquez-Cortés et al., 2023).

Bogota is the most advanced city in implementing the Open Streets initiative. Every Sunday and public holiday from 7 am to 2 pm, 128 km of routes are closed to motorised vehicles. This initiative aims to create safe and accessible environments for recreational activities, walking and cycling, promoting active mobility and physical activity, and restoring the feeling that the city belongs to its citizens (Sánchez, n.d.; Pojani and Stead, 2015; Velázquez-Cortés et al., 2023).

Health impacts were measured for 15 out of 77 city initiatives. The results demonstrated that Open Streets initiatives effectively promote active mobility. Across the fifteen cities, the initiatives prevented an estimated 363 premature deaths per year by mostly promoting physical activity, which translates to an annual economic impact of USD 194.1 million (Velázquez-Cortés et al., 2023).

Figure 4. Mexico City Ciclovía Recreativa (2020)

Source: Philippe Crist (2020)

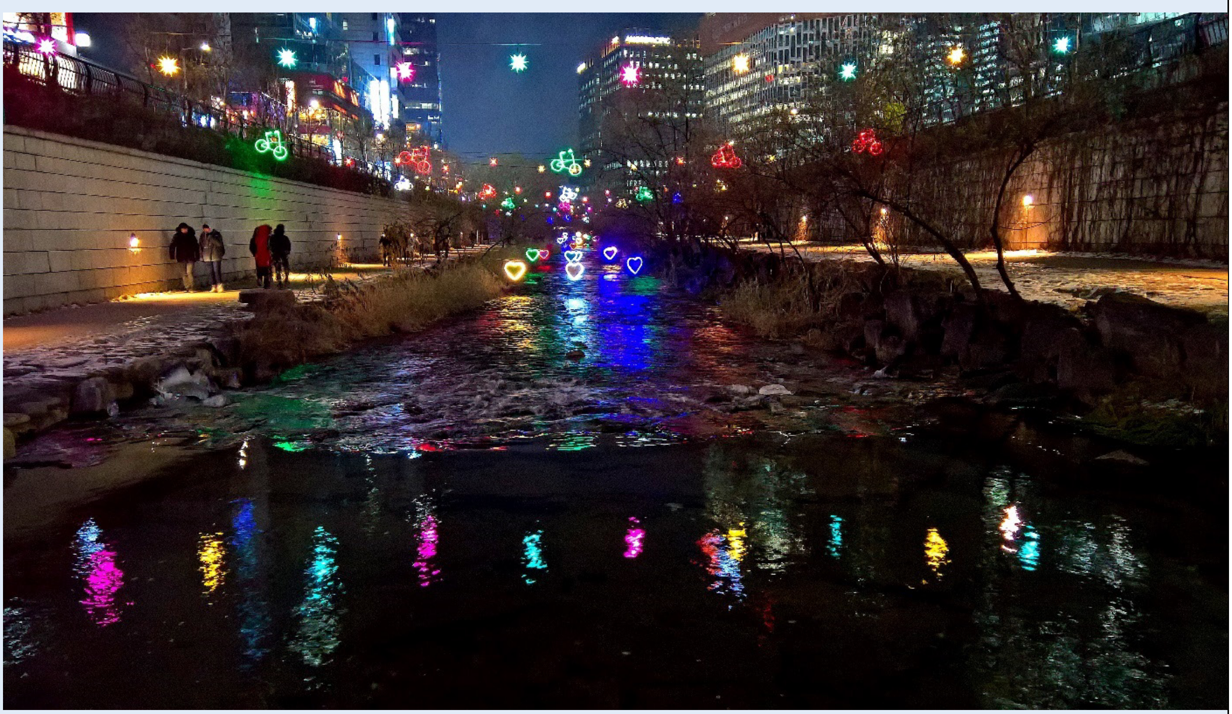
Similar measures are gradually being adopted by some African cities. One of the most advanced examples is Addis Ababa, Ethiopia. There, since August 2023, twenty roads are exclusively open to pedestrians and cyclists monthly, and three roads every Sunday, totalling over 100 km of road (WRI Africa, 2023; Guerrero Casas and Kramer, 2024). So far it has been found to popularise cycling and influence new policies and implementations with an increase of bike lane and walkway infrastructures (WRI Africa, 2023).

In India, similar initiatives called “Happy Sundays”, or “Happy Streets”, have emerged in several major cities. However, these events often lack regularity, which partly explains their decline. They are often initiated by private partners like the national newspaper The Times of India, for promotional purposes (Vizianagaram, 2017; Times of India, n.d.). Lucknow, Bengaluru, and Pune hold Happy Streets events sporadically in specific neighbourhoods (Times of India, n.d.; Times of India, 2023). In Mumbai, initially, six and later nine streets were closed for a few hours every Sunday in 2022-23, as part of a police initiative. Due to inconsistent support from authorities, the street closures eventually ceased (Kotak, 2022; The Indian Express, 2022). These initiatives, while a positive step forward, are treated more as special events than regular occurrences, making them less remarkable than similar efforts in cities of Latin America.

Box 3. Urban stream restoration encouraging public transport: Cheonggyecheon, Seoul

Inspired by a small group of academics and environmentalists in the 1990s, the Seoul Metropolitan Government launched the Cheonggyecheon restoration project. This 5.86 km long and 16 m wide stream, covered by a road and elevated highway during Korea's industrialisation in the 1960s, was restored between 2003 and 2005 (Shin and Lee, 2006; Lee and Anderson, 2013; Kim and Jung, 2019). The project's political motivation was to transform Seoul into a symbol of environmental sustainability. It aimed to enhance liveability by improving air quality through shifting mode priorities and increasing green spaces (Lee and Anderson, 2013). Before restoration, over 168 000 vehicles passed daily, causing severe congestion and poor air quality, which contributed to health issues and a declining population in the area (Chung et al., 2012; Lee and Anderson, 2013). Nationwide health and nutrition examination surveys since 1998 have indicated that before the restoration residents near Cheonggyecheon were twice as likely to suffer from respiratory diseases compared to others in Seoul (Lee and Anderson, 2013; Oh et al., 2021).

Figure 5. Cheonggyecheon Stream (2017)



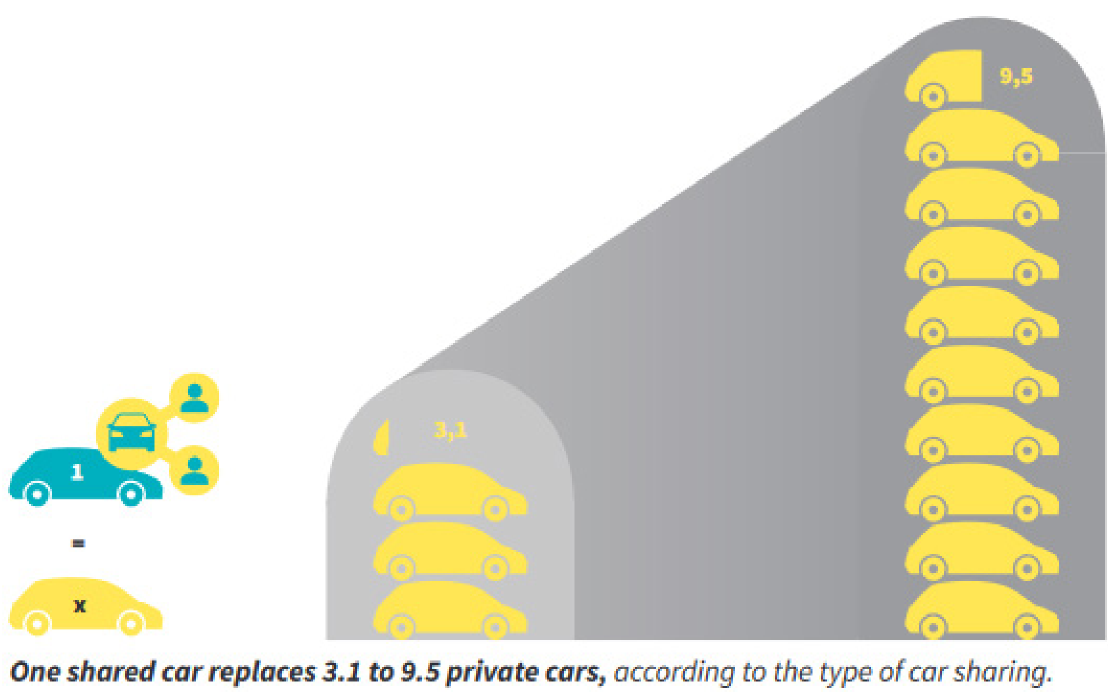
Source Philippe Crist (2017)

Today, Cheonggyecheon stretches along 6 km of stream within a 12.04 km trail, providing a pedestrian-friendly environment (Chung et al., 2012; Kim and Jung, 2019). The project's deconstruction of the highway disrupted travel patterns, necessitating a shift in travel behaviour to prevent severe traffic issues. The authorities proactively implemented side policies to help promote a modal shift towards more sustainable modes of transport in offering alternative travel options, such as new Bus Rapid Transit (BRT) corridors and metro lines serving the area (Chung et al., 2012). Pedestrian traffic significantly improved, and residents adapted to travel options, reducing traffic and pollution over time (Lee and Anderson, 2013). The health and nutrition examination surveys showed substantial health improvements, particularly in mental health (Kim and Jung, 2019). The Cheonggyecheon stream restoration successfully combined urban and transport planning, reducing local car traffic and improving public transport. The restoration cost about USD 351 million, which over time was partially covered by increased tourism and urban development (Lee and Anderson, 2013). Gentrification was a noted side effect (Chung et al., 2012).

Category 2. Transport service improvements

Optimising public transport services and promoting shared-mobility options such as bike-sharing and car-sharing can indirectly improve health by reducing car dependency and encouraging more active lifestyles. Shared-mobility incentives, like bike-sharing, provide an opportunity for individuals to incorporate physical activity into their daily routines. Box 4 illustrates how well-maintained and extensive bike-sharing systems in New York and Paris contribute to optimising urban space by promoting cycling over car use. In cities such as Brussels and Flanders (Figure 6), shared-mobility systems have successfully reduced the number of privately owned vehicles, leading to decreased congestion and pollution, thereby improving urban health outcomes (Autodelen.net, 2022). Carpooling policies can foster social interaction and community cohesion, which improves well-being and liveability (Aguiléra and Pigalle, 2021).

Figure 6. Carsharing decreasing the need for private vehicles in Flanders, Belgium



Source: Autodelen.net (2022).

Islamabad's example of carpooling initiatives shows that wider adoption of carpooling can significantly cut vehicle numbers and associated emissions, leading to positive health and environmental outcomes (Haroon et al., 2024). Similarly, a study in 2012 in Montreal revealed that 88.1% of households participating in a carsharing organisation did not own a car, compared to only 34.2% of the general population (Kent, 2014; Sioui, Morency and Trépanier, 2013). However, these measures need to be complemented with broader policy frameworks to ensure long-term benefits.

Table 2. Transport service improvement measures

Measure	Description	Health Impacts	Costs	Notes/Examples
Public transport service optimisation	Improve the frequency, reliability, and comfort of public transport without expanding infrastructure.	Reduces car use, which positively impacts health by lowering exposure to traffic-related air pollution, noise, and the risk of road accidents, while also promoting physical activity through active travel. However, a negative health impact remains from fine particulate matter exposure within public transport vehicles and stations, which can exacerbate respiratory and cardiovascular issues if not adequately mitigated.	Moderate – Based on service enhancements (e.g. fare systems, frequency increases).	Increasing travel speeds and integrating fare systems can raise public transport use and reduce car ownership by half a percentage point (ITF, 2023a).
Shared-mobility incentives (bike-sharing, carsharing)	Promote shared-mobility options to reduce private car ownership and encourage active modes like cycling.	Indirect health benefits through reduced traffic and improved air quality. Bike-sharing also promotes active transport.	Moderate – Costs for installation, maintenance, and public space use for bike-sharing systems.	Bike-sharing systems operate in over 1 500 cities globally, supporting first- and last-mile connectivity (Teixeira, Silva and Moura e Sá, 2023). In Flanders, households who use shared car services significantly decrease their car ownership and postpone future car purchases. (Autodelen.net, 2022).
Carpooling policies	Encourage shared vehicle use to reduce traffic and emissions.	Reduces pollution, improves social interaction, enhances overall well-being.	Low – for individuals, cost-sharing reduces expenses. For authorities, it lowers congestion.	Islamabad's carpooling policies could reduce car ownership by 33.6%, cutting CO_2 emissions by over 411 035 tonnes annually (Haroon et al., 2024).

Box 4. Bike-sharing systems in New York and Paris

A health impact analysis was conducted in New York City for 2020, and demonstrated that implementing a largely, well-maintained, and reliable bike-sharing service had positive health benefits. In 2020, with 19 000 bikes, an average of 1.7 million rides, and over 1 000 stations, estimates showed an annual reduction of two premature deaths, an increase of 355 life years (DALYs), and USD 15 million in health economic benefits, mostly due to increased physical activity (Clockston and Rojas-Rueda, 2021). By 2024, New York City had a total of 30 000 bikes, including e-bikes, and over 2 000 docking stations, with a record of over 4 million rides in August 2023 (Clockston and Rojas-Rueda, 2021; Citi Bike, 2023). Overall, well-maintained and sufficiently large bike-sharing systems encourage cycling as was demonstrated in the example of New York.

Vélib' Metropole in Paris has become increasingly popular. As of April 2024, it operates 1 481 stations across over 55 municipalities, covering nearly 400 square km with 19 184 bikes. The system has around 409 000 annual subscribers and records about 136 783 daily trips, representing a 9% increase compared to April 2023. Electric Vélibs bikes account for 68% of the distance travelled, as they are commonly used for longer trips, averaging up to twelve trips per day compared to seven for standard bike models. This growing adoption results from improved coverage and maintenance, which are essential for increasing bike-sharing adoption (Ivanovic, Wood and Purves, 2023; SAVM, 2024). Additionally, private dockless bike-sharing systems are in operation, expanding the bike-sharing options.

Category 3: Regulatory interventions

Regulatory interventions can play a pivotal role in promoting healthier, more liveable cities. Urban vehicle-restriction schemes are a key regulatory measure to improve health and liveability in cities. These schemes, such as low-emission and zero-emission zones, pedestrian-only zones, slow-speed zones and low-traffic neighbourhoods restrict access for high-emission vehicles, resulting in significant improvements in air quality and reductions in health risks related to respiratory issues. In Stockholm, for example, the implementation of a low-emission zone led to a 40% reduction in particulate matter, yielding substantial public health benefits (ADEME, 2020). While vehicle restrictions are effective in cutting emissions, they must be coupled with policies that promote active transport and affordable mobility alternatives to avoid equity issues and maximise health outcomes.

Table 3. Regulatory interventions

Measure	Description	Health Impacts	Costs	Notes/Examples
Urban vehicle-restriction schemes	Implement low-emission or zero-emission zones, pedestrian-only zones, low-speed zones, and low-traffic neighbourhoods, restricting vehicles that do not meet emission standards.	Improves air quality and promotes active transport modes (walking, cycling).	Varies – Dependent on signage, monitoring systems, and enforcement.	Stockholm's low-emission zones reduced NO_2 by 10% and PM10 by 40%, significantly improving residents' health (ADEME, 2020). European cities often use these schemes to encourage newer, compliant vehicle purchases (ICCT, 2021).

Category 4: Complementary urban enhancements

Complementary urban enhancements play a crucial role in fostering healthier, more liveable cities. By rethinking how urban spaces are used and prioritising measures that promote well-being, cities can reduce emissions and improve quality of life for inhabitants. One key aspect of this approach is expanding green spaces in cities. Urban greening initiatives, such as creating parks, green corridors, and urban forests, enhance public health by improving air quality and encouraging physical activity. People are more likely to walk and engage in outdoor activities in greener, safer environments, which reduces the risk of chronic diseases and boosts mental health (Barron et al., 2019; Glazener et al., 2021). Beyond physical health benefits, these green areas provide spaces for social interaction and cultural activities, enhancing community well-being and reducing urban isolation (Lee, Jordan, and Horsley, 2015). Box 5 further shows how policies in Turkey helped to promote greener urban development through the rehabilitation of the Porsuk river, expansion of green spaces, and improvements in public transport, resulting in reduced air pollution, enhanced pedestrian and cycling infrastructure, and positive health outcomes.

Box 5. Greener urban development in Eskişehir, Turkey

For several decades, Eskişehir, Turkey, has experienced rapid urbanisation and industrialisation (Kacar and Alpan, 2018; Deliry and Uyguçgil, 2023). In 1999, an earthquake partially damaged the city, prompting the rehabilitation of 13 km of the polluted Porsuk river (Kacar and Alpan, 2018). The Eskisehir Greater Municipality, funded up to USD 159 000 000 by the European Investment Bank and the Nordic Investment Bank, initiated the Urban Development Project from 2001 to 2009 (UN Habitat, n.d.; Kacar and Alpan, 2018). This project established green corridors and open areas around the river, encouraging pedestrian and cycling. It also introduced a boat public transport service and the city's first tram network, with two main lines totalling 15 km in length, operational since 2004 (Kacar and Alpan, 2018).

As a result, green spaces increased by 26% from 2009 to 2012, reaching 9.07 square metres per person by July 2012, which helped reduce air and noise pollution and the urban heat island effect (Iungman et al., 2023; Tuna, 2015). Years later, ongoing urbanisation has resulted in insufficient and inadequately distributed green spaces across neighbourhoods, a consequence of significant disparities in urban planning priorities and resource allocation (Deliry and Uyguçgil, 2023). Overall, this rehabilitation project has brought positive benefits, including attracting tourism and commercial activities (e.g. hotels, bars, restaurants, tourist attractions), on top of improving health, especially for those living or working near the green areas (Galvin and Maassen, 2019).

Another important component is teleworking, which reduces commuting stress, emissions, and traffic congestion. Although teleworking offers benefits like increased flexibility and better work-life balance, it also presents challenges such as the risk of isolation or overworking and an incentive to increase the distance between the workplace and place of dwelling. On a broader scale, however, the reduction in daily commuting generally leads to fewer road emissions and improved air quality, creating a healthier urban environment (Li, Liu and Long, 2023). It also offers economic advantages by cutting commuting costs and reducing the need for office spaces, benefiting both employers and employees.

Land-use policies and transit-oriented development (TOD) complement these efforts by shaping cities that prioritise active mobility and public transport. Compact, high-density urban areas with diverse land uses reduce transport demand, lower emissions, and encourage walking and cycling. Models like Barcelona's superblocks show how redesigning urban spaces can reduce reliance on cars and create more walkable, accessible, areas leading to improved public health (Mehdipanah et al., 2019; Nieuwenhuijsen et al., 2024).

Box 6 highlights how the 15-minute city concept, embraced by Paris and Melbourne, focuses on improving land-use efficiency by creating compact, mixed-use neighbourhoods where essential services are within walking or cycling distance, reducing the need for long commutes and optimising the use of urban space. By integrating green spaces, teleworking options, and TOD strategies, cities can create a holistic framework for enhancing sustainability and public health.

Table 4. Complementary urban enhancement measures

Measure	Description	Health Impacts	Costs	Notes/Examples
Multiplying green spaces	Develop green spaces such as parks, urban forests, and green corridors to improve air quality and recreational spaces.	Enhances mental health, encourages physical activity, and reduces pollution.	High – Creating and maintaining green spaces, especially in urban areas, can be expensive.	Green spaces promote social interaction and reduce isolation, especially for older adults. In some cities, converting vacant lots into green spaces reduced crime and insecurity (Lee, Jordan, and Horsley, 2015; Barron et al., 2019).
Land-use policies and Transit-Oriented Development	Encourage compact, mixed-use urban development to reduce transport demand and support active mobility.	Promotes physical activity, reduces CO_2 emissions, and improves public health.	Higher costs in developed cities due to retrofitting challenges.	Barcelona's superblock model encourages cycling and walking while reducing car traffic. Other cities like Shanghai, Dubai, and Singapore have adopted similar models (Lehmann, 2016; Scoppa, Bawazir and Alawadi, 2018).
Teleworking	Reduce commuting by allowing flexible working from home.	Lowers commuting stress but can lead to isolation and work-life imbalance. It also reduces emissions and improves air quality.	Low to moderate – Savings for companies and employees, but IT infrastructure costs may increase.	Teleworking reduced Beijing's road transport emissions by 7.05%, cutting carbon emissions by 1.32 million tonnes in 2022 (Li, Liu and Long, 2023).

Box 6. The 15-minute city, adopted by Paris and Melbourne

The concept of the 15-minute city encourages proximity, diversity, density and ubiquity to create rich urban environments that are easily walked or cycled. By favouring more compact and functionally mixed neighbourhoods, the concept seeks to maximise people's access to six essential urban functions: living, working, commerce, health care, education and entertainment (Moreno et al., 2021). Achieving easily walkable and bikeable urban areas can reduce travel distances, support accessibility, improve land-use efficiency, and, in turn, offer health benefits (Khavarian-Garmsir et al., 2023; OECD, 2021). While the "15-minute city" is more of a guiding concept than fully realised design and zoning practices, many cities seek to incorporate its principles into their urban planning (Khavarian-Garmsir et al., 2023).

For example, the municipality of Paris follows the principle of decentralisation and proximity in its urban policies. The concept of the 15-minute city is envisioned here through cycling distances. Priority is given to rehabilitation and space transformation over the construction of new infrastructures. Since 2014, Paris has allocated approximately EUR 316 million to create more than 1 500 km of cycling infrastructure (of which nearly 500 km is protected infrastructure), 12 new pedestrian squares, 180 pedestrianised school streets, seven new urban forests and one park converted from roadway and over 130 000 cycling parking spaces (La Ville de Paris, 2021, 2022, Ville de Paris, 2022; WRI, n.d.)..

Following the concept’s guidelines, authorities in Melbourne, Australia, have integrated the notion of 20-minute neighbourhoods into the city planning vision for 2017-2050. This strategy aims to improve proximity by ensuring a fairer distribution of basic urban functions and employment opportunities across neighbourhoods (Pozoukidou and Chatziyiannaki, 2021).

The 15-minute city concept demands both a local focus and a cohesive global urban vision, as there is a significant risk of excluding certain areas, particularly the less advantaged populations often residing in the outskirts or surrounding regions (TUMI, 2021). Policymakers implementing the principles of the 15-minute cities should ensure a certain level of equity between neighbourhoods in terms of public intervention.

Evaluating health impacts of low-carbon mobility scenarios in cities

Low-carbon mobility scenarios offer significant health benefits in urban environments when properly integrated into transport and health policy frameworks. Traditional transport models have primarily focused on predicting traffic flows and infrastructure needs based on socio-economic and demographic factors. However, these models have often overlooked important health outcomes, such as the effects of increased physical activity and reduced air pollution on public well-being. By combining the International Transport Forum's (ITF) Global Urban Passenger model with the OECD Strategic Public Health Planning model for non-communicable diseases (SPHeP-NCD) health policy model, this chapter presents a more comprehensive approach to urban mobility, illustrating how different transport policies can influence public health. The analysis contrasts two scenarios Current Ambition and High Ambition, detailed later in this chapter, to highlight the potential for co-ordinated actions that not only lower emissions but also improve life expectancy, reduce the burden of chronic diseases, and lower health-care costs, all while supporting sustainable urban development.

Integrating transport and health models: A cross-sectoral approach

The initial goal of urban transport models was to estimate the evolution of traffic flows based on the socio-economic and demographic evolution of an urban area. Most of these were designed to evaluate the potential impact of building road or public transport infrastructures. From this starting point, mobility models were enhanced and adapted to address many new challenges, such as deriving carbon emissions from people and vehicle flows. The ITF Global Urban Passenger model (Box 7), for example, enables analysts to assess local pollutant emissions. While carbon emission developments can be assessed against international emission reduction commitments, with some additional efforts to convert national objectives to the urban transport level, such commitments are not usually available for local pollutants. Although it is commonly agreed that local pollutants should also decline, the lack of quantified commitments by governments, industry and individuals contributes to them featuring less in project and policy evaluations, labelling the local pollutant impacts secondary. In a similar manner, the increase of active modes is perceived as positive, but lacks concrete understanding and accounting of their benefits. To better represent the benefits from reduced local pollution and improved physical activity, it is necessary to go beyond the current scope of traditional urban transport models and convert their outputs into health impacts and outcomes.

Conversely, health models are well-suited to represent the impact of physical activity and local pollutants on health but are generally not designed to represent the complex impacts of specific transport policies on concrete mobility practices. Box 8 gives a brief overview of the OECD SPHeP-NCD health policy model for non-communicable disease. By combining the ITF Global Urban Passenger model with the OECD SPHeP-NCD health policy model, the expertise of both institutions can be leveraged to adequately represent transport and health impacts of policy making. It provides the opportunity to enhance traditional ITF analyses and adopt a more holistic, cross-sectoral perspective, better representing financial, emissions and well-being impacts of urban transport policies.

It is important to note that this analysis does not account for the fact that walkers and cyclists might be more exposed to air pollution than other passengers, potentially offsetting some of the health benefits of shifting to these modes due to externalities caused by other transport modes. Additionally, due to current modelling integration limitations, road safety elements have not been included in this analysis but are strongly envisioned for future work.

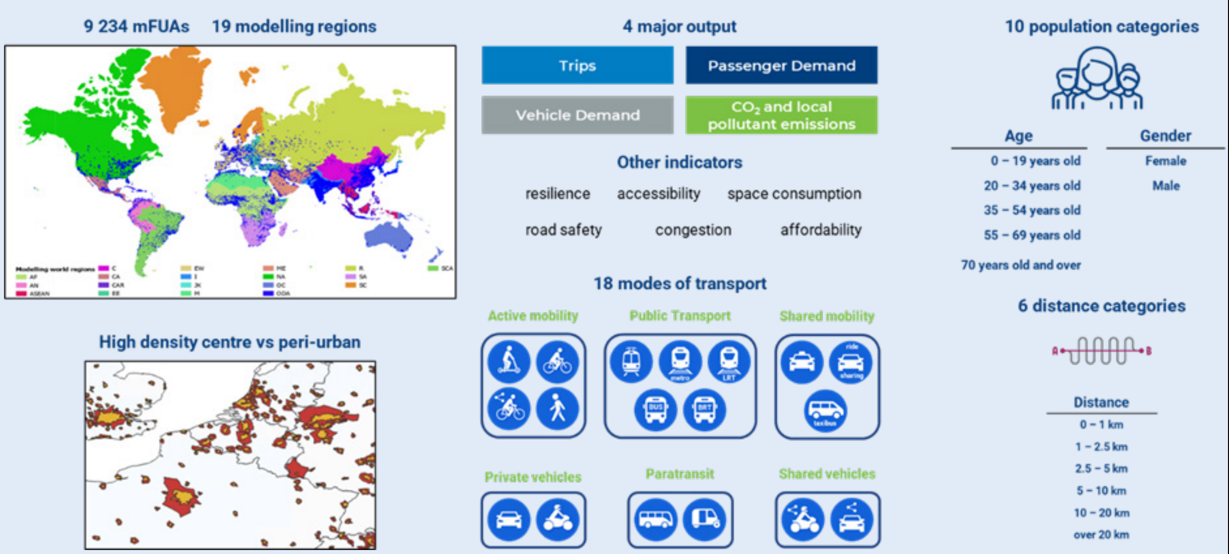
Overview of the ITF Global Urban Passenger and OECD SPHeP-NCD models

Including the impact of transport policies into health models or developing joint urban transport and health models is a growing area of research. Within the consultations conducted for this project, several major modelling approaches were identified: the Health Economic Assessment Tool for Walking and Cycling (HEAT) from the World Health Organisation; the Integrated Transport and Health Impact modelling tool (ITHIM) from Cambridge University, the Urban and Transport Planning Health Impact Assessment tool (UTOPHIA) from IS Global, and the Healthy Cities tool from Bax & Company. While all relevant, these are typically developed for one urban area only, or up to a national level for the HEAT. See Annex B for an overview of these models.

Box 7. The ITF Global Urban Passenger model

The ITF Global Urban Passenger model assesses mobility supply, demand, and performance using a dynamic systems approach. It estimates trips, mode shares, passenger and vehicle activity, and pollutant emissions for the timeframe from 2015 to 2050. These pollutants include carbon dioxide (CO_2), black carbon (BC), carbon monoxide (CO), ammonia (NH_3), nitrogen oxides (NO_x), particulate matter (PM), sulphur dioxide (SO_2), and volatile organic compounds (VOCs), with emissions calculated for 18 different transport modes. Furthermore, additional performance indicators are derived. Up to 23 policy measures or technology developments are included within the model, for 19 regional markets. A total of 9 234 metropolitan areas including the core cities and their suburbs, technically defined as macro Functional Urban Areas (mFUAs), are included.

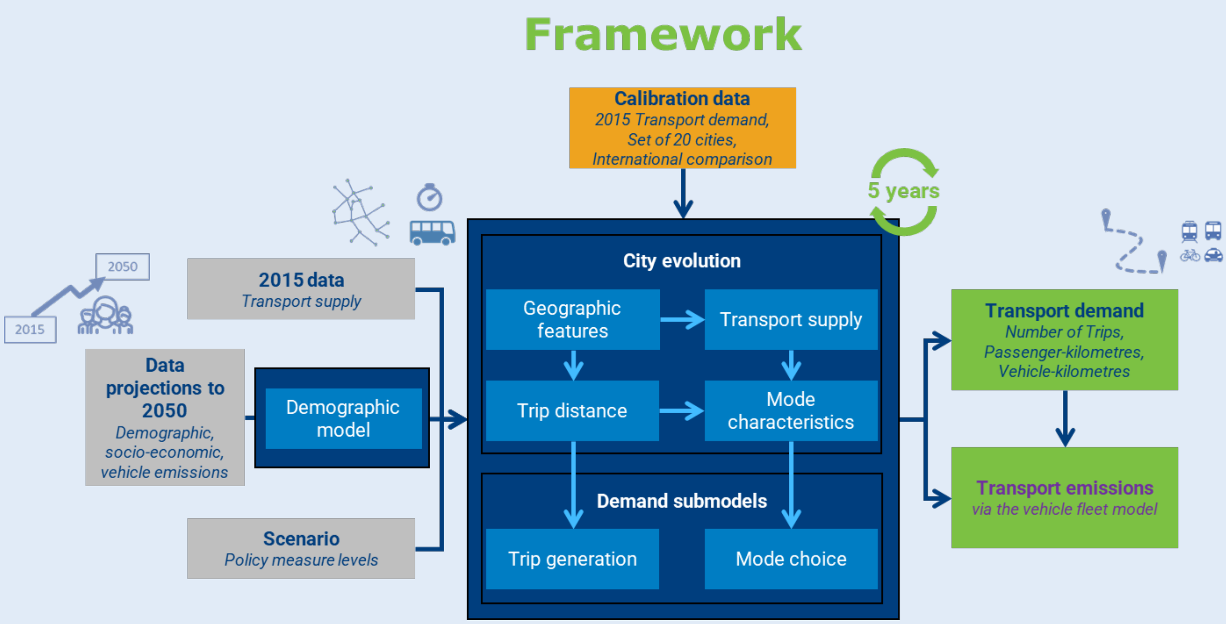
Figure 7. Characteristics of the ITF Global Urban Passenger model



Source: The ITF Modelling Framework, https://www.itf-oecd.org/itf-modelling-framework-pasta-2023

The model simulates the evolution of the population of each mFUA every five years from 2015 to 2050. The combination of population and economic development assumptions leads to an evolution of cities, first by simulating urban growth, second by estimating the related evolution of transport supply and trip distance distribution. New modal characteristics are derived before the trip generation and mode choice demand submodels are launched. The latter is based on a multinomial logit theoretical approach. The final transport demand is then assessed and converted into emissions using emission factors from the ITF vehicle fleet model. The model outputs comprise information on total transport-related physical activity for each population category and particulate matter emissions for this joint exercise.

Figure 8. Structure of the ITF Global Urban Passenger Transport model



Source: The ITF Modelling Framework, https://www.itf-oecd.org/itf-modelling-framework-pasta-2023

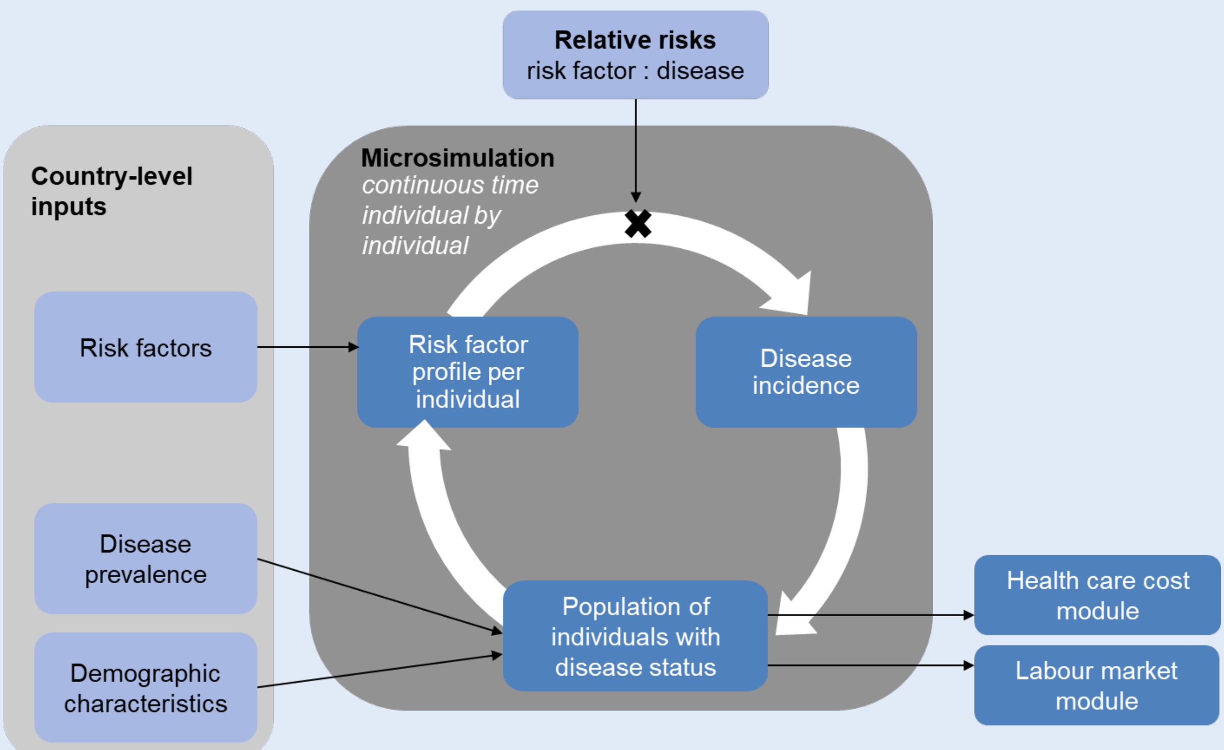
Additional resources on the model and the wider ITF Policy Ambitions and Sustainable Transport Assessment (PASTA) modelling framework:

- https://www.itf-oecd.org/itf-modelling-framework-pasta-2023
- Methodology note (2020): https://cordis.europa.eu/project/id/831743/results
- Trouvé, Caros and Martinez (upcoming) Global trajectory for urban passenger transport decarbonisation: A policy-based modelling approach

Box 8. The OECD model for Strategic Public Health Planning for Non-communicable Diseases

The OECD model for Strategic Public Health Planning for Non-communicable Diseases (SPHeP-NCD) is an advanced systems modelling tool for public health policy and strategic planning. It projects population, health and economic outcomes to assess long-term impacts of policies over 2023-2050. The model covers 52 countries, including OECD, EU and G20 countries. For each, the model uses demographic and risk-factor characteristics by age and gender to generate synthetic populations. Individuals within these populations are assigned demographic characteristics and a risk factor profile (alcohol consumption, body mass index, tobacco use, blood pressure, pollution and diet) with a probability of contracting a Non-Communicable Disease (NCD): Type 2 diabetes, stroke, ischaemic heart disease, cancers (lung, breast, colorectum, oesophageal, liver, stomach, nasopharynx, pharynx, oropharynx, lib and oral cavity), depression, dementia, musculo-skeletal disorders, chronic obstructive pulmonary diseases, cirrhosis, alcohol dependence and injuries. The model uses a competing event framework: for any individual, diseases and causes of death compete to determine the death of an individual.

Figure 9. SPHeP-NCD Modelling Framework



Source: Adapted from: http://oecdpublichealthexplorer.org/ncd-doc/_2_1_Modelling_Principles.html

Healthcare costs of disease treatment are estimated on a per-case annual cost. Disease-related costs are calculated for cardiovascular diseases, cancers, chronic obstructive pulmonary disease, dementia, musculo-skeletal disorders, depression, diabetes, cirrhosis, lower respiratory diseases, alcohol use disorder, and injuries. Individual healthcare access and consumption are considered constant over time for a given age, sex and disease profile. The additional cost of multimorbidity is also calculated and applied. End-of-life costs are also applied, accounting for an increasing cost in the last year of life.

The labour market module uses relative risks of a disease status and to the risk of absenteeism, presenteeism, early retirement and employment. The changes in productivity and labour market participation are calculated in full-time equivalent workers, and are costed based on a human capital approach, using national average wages.

Additional resources on the model and related work:

- Model website: Modelling the burden of disease — SPHeP-NCDs documentation
- http://oecdpublichealthexplorer.org/ncd-doc/_2_1_Modelling_Principles.html
- 2021 study on alcohol prevention:
- Goryakin, Y., et al. (2021), "The health and economic burden of alcohol consumption", in *Preventing Harmful Alcohol Use*, OECD Publishing, Paris, https://doi.org/10.1787/2304eb8c-en.

-2024 paper on tobacco control: Devaux M, Dorfmuller Ciampi M, Guignard R, et al (2024), "Economic evaluation of the recent French tobacco control policy: a model-based approach", *Tobacco Control,* https://doi.org/10.1136/tc-2023-058568.

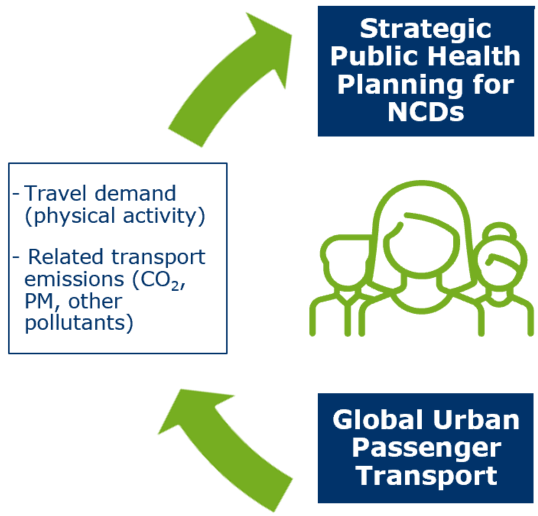
Defining geographic scope when combining data sources

The main challenge of this joint transport and health modelling exercise relies on the combination of two models with different data sources and scopes. Fortunately, both models rely on the joint OECD and European Commissions Functional Urban Area definition, ensuring the compatibility of the analysis. However, while the ITF model is global and considers all urban areas in all countries, the SPHeP-NCD model focuses on OECD, EU and G20 countries, limiting the scope available in the ITF Transport Outlook 2023, which covers more countries. As a result, and to ensure regions of similar size are represented, the regional output is displayed according to the following world regions: UCAN + JK (United States, Canada, Australia, New Zealand, Japan and Korea), China, India, LAC (Latin America and the Caribbean) and Europe (EEA + Turkey). Among these, only the India and LAC regions are considered as emerging economies in the analysis of results that follows.

Articulating two models with different structures and from different sectors

Along with the geographical scope, several challenges arise when combining two models relying on different approaches. The articulation for this project is based on the communication of physical activity and transport emissions generated with the ITF global urban passenger model being inputted to the OECD SPHeP-NCD.

Figure 10. Articulation of ITF Global Urban Passenger model and the OECD SPHeP-NCD model



Typically, the unit modelled by the ITF global urban passenger model is the trip assigned to an age and gender category within an urban area, while the SPHeP-NCD model is representing individuals going through life events. As a result, the physical activity stemming from the ITF model is produced as a total volume of passenger-kilometres (pkm) for each age and gender category. Additional assumptions must be made to determine the number of individuals who will experience a change in physical activity, as opposed to the overall variation. For example, an increase of 1 000 km by walking in the ITF model could be the result of either one individual walking much more, or from 1 000 individuals each walking 1 km more, which would be more beneficial from a health perspective. Similarly, pollutant emissions are generated at the city level and additional assumptions must be made to assign them to the city centre or the suburbs, where their concentrations usually vary. Eventually, the passenger activity is converted into Metabolic Equivalent of Task (METs)-minutes per week by the OECD. Here, METs are a standardised unit used to estimate the energy expenditure of physical activities, with one MET representing the energy spent at rest. The measurement "MET-minutes per week" quantifies physical activity by multiplying the intensity of an activity (in METs) by its duration, providing a meaningful metric for assessing the health benefits of transport-related physical activity. The modelled impact of physical activity is measured by the difference in METs-minutes per week between the Current and High Ambition scenarios.

Further improvements in the interplay of both models are the inclusion of a road safety indicator translating the average number of road conflicts that can also be inputted in the SPHeP-NCD model. Conversely, a feedback loop from the health to the transport model is under consideration. This could, for example, reflect the use of active modes for longer distances following the health benefits generated by the health model. Further calibration on age and gender categories to investigate the equity impacts of transport policies in more detail is also envisioned.

Comparing low-carbon mobility pathways: Current versus High Ambition scenarios

The two policy scenarios studied in this modelling exercise are the Current Ambition and High Ambition scenarios from the ITF Transport Outlook 2023.

"The Current Ambition scenario provides insights into how transport demand and emissions could evolve over the coming decades if transport policy continues along its current path. The High Ambition scenario, by contrast, looks at the impact of adopting more ambitious policies to decarbonise the transport sector." (ITF, 2023c).

At the urban passenger transport level, scenarios were derived by estimating several policy measures being implemented, and infrastructure and technology developments. It is important to note that the High Ambition scenario was designed by stating how far each measure could individually be implemented, before being aggregated in the scenario. As a result, each separate implementation of a measure is likely feasible, but there is lower confidence for the feasibility of the sum of all these measures at their maximum level. The High Ambition scenario can be considered as slightly more ambitious than what experts consider feasible today in terms of policy implementation. The GPD per capita assumption does not vary across scenarios, even though evidence of the impact of climate change on GDP evolution could lead to different GDP trajectories.

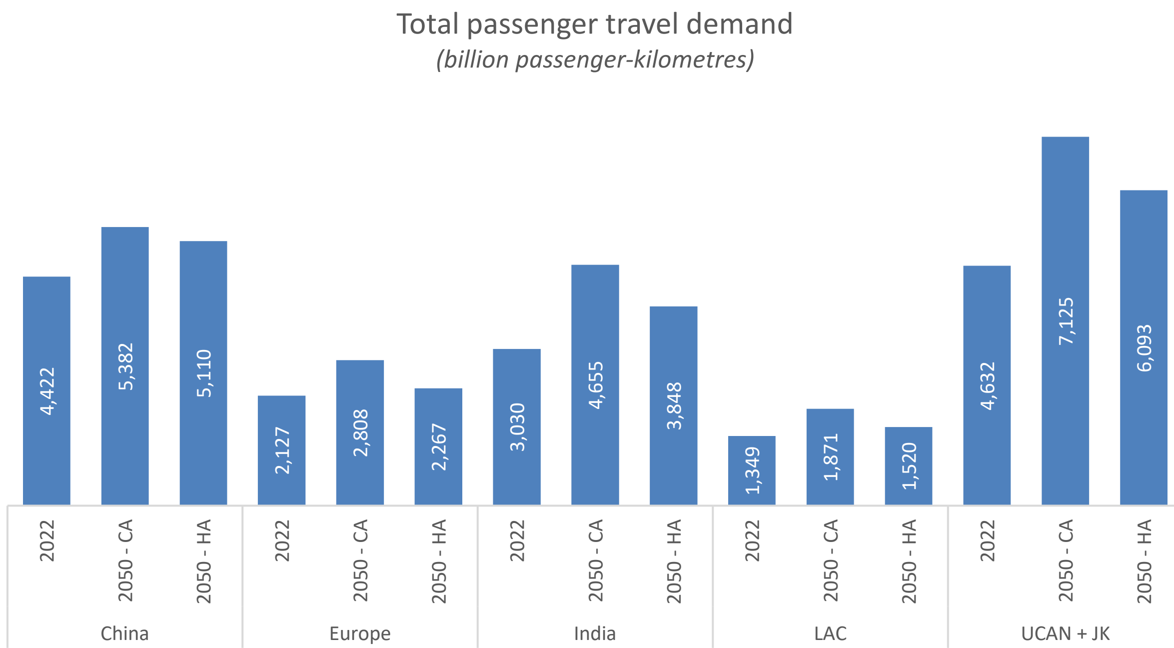
The measures feeding into these two scenarios can be grouped into five categories: economic instruments (carbon pricing, road pricing, parking pricing), infrastructure enhancement (bike and pedestrian infrastructure improvement, public transport infrastructure improvement), service improvement (public transport service improvement, public transport priority and express lanes, vehicle-sharing incentives, carpooling policies, Mobility As A Service, integrated public transport ticketing), regulatory measures (parking restrictions, urban vehicle restrictions, speed limitations,), and others (land-use planning, Transit-Oriented Development) listed in Annex A.

Comparing two different scenarios

In the scenario comparison for this project, it is important to consider that the two scenarios were simulated with complex models and vary not only along one, but several measures and variables. As a result, the output must be interpreted comprehensively to draw accurate conclusions. For instance, the average mode share of walking, measured in passenger-kilometres (pkm), may change across the scenarios, while the total amount of PKM covered by walking is the same, yet the total amount of PKM (across all modes) varies across the scenarios.

Figure 11 shows the evolution of the total volume of passenger transport demand between 2022 and 2050, under each scenario and for each world region. All regions show a decrease in total demand between Current and High Ambition coming from a reduction in urban sprawl and diversification of land-use mixtures, reducing the need for travelling long distances. The total demand systematically increases across scenarios by 2050 under the expected economic and demographic growth. In Europe and LAC, the total demand in 2050 under the High Ambition is relatively steady, in the same order of magnitude as in 2022.

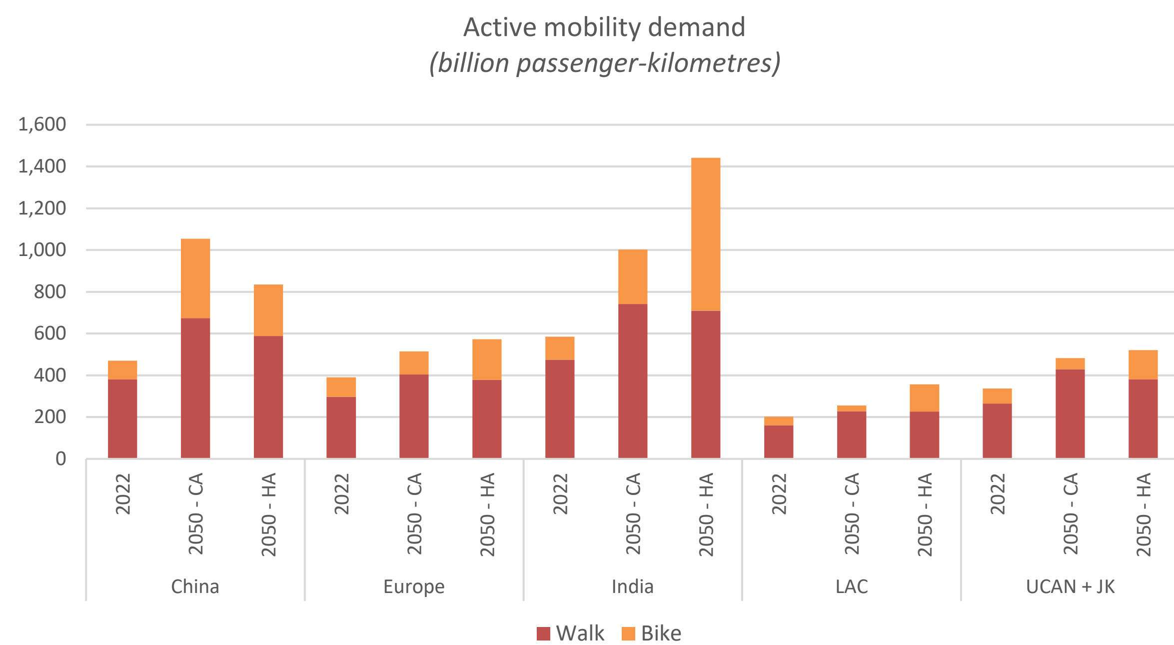
Figure 11. Total volume of passenger travel demand by region and scenario to 2050



Note: Outputs in the figure are displayed according to the following world regions: UCAN + JK (United States, Canada, Australia, New Zealand, Japan and Korea), China, India, LAC (Latin America and the Caribbean) and Europe (EEA + Turkey)

When focusing on active mobility, Figure 12 shows total pkm for all regions is higher in the High Ambition (HA) scenario than in the Current Ambition (CA) scenario in 2050, except for China. This could be driven by stronger densification measures and significant promotion of public transport infrastructures and services. However, walking always has a lower level of pkm in the HA scenario than in the CA scenario, and the increase of physical activity generally comes from a higher cycling level. This is the result of a shift from a predominantly urban-sprawl growth under the Current Ambition to one driven by the promotion of active mobility via adapted policies and well-designed infrastructure under the High Ambition scenario. This is especially the case for lower income countries where private motorised transport is less available. The outcome, while increasing overall active mobility, reduces walking by removing some of the trips that were made on foot due to a lack of other alternatives and reducing overall trip distances.

Figure 12. Active mobility demand by region and scenario, including within public transport to 2050



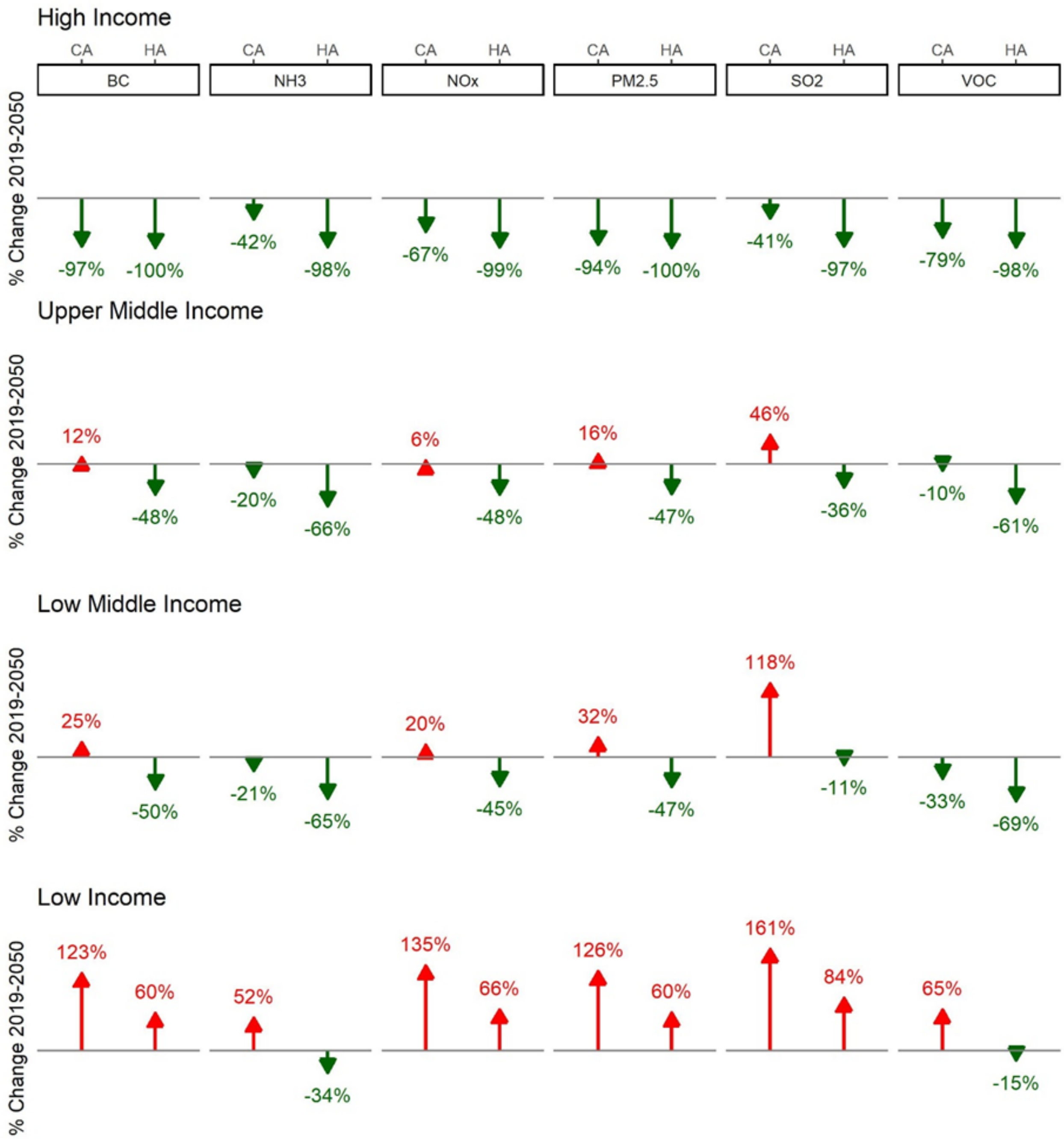
Note: Outputs in the figure are displayed according to the following world regions: UCAN + JK (United States, Canada, Australia, New Zealand, Japan and Korea), China, India, LAC (Latin America and the Caribbean) and Europe (EEA + Turkey)

Bending the emissions trajectory

The ITF Transport Outlook 2023 shows that transport-related emissions (including passenger, freight, urban and non-urban transport) are expected to remain steady under Current Ambition scenarios and decrease under High Ambition scenarios to a point compatible with the IPCC 1.5 degree scenario's annual emissions by 2050 (ITF, 2023c).

In this modelling exercise for this report, the difference in exhaust particulate matter (PM2.5) emissions is the input variable that is used by the SPHeP-NCD model, coming as output from the ITF's model, for model interoperability reasons. As non-exhaust emissions of fine particulate matter are not included, the results likely underestimate actual PM2.5 levels, particularly in high-electrification scenarios where exhaust emissions decrease significantly but non-exhaust emissions persist or increase. Figure 13 represents its evolution across scenarios and levels of national income along with other relevant local pollutants (BC: Black Carbon, NH3: ammonia, NOx: nitric oxide, SO2: sulphur dioxide, and VOC: volatile organic compounds). Pollutants are significantly decreasing in high-income countries for both scenarios, and under the HA scenario for middle-income countries. However, despite decreasing for both CA and HA scenarios, they remain significantly above 2019 levels for PM2.5. This much less-efficient result for lower-income countries comes from the use of second-hand vehicles with high-emission levels for public transport and the lower technological improvement rate for vehicles. Even a shift towards public transport is not enough to tackle the local pollutant issue. China, on the other hand, is expected to experience a strong decrease in local pollutant emissions given its strong public transport infrastructure development and national vehicle electrification strategy.

Figure 13. Evolution of local pollutant emissions between countries of differing income to 2050



Source: (ITF, 2023c)

Health benefits of sustainable urban mobility systems

When converting transport indicators into health ones, the most meaningful is the number of years of life saved due to the High Ambition scenario, compared to those years for the Current Ambition. According to Figure 14, it is estimated that about 13 trillion life years could be saved in the urban areas of the study countries over the 2022 to 2050 period. The highest positive effect is expected in China, Europe and UCAN

+ JK where the urban air quality is expected to strongly increase. It is worth noting that these results likely underestimate the total years of life saved, as the model only accounts for changes in passenger transport and does not include the potential additional health benefits from reduced freight transport emissions. When considering Disability-Adjusted Life Years (DALYs), where life years are discounted when an individual suffers from a chronic disease, the impact is even stronger with 21.5 trillion DALYs saved. This value, higher than the years of life, means that the High Ambition scenario increases the overall number of years of life, but it also reduces the number of years of life lived with a chronic disease.

Figure 14. Life years saved by the High Ambition scenario

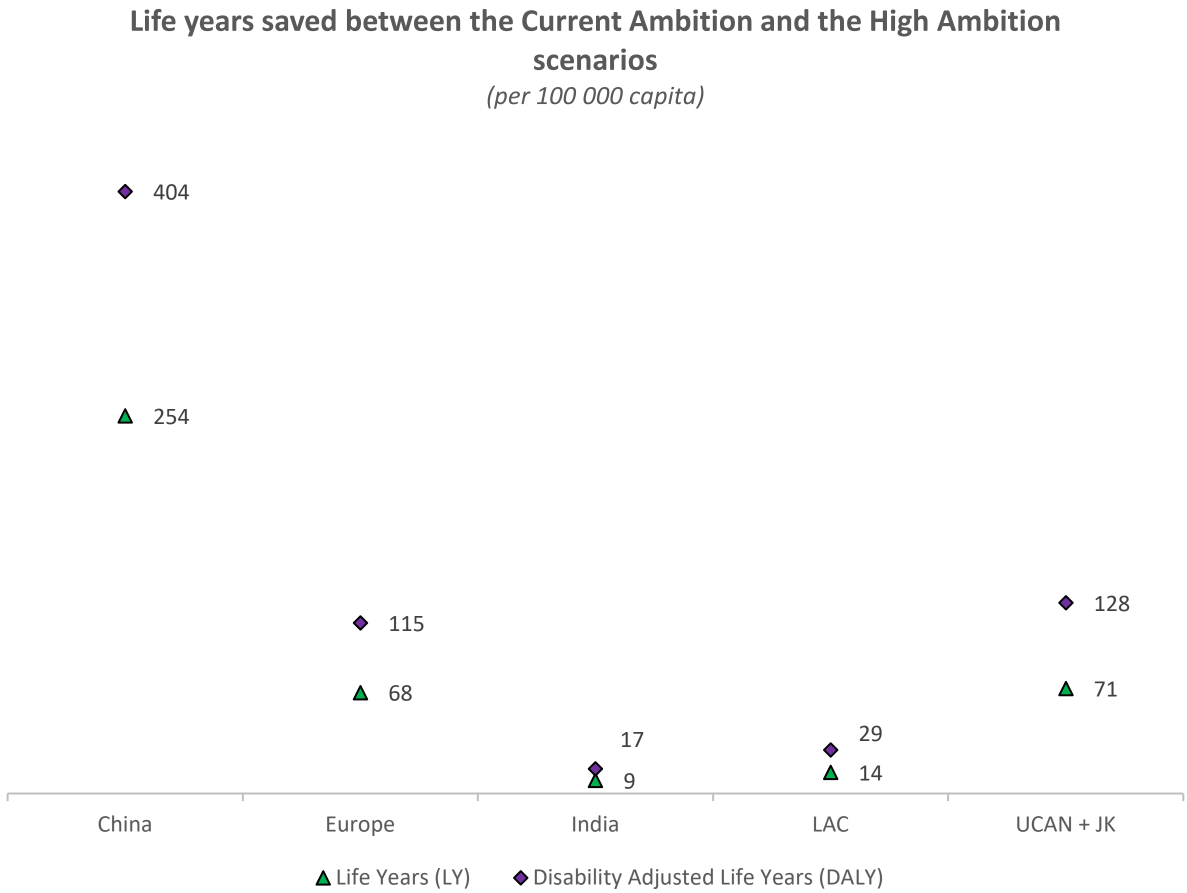
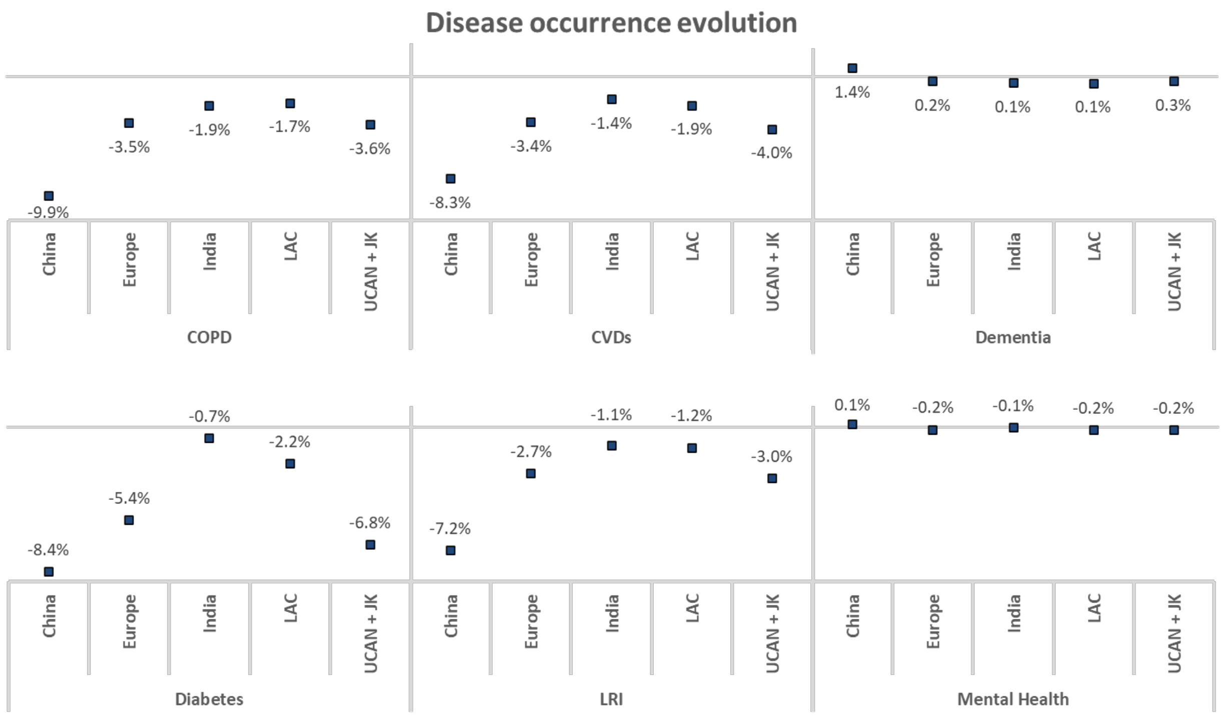


Figure 15 shows that the impact of the High Ambition scenario is stronger for reducing the occurrence of diabetes, respiratory and cardio-vascular diseases. The occurrence of these illnesses can be reduced by 10%. Noncommunicable diseases (NCD) account for 74% of global deaths, with 77% occurring in low- and middle-income countries, where cardiovascular diseases, chronic respiratory illnesses, and cancers are most prevalent (WHO, 2023c). Premature NCD deaths are particularly severe in these regions, making targeted transport and environmental interventions potentially transformative. For instance, improving air quality and promoting active mobility can significantly reduce cardiovascular and respiratory risks, contributing to global efforts to combat NCDs while addressing inequalities. This dual benefit highlights the importance of prioritising equitable urban transport planning, addresses regional challenges but also maximises health outcomes where they are needed most.

Improvements, albeit lower levels are observed for mental health as physical activity increases, with a diminution of occurrence of 0.1-0.2%. For dementia, it is worth observing that it follows an opposite trend as its occurrence increases up to 1-2%. This comes from the longer life expectancy enabled by the increase in years of life, which increases the older population subject to dementia.

Figure 15. Evolution of non-communicable disease occurrence to 2050



Index: COPD: Chronic Obstructive Pulmonary Disease; CVD: Cardio-Vascular Disease; LRI: Low Respiratory tract Infection

A future limited by our ambition, not by financial capacities

Improvements in health and overall well-being are anticipated to drive a long-term shift in health-care expenditure and workforce productivity. Primarily, direct health benefits influence life expectancy, the prevalence of chronic diseases, and the age at which these conditions emerge. Depending on how this distribution evolves, it could lead to a prevalence of either more or less expensive diseases for public health systems. However, Figure 15 shows a broad decline in costly diseases for society, with only a marginal increase in those not particularly expensive. Therefore, a positive impact leading to savings in health-care expenditure is expected. For this project, we have defined health expenditure as the final consumption of health care goods and services including personal health care and collective services.

Improvements in well-being enhance physical capacity, resilience to stress, and reduce the likelihood of various diseases, in turn boosting motivation. These factors influence productivity in terms of Full-Time Equivalent (FTE) availability of workers, absenteeism (i.e. missing workdays), presenteeism (i.e. being at work with reduced productivity), and early retirement.

Figure 16. Yearly public health spendings avoided with a High Ambition scenario

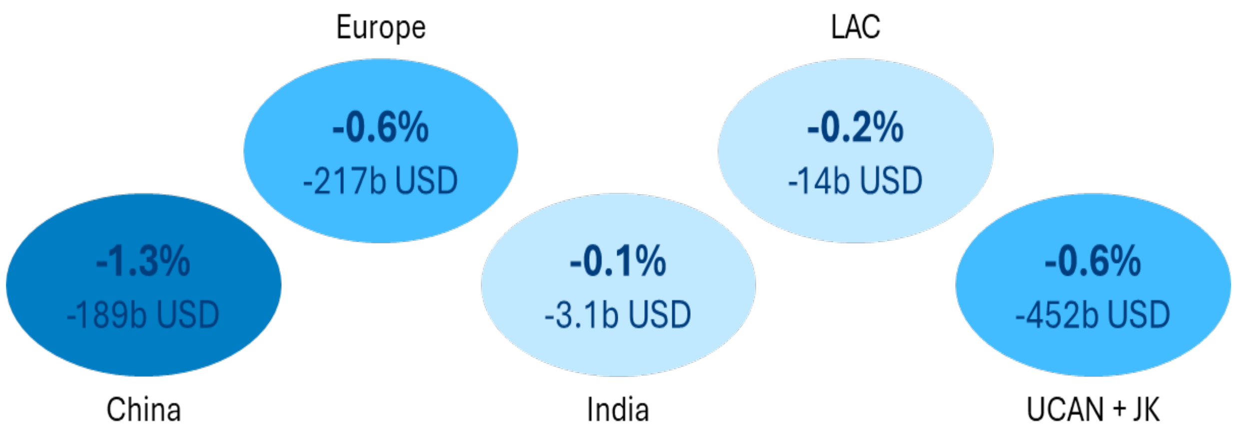
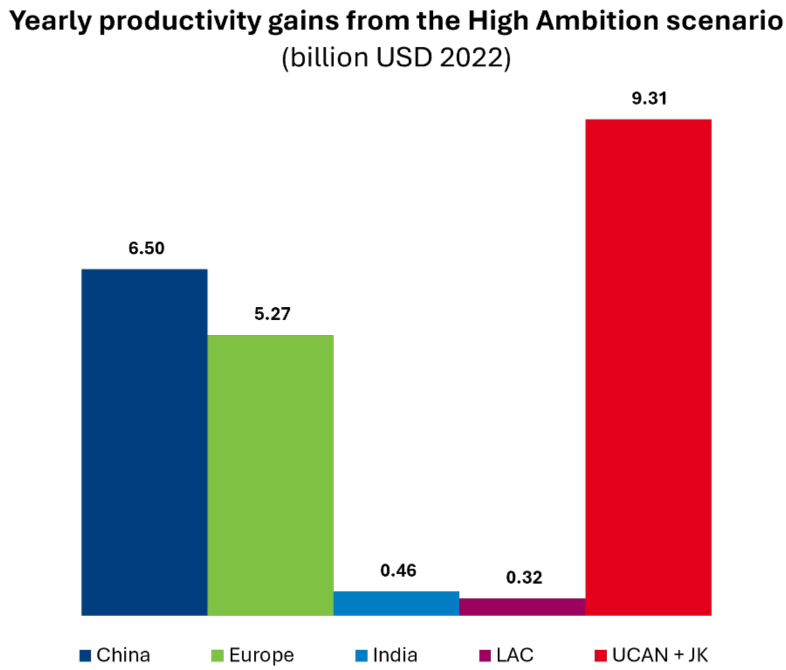


Figure 16 presents the estimated evolution of health-care expenditures. In total, about USD 875 billion could be saved annually in the study regions, with the largest savings expected in regions where health improvements are most pronounced. At the national level, these savings are estimated to be between 0.1% and 2.0% of public health spending under the Current Ambition scenario. This outcome is particularly positive, considering that health benefits are not the primary aim of the sustainable urban transport policies tested in the model. However, it is important to note that baseline physical activity levels vary significantly across regions, which can influence the extent of health improvements observed. Regions with lower initial physical activity levels may see greater gains, while those with higher baseline activity levels may experience more modest improvements. These variations could also indirectly affect the prevalence of diseases linked to physical inactivity, amplifying or moderating the health benefits across different contexts.

Figure 17 shows the estimated outcomes when focusing on productivity impacts. Overall, health improvements lead to a significant increase in workforce availability, with an additional 860 000 FTE years projected. Approximately 75% of this increase comes from higher employment, with the remainder almost equally split between reductions in absenteeism and presenteeism. Changes in early retirement remain relatively marginal. Converting this added workforce capacity into economic value, the projected yearly gains amount to USD 22 billion. While this figure is smaller than the expected savings in public health spending, it underscores the additional benefits of sustainable and health-focused transport measures.

Figure 17. Yearly annual Full Time Equivalent and productivity gains from the High Ambition scenario to 2050



	FTE Employment	Absenteeism	Presenteeism	Early Retirement	Total
China	335 779	53 206	56 155	-7 514	**437 625**
Europe	100 773	11 091	15 680	2 801	**130 346**
India	59 567	23 738	17 625	-1 006	**99 924**
LAC	29 218	6 120	6 506	1 565	**43 410**
UCAN + JK	116 533	12 380	17 026	3 720	**149 658**
Total	**641 870**	**106 535**	**112 991**	**-433**	**860 962**

Building on the previous investment analysis from the ITF Transport Outlook 2023, the High Ambition scenario was shown to result in lower overall transport expenses for the sector. This may be less true at the urban level, where significant investments in public transport are anticipated. However, the health benefits identified in this analysis significantly compensate for these investment costs. Since health expenditures are typically two to three times greater than transport expenditures, the savings observed are likely to fully cover the increased costs of urban passenger transport, even without accounting for productivity gains. Consequently, the argument that financing such measures is overly expensive no longer holds, as investments in sustainable transport policies also have the potential to boost GDP.

The findings of this analysis underscore the substantial health, economic, and environmental benefits that can be realised through the adoption of ambitious low-carbon mobility scenarios in cities. By integrating transport and health models, a more comprehensive view of the impacts of urban mobility policies emerges, illustrating that these initiatives reduce emissions but also improve public health outcomes, increase life expectancy, and reduce the prevalence of chronic diseases. The High Ambition scenario demonstrates that co-ordinated efforts towards sustainable urban transport can lead to significant savings in health-care costs, productivity gains, and reduced health-care expenditures, ultimately contributing to a more resilient and economically viable future. These results reinforce the argument that ambitious investment in sustainable transport infrastructure is not only feasible but essential for long-term societal well-being.

Towards a healthy low-carbon future

As cities grow, promoting healthier and more sustainable urban environments becomes increasingly challenging. This chapter outlines the primary challenges, such as financial barriers, fragmented urban governance, political resistance, and the balance between decarbonisation and well-being. It also offers solutions and strategies, focusing on cross-sectoral collaboration, citizen engagement, and context-specific policies that account for socio-economic inequalities. These approaches aim to create a more equitable, sustainable, and healthier urban future for all.

Addressing financial barriers to healthier urban environments

Financing healthier urban environments remains a significant challenge to policymakers globally. Although policies promoting active transport and urban health could result in long-term savings, such as reduced health-care costs, the short-term financial benefits are not always apparent to policymakers. Often, there is hesitance to implement health-prioritising policies because the return on investment is not immediately visible, with urban authorities viewing health investments as a potential financial loss (Brown et al., 2019). The WHO estimates that from 2020 to 2030, physical inactivity could lead to costs of about USD 300 billion (USD 27 billion annually) for global public health-care systems if the trend of rising sedentary behaviour persists (WHO, 2024).

To overcome these financial barriers, focus must be on the long-term savings that health-centred policies can provide. Encouraging active transport and physical activity through urban design can mitigate the rising health-care costs associated with physical inactivity. Policymakers should integrate a concept equivalent to the economic rational of the "value of time", which assigns a monetary value to time saved, to assess how reducing health risks can lead to both economic and societal benefits. This means recognising that investing in health improvements can save lives, reduce health-care costs, and improve productivity, ultimately benefiting society as-a-whole. Engaging with experts across sectors to provide evidence-based analyses can help demonstrate the potential financial gains of healthier urban environments.

Breaking down silos for collaborative urban health solutions

Urban planning, transport, public health, and environment departments often operate in silos, leading to inefficiencies in creating integrated health-focused urban policies. The lack of co-operation both within and across various levels of governance (municipal, urban, and national) complicates decision-making (Nieuwenhuijsen, 2016). In major cities with several local governments, transport is often managed by multiple agencies, each with different priorities, further fragmenting efforts to implement cohesive urban strategies (Pojani and Stead, 2015). This translates into budget allocations typically dispersed across administrations, complicating the financing of urban transformation initiatives that require collaboration across multiple sectors to implement well-considered decisions and operations (Nieuwenhuijsen, 2016; Khreis, May and Nieuwenhuijsen, 2017).

One innovative way to achieve a more co-ordinated, health-focused strategy across sectors is to establish a Healthy City Manager position within urban municipalities. This role would be responsible for reviewing and defining strategic actions and policies, evaluating their health impact to ensure that the well-being of citizens is prioritised and improved upon (Lenzi et al., 2020).

Collaboration across disciplines and sectors is essential for understanding and addressing complex challenges that transcend different fields such as the environment, finance, sociology, medicine, urban planning, and transport. Working across sectors and disciplines can help to address complex health issues and promote interventions that support both population health and equity (Ramirez-Rubio et al., 2019; Zumelzu and Herrmann-Lunecke, 2021). In Quebec, Canada, intersectoral collaboration approaches were developed through the creation of working groups and steering committees involving cross-sectoral authorities at different scales (health, urban planning, education, economics, and others). Similarly, the Transport, Health and Environment Pan-European Programme (THE PEP), established by UNECE and WHO, provides a platform for countries to collaborate on linking transport, health, and environmental goals (UNECE, n.d.). It promotes active mobility, clean transport, and urban design that improves public health while addressing climate and air pollution challenges. These collaborations aim to integrate health considerations into most policies, to better understand and address the risks associated with chronic diseases and diabetes (Gamache et al., 2020; Lamanna et al., 2020). In addition to these collaborations, a mechanism for sharing the benefits of a policy across different administrative levels and different sectors would be key.

In traditional settings, cities lack incentives to adopt transport policies that may be unpopular with the public, especially if the financial benefits ultimately go to the health ministry. Having every stakeholder collaborate is a good step forward, yet it is not enough. Co-financing mechanisms must be set up to ensure that all actors are compensated and incentivised for implementing healthier low-carbon policies.

Ensuring the implementation of long-term urban health policies

Local administration plays a crucial role in shaping the city toward more sustainable paradigms (Tokay Argan, 2016). However, the frequent changes in political administrations can disrupt long-term health-focused initiatives, leading to inconsistent policy. Politicians often focus on short-term, visible gains due to electoral cycles, which hinders the long-term commitment necessary for impactful health and environmental reforms (Hudson et al., 2019).

Furthermore, enforcing regulations that improve health and air quality, such as car-restricted zones, requires strong political backing. Without consistent political and institutional support, such measures may not be effectively implemented, reducing their potential impact (Parajuli and Pojani, 2018).

Depoliticising issues like health and transportation could help align urban policies with long-term sustainability goals, though this is difficult in practice due to the changing visions of political parties. Transparent communication about the objectives and benefits of these initiatives can help build public support. Establishing dedicated non-elected positions in the administration or cross-party urban health boards could also provide continuity and political accountability, ensuring that urban health remains a priority across different administrations.

Raising public awareness and engagement for healthier urban policies

Public resistance to urban health initiatives can slow the implementation of critical policies, particularly when these policies disrupt daily routines or are perceived as inconvenient. For example, pedestrianisation or the addition of bike lanes can be met with resistance from car users who may feel their convenience is being sacrificed (Gössling et al., 2024; Ohlund et al., 2022; Parajuli and Pojani, 2018). Limited awareness about the long-term benefits of these changes often fuels this resistance. Without adequate public support, even well-designed policies risk failure or significant delays (Nieuwenhuijsen, 2021).

Public awareness campaigns are essential to build support for transformative urban health policies. Decision makers should prioritise transparent communication, explaining how these initiatives improve well-being and the environment in the long term. Platforms that engage citizens, such as public consultations and feedback forums, can create a sense of ownership and encourage more positive reception to changes (Latif, Rashid and Nasir, 2023). Media campaigns highlighting tangible benefits, such as improved air quality and reduced traffic congestion, can also help to shift public perception. Engaging local communities through participatory processes ensures that public concerns are addressed, and policies are tailored to meet diverse needs (WHO, 2023b).

Navigating trade-offs between decarbonisation and well-being

Balancing efforts to reduce carbon emissions with the aim of improving overall well-being can present difficult trade-offs. For instance, increasing green areas can reduce pollution and improve health, but it may also lead to rising property values, disadvantaging lower-income individuals (Moreno et al., 2024). Similarly, implementing car usage taxes (e.g. parking charges, geofencing) can reduce traffic and improve environmental conditions. However, it might increase inequalities, as higher-income individuals may be less affected and thus not change their car usage, which compromises the fairness of collective efforts to reduce pollution, and disadvantage lower-income individuals. Such policies, if designed inclusively, can foster safer streets with reduced congestion and noise levels, enhancing urban liveability and the overall quality of life. Some measures such as restricting car usage can also bring inconveniences to travel if public transport is inadequate and unreliable, reducing access to urban amenities.

To minimise the negative externalities of decarbonisation policies, governments must develop comprehensive strategies that consider both environmental and socio-economic factors. For example, controlling housing prices in areas where green spaces are being introduced can prevent the displacement of lower-income residents. Similarly, income-based car usage taxes could ensure that all individuals contribute fairly to pollution reduction efforts (World Economic Forum, 2018). Improving access to safe, efficient, and inclusive public transport can enhance mobility while reducing the stress and fatigue often associated with inefficient travel options, thereby supporting better mental and physical health outcomes. By addressing potential conflicts in advance and continuously evaluating the effects of policies, cities can create more inclusive and equitable solutions that improve both health and well-being (Moreno et al., 2024).

Adopting context-specific approaches

The priorities of urban administrators vary significantly depending on the context, making the replication of best practices challenging due to the unique conditions and dynamics of each city or urban region (Pojani and Stead, 2015). In low- and middle-income countries, priorities typically centre on development goals such as poverty reduction and economic growth, often driven by limited funding that necessitates a focus on the most urgent issues. Conversely, high-income countries tend to prioritise policies emphasising co-benefits, such as environmental sustainability and public health (Stahlke, 2023).

Rapid and uncontrolled urban development characterises low- and middle-income countries, leading to significant environmental and sociocultural changes (Cheshmehzangi and Butters, 2022). This rapid growth frequently increases volumes of motorised vehicles exceeding urban infrastructure capacities and contributing to major traffic congestion (Khreis, May and Nieuwenhuijsen, 2017; Ramirez-Rubio et al., 2019). In many contexts, owning a private car is perceived as a symbol of socio-economic status associated with comfort and freedom, while walking and cycling are often stigmatised as indicators of poverty (Cheshmehzangi and Butters, 2022; Pojani and Stead, 2015). Consequently, urban and transport planning in these rapidly growing cities often prioritises car-centric norms, neglecting non-motorised infrastructure and marginalising less mobile and vulnerable groups, including women and low-income individuals (Gil Solá and Vilhelmson, 2022; Pojani and Stead, 2015).

In many sub-Saharan African cities, essential pedestrian infrastructure like streetlighting and well-maintained paths and bridges is often lacking, even though walking accounts for 50% to 90% of daily trips. Policymakers tend to prioritise roads for motor vehicles, leading to unsafe conditions and unpleasant walking experiences (Benton et al., 2023; Okyere et al., 2023; Oviedo et al., 2024). In car-centric cities, transport-related externalities such as air pollution, congestion, accidents, noise, and the heat island effect raise health risks, including increased morbidity. More and more urban residents face health problems linked to sedentary lifestyles, partly due to excessive private vehicle use (Abusaada and Elshater, 2024).

Despite limited financial resources, cities in low- and middle-income countries can implement cost-effective policies to raise public awareness, shift mobility paradigms, and increase green spaces. These measures can enhance residents' well-being and health while reducing long-term health-care costs (Pojani and Stead, 2015; Brown et al., 2019). Specific actions may include:

- Awareness campaigns: Developing public campaigns that promote the health benefits of active transport modes like walking and cycling.
- Infrastructure investment: Prioritising the development of non-motorised infrastructure, such as pedestrian paths and cycling lanes, to create safe and accessible environments for all residents.
- Green space development: Increasing green spaces in urban areas to provide recreational opportunities and improve mental health, while also enhancing urban biodiversity.
- Policy reform: Encouraging policymakers to shift from car-centric planning to a more balanced approach that includes all forms of mobility, ensuring equitable access for vulnerable populations.

Promoting equity in health and mobility

Guiding principles for city design should prioritise inclusivity, ensuring the city is planned for everyone, not just for the most visible groups. Infrastructure and urban environment must ensure the independence and security of all individuals to promote equitable access to health and well-being (Van Schalkwyk and Mindell, 2018). Experiences of urban environments vary significantly based on gender, age, socio-cultural factors, class, and disability, which influence both health and mobility outcomes. Many disadvantaged groups face mobility barriers that restrict their access to essential services, health care and social opportunities, leading to poorer health outcomes and exacerbating inequalities. Specific challenges include:

Gender

Women often encounter unique mobility challenges due to differing travel patterns and fewer available transport options compared to men. They typically rely more on public transport and walking, which may involve managing multiple short trips and additional caregiving responsibilities (Hanson, 2010; Goel et al., 2023). Women also cycle less than men, particularly in cities with low cycling rates. In cities with higher cycling rates, the gender gap narrows (Ravensbergen, Buliung and Laliberté , 2019; Kosmidis and Müller-Eie, 2024). Factors contributing to this disparity include greater safety concerns among women, discouraging cultural norms and their disproportionate responsibility for care-related tasks, which often require complex trip patterns, strict schedules, and access to safe, reliable, and inclusive transport options.

Improving urban access and health for all requires addressing such mobility barriers. Policy making should address women's specific needs to improve their mobility experience and ensure they can travel where they need to go. This includes prioritising pedestrian and safer cycling infrastructures, ensuring safety from road crashes, harassment, and any criminal risks, and increasing the reliability and functionality of public transport (Goel et al., 2023).

Age

Older adults often face limited access to mobility due to physical or psychological limitations and may experience difficulties in walking or cycling (Gorman et al., 2003). Often, public transport systems are inadequately designed to meet their needs. These mobility limitations and the lack of accessibility can lead to social isolation and associated health risks (Matsuda et al., 2019). However, it is important to recognise that prolonging physical activity among older adults provides significant health maintenance benefits, such as improved cardiovascular health, reduced risk of chronic diseases, and better mental well-being. These benefits often outweigh the potential risks of falls or crashes leading to traumatic injuries among pedestrians and cyclists, highlighting the importance of designing safe infrastructure to support active mobility.

Similarly, young children and parents also have a much-reduced access to the mobility system. Parents managing childcare responsibilities may struggle with unreliable or inaccessible public transport, while children are more dependent on safe walking and cycling environments. Understanding the mobility barriers faced by each age group is fundamental for developing policies that address their specific needs and promote equitable health outcomes.

Income and employment

Income and employment disparities significantly influence urban living conditions, shaping access to resources, opportunities, and health outcomes. Urban form can contribute to social and economic inequalities, leading to health inequalities (Smit et al., 2011). Lower income earners often live in areas with limited public transport access, leading to long commutes and exposure to higher levels of air pollution. Urban policies that prioritise city centres can exacerbate these inequalities, leaving peripheral areas underserved (Prior Filipe et al., 2024; Tobollik et al., 2016). Additionally, they are often exposed to higher levels of traffic-related air pollution as their housing is frequently located near motorways, airports, or far from recreational and green areas (de Vries et al., 2003; Van Schalkwyk and Mindell, 2018; Martens, 2020). Lower income earners may rely more on walking, cycling, and public transport due to the higher cost of owning a car or a motorbike. In car-centric environments, they tend to be more vulnerable to traffic-related injuries and fatalities (Martens, 2020).

Mobility constraint and disability

Persons with disabilities encounter significant challenges in accessing mobility on a global scale (Gorman et al., 2003). With limited mobility options, their reliance on others increases which reduces their social and physical autonomy, affecting their well-being (Alauzet, 2017; Van Schalkwyk and Mindell, 2018).

To create more inclusive and accessible cities for all groups mentioned here, policymakers should implement strategies that address these barriers:

- Diverse hiring practices: Employing a diverse range of professionals in urban planning can ensure a broader spectrum of personal experiences is considered in the design of city infrastructures.
- Data collection: Conducting quantitative surveys and qualitative interviews to gather data on mobility access and pollution exposure across socio-economic groups can help to identify barriers and prioritise areas for transport improvements (Gorman et al., 2003).

- **Targeted interventions:** Developing specific policies addressing the mobility needs of different groups, such as safer pedestrian infrastructure for women and better public transport access for older adults.
- **Equitable infrastructure distribution:** Ensuring the equitable distribution of active mobility and public transport infrastructure throughout the city, including peripheral areas, can enhance opportunities for lower-income individuals. Additionally, improving living conditions in economically disadvantaged areas by better controlling pollution and increasing green spaces can support overall health and well-being.

This chapter has explored the challenges and solutions necessary for fostering a low-carbon future that enhances urban well-being. By integrating financial, collaborative, political, and social strategies, policymakers can create healthier urban environments that serve all residents. A commitment to inclusive, long-term planning will be crucial in achieving the dual goals of sustainability and health for all.

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Annex A. Composition of the ITF policy scenarios

This table outlines the policy pathway assumed under the Current and High Ambition scenarios over the next three decades till 2050, as used for this project and in the ITF Transport Outlook 2023.

Measures feeding into ambition scenarios	Current Ambition target – 2050	Higher Ambition target – 2050
Economic instruments These include road pricing and parking pricing are gradually set up or enhanced worldwide.	When implemented, road pricing can increase non-energy-related car-use costs by up to 5%. Meanwhile, parking prices are expected to increase further, by up to 40%.	Road pricing increases non-energy-related car-use costs by 1.8%-18%, while parking prices increase by 13%-100%.
Infrastructure enhancement Transport infrastructure enhancements, including the expansion of bicycle and pedestrian networks, the development and expansion of public transport systems, and express lanes for buses, are set up or enhanced worldwide.	Bicycle and pedestrian infrastructure networks increase by 13%-200%, while public transport systems expand by up to 67%. Meanwhile, express or priority lanes comprise up to 27% of bus networks and public transport fares decrease by 1%-5%, due to integrated ticketing.	Bike and pedestrian infrastructure networks increase by 26%-334%, while public transport systems expand by up to 134%. Meanwhile, 6%-40% of the bus networks are prioritised and public transport fares decrease by 1%-8.4%, due to integrated ticketing.
Service improvements Transport service improvements, including public transport service optimisation, shared-mobility incentives, carpooling policies and support for Mobility as a Service (MaaS) systems, are set up or enhanced worldwide.	Public transport service levels change by between -7% and 20%. The number of shared vehicles per capita is boosted by 0%-134%. The average private vehicle occupancy rate grows by 2.3%-5.6%. Meanwhile, MaaS systems decrease fares for public transport and shared mobility by 0.6%-6.7%.	Public transport service levels increase by between 6% and 34%. The number of shared vehicles per capita is boosted by 3%-200%. The average private vehicle occupancy rate grows by 5.1%-11.2%. Meanwhile, MaaS systems decrease fares for public transport and shared mobility by 1.3%-13.4%.
Regulatory measures An extensive set of regulatory measures, including speed limitations, parking restrictions, and urban vehicle-restriction schemes, are gradually enforced more strongly.	Speed limits decrease by 1.3%-20%. Between 3.3% and 34% of urban surface areas are subject to parking constraints. Car ownership decreases by 11.7%	Speed limits decrease by 3.3%-33.4%. Between 4.6% and 50% of urban surface areas are subject to parking constraints. Car ownership decreases by between 2.3% and 16.7%.
Other Additional measures, including land-use policies, transit-oriented development (TOD) and teleworking-promotion policies, are gradually improved.	The average population density ranges between -6.7% and 13.4%. There is a 3.3% increase in the land-use mix. Exogenous changes such as teleworking are maintained after the pandemic. Between 1.6% and 13.4% of the active population teleworks regularly.	The average population density increases by up to 26.7%. There is a 5% increase in the land-use mix. Between 2.3% and 20% of the active population teleworks regularly.

Annex B. Selected global models interlinking urban mobility and health

Below are some key models, presented in three distinct groups based on their focus. The list is not exhaustive, adding to the fact that some of these tools were adjusted over the years or were adapted for other focuses. Except for the UKIAM model, which is specific to the United Kingdom, the other tools have global application.

Integrated transport, health, and environmental modelling

These models combine transport and health assessments, often integrating environmental factors like air pollution.

Model name	Key features	Main model inputs	Main model outcomes
Health Impact Assessment (HIA)	Combines mixed methods to identify and quantify a policy or intervention's health impacts and distribution and analyses the link between health and inequalities.	Census data, death and disease registries, population surveys and interviews, environment data, traffic safety, community violence, access to parks, etc.	Varies by data types: qualitative datasets lead to more ethnographic results, while quantitative datasets tend to produce more epidemiologic results. HIA outcomes identify health effects, assess risks and analyse health equity.
Health Economic Assessment Tool (HEAT)	Quantitatively translates the benefits of cycling and walking into economical assessments using comparative risk assessment methodologies.	Datasets on demographics, physical activities, transport modes (e.g. volume of walking and cycling), health (e.g. mortality, traffic crash rates), economics, air pollution, etc.	Economical evaluation of how active mobility affects health and carbon emissions.
Integrated Transport and Health Impact Modelling Tool (ITHIM)	Quantifies health impacts of transport strategies using microsimulation to assess changes in pollution-related illnesses and traffic injuries.	Requires five + users, city-specific data (travel, injuries, demography, activity), and global files for health outcomes, pollution, and physical activity.	Estimates health impacts by comparing travel patterns and modelling intervention effects, including physical activity, traffic injuries, air pollution, CO_2 emissions, and health outcomes.
Integrated Sustainable Transport Health Assessment Tool (iSThAT)	Evaluates health and economic benefits of carbon reduction in urban transportation.	Country- and city-specific data (pollution, economic, epidemiological, fuel emissions, etc.)	Provides annual trends from 2015 to 2050 and calculates health risks using impact pathway analysis, tracking pollutants from release to health impact within different scenarios.

Sources:
HIA: Human Impact Partners (2011).
HEAT: WHO (2017): University of Cambridge (n.d.).
ISThAT: WHO (n.d.).

Air pollution exposure and health impact modelling

These models focus specifically on air pollution and its direct effects on public health.

Model name	Key features	Main model inputs	Main model outcomes
UK Integrated Assessment Model (UKIAM)	Represents current and future emission scenarios, evaluates abatement effectiveness, and assesses health benefits from reduced air pollution.	Traffic flows and emissions from multiple sources (road transport, etc.).	Evaluates the effectiveness of abatement measures in reducing air pollution exposure and health impacts.
Environmental Impact Assessment (EIA), and Strategic Environmental Assessment (SEA)	Structured methods for gathering and evaluating environmental information before making policy decisions.	Historical environmental data (e.g. air quality, noise levels, biodiversity, etc.), legal and policy frameworks, and stakeholder surveys, etc.	EIA predicts environmental changes from specific projects like highways or power stations and provides management advice. SEA assesses impacts of broader policies, laws, and plans. Both include evaluations of social, economic, health, and environmental impacts.

Sources:
UKIAM: Imperial College London (n.d.).
EIA and SEA: UNEP (2004).

Health-specific risk and economic evaluation models

These models assess health risks and economic implications without direct transport or environmental components.

Model name	Key features	Main model inputs	Main model outcomes
Comparative Risk Assessment (CRA)	Evaluates how exposure to risk factors affects health using a causal comparison approach.	Death and disease registries, risk factor data, demographic information, etc.	This approach enables multi-causal health outcomes, recognising that morbidity and mortality result from multiple risk factors.
OECD's Strategic Public Health Planning for NCDs (SPHeP-NCD) model	Simulates health outcomes and assesses the economic impacts of policies.	Demographic characteristics, risk factor profiles, disease epidemiology, health expenditure, and labour market characteristics.	The burden of behavioural risk factors and chronic diseases on population health and economy. Assesses potential impacts of public health options.
The Value of a Statistic Life (VSL)	Provides an evaluation of the economic value of preventing negative chemical-related health outcomes.	Demographic data (age, gender, income level), mortality risk, economic data (wages and compensation for jobs, expenditure data), health data (general health conditions, risks factors), survey data, etc.	Estimations of the economic value of reducing death risk, the efficiency of interventions, and the willingness to pay for small reductions in mortality risk.

Sources:
CRA: Kjellstrom et al. (2003).
SPHeP-NCDs: OECD (n.d.).
VSL: World Bank (2010).

Annex C. List of Workshop participants

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Health Impacts of Low-carbon Transport in Cities

Evidence for Better Policies

Urban transport is a major contributor to air pollution, greenhouse gas emissions, and associated health risks. It can disproportionately affect vulnerable groups while driving up healthcare costs. Addressing these challenges is crucial to creating liveable, equitable and sustainable cities.

Ambitious low-carbon transport measures can drastically cut emissions, save trillions of life years, and slash healthcare costs by hundreds of billions annually. Yet health is rarely considered as part of transport policy making.

This report promotes a transition to low-carbon mobility that prioritises environmental goals and human well-being. By evaluating low-carbon policy scenarios, the report offers evidence-based recommendations for policy makers to integrate health into transport and urban planning. It features insights to invest in active and public transport infrastructure, and equity-centred approaches to urban development. It is a roadmap for creating sustainable cities that are healthier, safer, and more inclusive.

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