



RESEARCH NOTE – IMPROVING HEALTH THROUGH URBAN DESIGN

NOVO NORDISK FOUNDATION

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1. EXECUTIVE SUMMARY

Urbanisation presents both significant opportunities and risks for public health, making careful urban planning crucial. Well-designed cities can promote physical, mental, and social well-being, but urban growth can also introduce serious health risks. Urban planning can, in this respect, have a profound influence on various dimensions of health, including facilitating physical activity, promoting improved well-being or increasing social interactions.

This research note investigates the available evidence on how and if built environment interventions in urban areas can have an impact on public health. The review reveals an uneven research landscape where certain urban design elements receive considerable attention while others remain understudied. The same holds true for the health outcomes investigated. Most studies focus on physical activity levels, while neglecting broader cardiometabolic health impacts such as effects on heart disease, diabetes, and obesity. Far less emphasis is also placed on mental and social well-being outcomes.

Adding to this complexity, researchers measure health outcomes in many ways — from self-reports to clinical measurements—making meaningful comparisons difficult. In addition, the evidence reviewed for this report is overall of moderate quality. This indicates a range of challenges that affect the reliability and generalisability of findings. Despite these limitations, experts agree the field holds large potential.

As the understanding of urban design-health connections grows, so does the opportunity to develop more effective approaches that will transform public health at scale. Strategic investment can accelerate this field toward broad evidence-based solutions with measurable population health impacts.

The review identifies several potential intervention areas where evidence on the relationship between built environment interventions and health outcomes is currently clustered:

- **Active transportation infrastructure**
 - Cycling and walking infrastructure investments generally promote physical activity
 - Implementation of tools to assess how friendly an area is for walking are highlighted in grey literature as a potential way to increase evidence-based urban planning decisions.
- **Strategic green and blue space development**
 - Green and blue spaces (parks, forests, waterfronts etc.) promote physical activity and social well-being
 - Increasing biodiversity and accessibility to natural spaces is highlighted in grey literature as an area of large promise to improve both physical and mental health outcomes.
- **Urban food environment transformation**
 - Proximity to healthy food outlets, such as supermarkets and grocery stores, show promise to positively impact children's dietary intake and BMI
 - Addressing over-availability of unhealthy food options provides substantial opportunity for intervention
 - Adult nutrition outcomes require more targeted strategies beyond simple proximity solutions
- **Comprehensive urban regeneration**
 - Urban regeneration means fixing up run-down neighbourhoods. This can for example involve improving buildings, creating new parks and playgrounds, adding bike lanes, opening community centres or bringing in new businesses and services. When cities combine better housing with environmental improvements research shows this can support people to be more physically active and improve their perceived mental health.

Several critical research gaps should be addressed to improve the overall impact of the field:

- **Expand beyond physical activity**
 - Current evidence heavily focuses on physical activity while neglecting broader cardiometabolic health impacts (effects on heart disease, diabetes, and obesity)
 - Mental and social well-being effects remain underexplored despite their importance to overall health
- **Understand health equity implications**
 - Limited research examines how urban interventions affect different age groups, genders, and vulnerable populations
 - Emerging tools for measuring impact across diverse communities need validation
- **Capture climate-health connections**
 - Urban climate adaptation measures (e.g. reduction of pollution, handling of flooding risks) are developing rapidly and can potentially offer substantial health co-benefits. They require systematic evaluation
 - Green infrastructure can simultaneously address climate resilience and health outcomes – it is therefore a fruitful area for further research and evidence generation

ACTION RECOMMENDATIONS

In this emergent field with large potential for future impact there are many potential options for supporting the development of more effective approaches. Regardless of the approach, experts highlight several underlying principles that should drive action for the future.

1. **Prioritize systemic approaches** - Single interventions must work within complex urban systems (the interconnected networks of transportation, housing, services, and social factors that make up cities); integrated strategies yield greater impact than isolated efforts.
2. **Strengthen data-driven decision tools** – Leverage and strengthen data infrastructure to measure, consistently monitor and report on policy and spatial indicators for healthy cities and neighbourhoods.
3. **Develop robust implementation science** - Address critical knowledge gaps in governance structures, financing mechanisms, and implementation barriers (the study of how to effectively put research findings into practice).
4. **Bridge research and practice** - Support practical tools like planning checklists and innovative financing mechanisms that translate evidence into action.
5. **Target under-researched areas** - Direct resources toward promising but under-examined domains as detailed in the research gaps described above.

2. SUMMARY REPORT

As cities grow, choices made about their design can potentially have a direct impact on public health. Thoughtfully planned urban environments can encourage physical activity, reduce stress, and foster social connection. Poorly designed ones can do the opposite. This research note distils current evidence on how built environment interventions influence health¹, identifies key knowledge gaps, and points toward future priorities for research and policy.

Drawing on a Rapid Evidence Assessment (REA), a grey literature scan, and expert input, the report explores how specific interventions — including transport systems, green and blue spaces, food environments, and neighbourhood regeneration — shape physical, mental, and social health outcomes. The goal is to inform more integrated and health-centred approaches to urban development.

This summary report highlights the key findings in the report - what is known about **what works** (for further detail see also chapter 5), indications of **where the evidence falls short** (for further detail see also chapter 4) and **emergent trends and potentials** that can contribute to future research priorities (for further detail see also chapter 6).

2.1 What works: Evidence from 29 studies

The evidence reviewed for this report is overall of moderate quality. This indicates a range of challenges that affect the reliability and generalisability of findings. Some of the limitations in the evidence include small sample sizes, indirect measures of exposure (for example, assuming that living close to a park automatically indicates that all residents use it equally), use of self-reported health outcome data and weak implementation tracking — all of which make it harder to draw firm conclusions.

2.1.1 Transport and mobility Interventions: Key findings

This section examines how transportation systems affect health, covering three types of interventions: those for vulnerable road users, public transport improvements, and multi-component approaches.

The below figure summarises the key insights in this section:



Bicycle and walking interventions, such as new or improved walkways and bicycle lanes generally promote physical activity, however, the studies did not find an effect on mental well-being.



Public transport interventions, such as new rail lines or more bus stops in proximity, show some positive impact on physical activity, but no clear impact on mental well-being in the form of fear of crime.



Multi-component mobility interventions, such as combining pedestrian/cycling pathways with public transport infrastructure or focusing on traffic calming measures, show some positive impact on physical activity, and no clear evidence on meaningfulness perception of crime or social health.

Findings for vulnerable road users

Several studies suggest that improving walking and cycling infrastructure tends to increase physical activity which can have a positive impact on health outcomes. Adding bike lanes appears to encourage more cycling, while better pedestrian infrastructure may promote more walking for both transportation

¹ The definition of health utilised in this research note aligns with WHO's overarching definition of health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.' In relation to physical well-being, we were particularly interested in health outcomes related to cardiometabolic health. Our understanding of cardiometabolic health is drawn from WHO's definitions of cardiovascular diseases and their associated risk factors. See Appendix A for further detail.

and recreation. One study found that when people move to more walkable neighbourhoods, they often become more active, with physical health benefits observed for at least three months. A walk-to-school program using electronic sensor systems with swipe cards along routes to encourage physical activity showed some success when combined with regular reminders. However, the one study that examined mental well-being found no connection between improved infrastructure and mental health outcomes.

Findings for public transport

Public transport interventions show mixed results. Some evidence indicates that increasing the number of available bus stops or train stations can increase walking activity, and there are suggestions that creating new light rail stops or lines may help reduce weight/BMI. However, the effects on overall walking and cycling activity vary considerably between studies. For mental well-being, limited evidence points to potential negative effects, with one study finding that having a public transport stop within 400 metres was associated with increased fear of crime.

Findings for multi-component mobility interventions

Results for urban greenways (paths combining cycling facilities with streetscape improvements) are inconsistent, with some studies showing increased physical activity for nearby residents while others found no significant effects. There are indications that combining approaches - such as pairing greenway interventions with promotion and marketing programmes or integrating public transport with infrastructure for vulnerable road users - may be beneficial. Some studies suggest traffic management strategies like street closures can have positive effects on children's physical activity, but there is limited evidence that improvements such as traffic-calming measures, benches, and lower curbs encourage physical activity in general.

Social well-being is less frequently used as an outcome measurement method across all three intervention types.

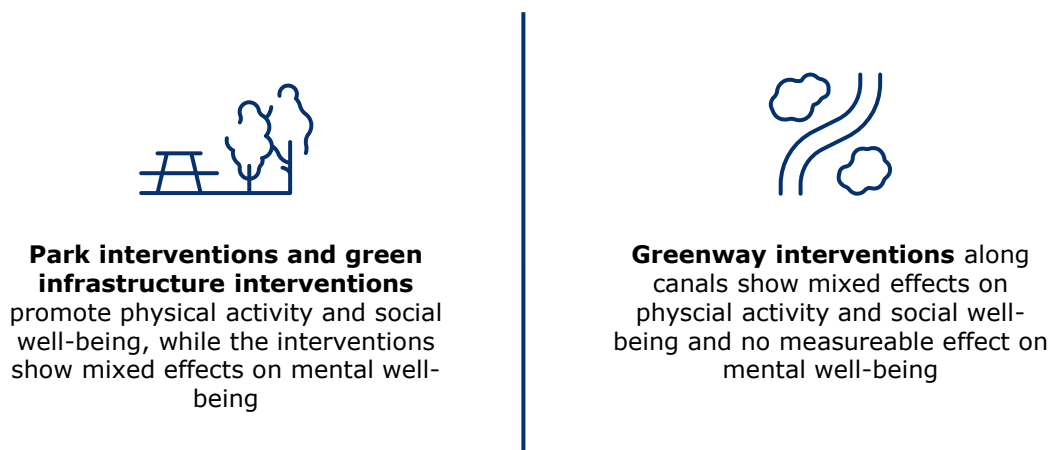
How strong is the evidence?

This section synthesises findings from 17 studies: seven primary research studies of moderately high credibility and ten secondary research studies (systematic reviews) of moderate credibility.

2.1.2 Green and blue spaces: Key findings

This section explores how green and blue space interventions in urban areas impact physical, mental, and social well-being. The research examines two main types of interventions: park interventions and green infrastructure, and greenway interventions along canals.

The below figure summarises the key insights in this section:



Findings for park interventions and green infrastructure

Several studies suggest that park interventions and green infrastructure can promote physical activity and social well-being. Improvements that add playgrounds, active equipment, or walking paths appear to increase park use in many cases. A "dual approach" that combines physical improvements with

promotional efforts such as community engagement seems particularly promising. One study found that a park co-designed by the community led to increased walking at both 3- and 15-months post-intervention compared to control sites, along with improvements in awareness of surroundings and social interactions.

Park design characteristics, such as playground availability and active transportation infrastructure, show some association with enhanced activity levels and potentially lower childhood obesity rates. However, the effects of park interventions on mental well-being are less clear, with mixed findings across studies. While some report positive associations between parkland design features and recreational walking, only limited evidence suggests improvements in mental well-being.

Findings for greenway interventions along canals

Studies examining greenway interventions along canals produced inconsistent results. One study observed increases in social interactions, environmental awareness, and walking behaviour at various follow-up points after renovating an urban canal in England. However, another study of a greenway project alongside three rivers in Northern Ireland found no evidence of increased physical activity, mental well-being, quality of life, or social capital. These contrasting findings may be partly explained by methodological limitations in both studies.

How strong is the evidence?

This section synthesises findings from 10 studies: Five primary research studies of moderately high credibility and five secondary research studies of moderate credibility

2.1.3 Food environment: Key findings

This section explores how urban food environments impact health, particularly focusing on how the availability of and access to different types of food outlets affect dietary behaviours and related health outcomes.

The below figure summarises the key insights in this section:



Findings for food environment interventions

The reviews provide limited evidence that food environments significantly impact dietary intake and BMI in adults. Studies examined interventions such as opening supermarkets, farmers' markets, and grocery stores in neighbourhoods, with one example involving the introduction of farm stands that operated a few hours weekly and sold only fruits and vegetables. Some evidence suggests that for children, greater availability and shorter distances to healthy food outlets may have a positive effect on dietary intake and BMI. Conversely, proximity to and higher availability of unhealthy food outlets appears to have a negative impact on children's health outcomes, regardless of socioeconomic status.

Mental and social well-being outcomes were largely unexamined in the food environment research, with only one low-quality study reporting on psychological well-being, making it difficult to draw conclusions about these aspects.

How strong is the evidence?

This section synthesises findings from three secondary research studies. All three studies are considered highly credible

2.1.4 Urban planning and regeneration: Key findings

This section examines how urban planning and regeneration affect physical, mental, and social well-being. Urban regeneration means fixing up run-down neighbourhoods. This can for example involve improving buildings, creating new parks and playgrounds, adding bike lanes, opening community centres or bringing in new businesses and services. The research covers three main types of interventions: large-scale multifaceted neighbourhood interventions targeting all residents, focused interventions targeting minority residents, and interventions combining greening or housing remediation with cleaning and maintenance.

The below figure summarises the key insights in this section:



Multifaceted interventions targeting *all* residents show some positive impact on physical activity (walking and cycling) and mental health, incl. perception of safety.



Focused multifaceted interventions targeting *minority* residents have a positive impact on perceived access to healthy food and neighbourhood satisfaction, but no effect on other food-related outcomes (perceived food insecurity, dietary intake, and BMI) or neighbourhood satisfaction



Greening and housing remediation combined with maintenance and cleaning show some positive impact on mental health (decreased depression and worthlessness, but no impact on perceived safety or physical activity.

Findings for multifaceted interventions targeting all residents

Evidence for these comprehensive interventions shows mixed results. One higher-credibility study found some positive effects of community design interventions on physical activity (increased walking and cycling), mental well-being (improved mental health and feeling of safety), and social well-being (enhanced sense of community). Interventions focusing on design, quality, aesthetics, and safety also showed some positive impacts on physical activity, mental and social well-being. However, two other studies reported no strong evidence of improvements in physical and mental well-being from similar large-scale interventions, although one noted an increase in positive neighbourhood perception after relocation to a newly built neighbourhood.

Findings for focused interventions targeting minority residents

Results for these targeted interventions are also mixed. One study focusing on low-income areas with minority residents found significantly positive changes in perceived access to healthy food but no effects on food insecurity, dietary intake, or BMI. Another study by the same researchers, which also focused on ethnic minority residents in a low-income neighbourhood, reported no effect on physical activity, BMI, or psychological distress. For interventions designed specifically for older adults, limited evidence suggests that changes to public spaces to enhance safety and mobility may have positive effects on walking activity, though methodological concerns affect confidence in these findings.

Findings for greening and housing remediation with cleaning

One high-credibility study found that greening vacant lots combined with regular maintenance showed positive effects on mental health, specifically lowering levels of depression and feelings of worthlessness. However, a later study found no impact on perception of safety or time spent outside when combining housing remediation with regular cleaning. Both studies reported no significant effects when implementing

only regular cleaning and maintenance interventions without the greening or housing remediation components.

How strong is the evidence?

This section synthesises findings from nine studies: seven primary research studies of moderately high credibility and two secondary research studies of moderate credibility.

2.2 Where the evidence falls short

To supplement the findings above, a mapping of knowledge gaps on how built environments impact health outcomes was carried out. By analysing keywords in 586 studies, patterns in research topics across various themes, health outcomes, and target groups were identified.

The analysis reveals that across the research landscape, certain topics are consistently overrepresented while others receive little attention. Transport, mobility and green and blue spaces dominate the literature, while issues such as pollution, sustainability and climate, food systems, and local services are comparatively neglected. Most health outcomes studied focus on physical activity, while neglecting broader cardiometabolic health impacts (effects on heart disease, diabetes, and obesity). Far less emphasis is also placed on mental and social well-being. This imbalance overlooks critical dimensions of health, including loneliness, social cohesion, and stress.

In terms of population coverage, older adults are underrepresented. About a third of studies include vulnerable populations, yet gender inequality was addressed in only one study. These findings highlight the need for more diverse and inclusive research that examines how built environment interventions affect different population groups, particularly to avoid creating one-size-fits-all solutions that might worsen existing health inequalities.

Finally, the overall methodological quality of studies remains a concern. Many are descriptive or exploratory, with few employing rigorous evaluation designs that can establish causal relationships or long-term impacts. There is a pressing need for research that can better inform policy and guide investment in built environment interventions.

2.3 Emergent trends and potentials: Key findings

This final chapter explores where the field of health-promoting urban planning is headed, drawing from grey literature and expert insights.

The below figure summarises the key insights in this section:



Tools and frameworks require validation -

numerous assessment tools, planning frameworks, and data platforms have been developed to support health-oriented urban planning, but their actual impact on decision-making and health outcomes remains largely unstudied, representing an important gap for future research.



Health co-benefits of climate adaptation

represent a particularly promising research area, as cities increasingly integrate resilience measures that may simultaneously address multiple health challenges, from heat-related illness to mental wellbeing.



Implementation research is critically needed

to understand if programs are delivered as planned. This research improves our understanding of health outcomes by revealing what people are experiencing and have been exposed to, not just what was intended. Without it, we can't truly know if or why interventions work.

Findings: Thematic intersections with built environment research themes

A central theme is the shift toward *place-making* strategies — holistic efforts that link environmental design to health, well-being, and equity. Air quality improvements through interventions like London's Ultra Low Emission Zone demonstrate how policy and regulation can reduce pollutants, though more evidence is needed on health impacts across different groups. Active transport is another priority. Cities are redesigning streets for walking and cycling, supported by tools that assess neighbourhood walkability and concepts like the 15-minute city. Yet, while the ambition is clear, data and research on health outcomes remains limited in this emergent area of practice. Whilst the rationale for this is not detailed in the sources reviewed, it is pointed out by experts that the implementation of such approaches is still at an early stage, and that the data collected is primarily technical in nature due to siloed working practices in several urban administrations.

Nature is also taking centre stage. Projects are mapping the health benefits of urban green spaces, using local data and participatory tools to better design for well-being. Similarly, cities are beginning to reshape food environments — limiting unhealthy options and promoting plant-based diets — although implementation is still in its infancy. Climate adaptation is also being reframed as a public health imperative, with cities like Paris introducing cooling strategies and expanding green infrastructure to protect vulnerable residents from extreme heat.

Findings: Systemic approaches

Beyond these thematic areas, the chapter underscores the importance of *systemic approaches*. Participatory design is gaining traction to ensure cities reflect the needs of their communities, while equity is increasingly recognised as a core concern, particularly in response to growing urban inequalities. Innovative governance and data-driven tools are emerging — from open data platforms to planning checklists — but much of this work is still experimental, under-researched and under-evaluated.

How strong is the evidence?

This chapter takes a more exploratory approach than previous sections, drawing on grey literature and expert insights rather than peer-reviewed studies. The trends and approaches identified represent emerging directions that point to fertile ground for future research rather than definitive evidence.

2.4 Final reflections

Urban design can be a powerful tool for improving public health – but the review reveals an uneven research landscape with gaps in the understanding of what works. Despite these limitations, experts agree the field holds large potential.

To move forward, stronger research is needed that goes beyond just physical activity, creates a better understanding of how design affects social connections and mental health, and focuses on communities that have previously been overlooked. The field must also prioritize implementation research that standardizes outcome measurements and strengthens methodological quality to produce reliable, comparable evidence that can guide effective public health interventions at scale. Only then can the creation of cities that truly promote health and well-being for everyone be achieved.

3. INTRODUCTION

3.1 Purpose of this research note

Urbanization represents one of the 21st century's most transformative megatrends. As populations increasingly concentrate in cities, both significant challenges and promising opportunities are presented to shape urban environments that holistically support public health—physically, mentally, and socially. Urban development and regeneration projects in Denmark and internationally offer valuable opportunities to create healthier, more sustainable neighbourhoods that enhance residents' well-being. And while the relationship between urbanization and public health is extensively documented in literature, sufficient evidence about which specific interventions yield the greatest impact on health outcomes is lacking. This research note therefore seeks to map existing knowledge, identify critical research gaps, and determine how to prioritize and monitor future research in urban development.

This research note addresses the central question: *What impact do changes or interventions in the built environment of urban areas have on public and cardiometabolic health?*

Rambøll has produced this comprehensive analysis synthesizing evidence-based knowledge on how built environment interventions affect public health (Chapter 5), while identifying key knowledge gaps across relevant academic disciplines (Chapter 4). To provide a more complete perspective, the note also incorporates grey literature in the form of practical materials and reports as well as expert insights that capture emerging trends not yet fully documented in academic research (Chapter 6).

This document will also serve as the foundation for developing an idea catalogue outlining development areas, project concepts, and inspirational case studies. The goal is to inform and inspire future research, development, and implementation initiatives that ensure urban environments evolve sustainably with public health as a core priority.

3.2 Why is urbanization relevant in the context of health?

Well-designed cities can promote health and well-being by prioritising human needs. Conversely, without careful planning, rapid urban growth can also introduce serious health risks for residents. This provides policymakers, urban planners and investors with an important task - to navigate the planning of urban environments with a clear intention and priority to plan for the health and well-being of current residents and future generations. Urbanisation is both a powerful tool for improving public health and a potential source of harm, depending on how cities are planned and developed. On the one hand, urbanisation holds a large potential as it offers closer proximity to services and infrastructure which improve health. On the other hand, cities give rise to significant issues that can negatively impact health, such as air pollution or urban waste. In an urban context, the lack of green areas and poor transport infrastructure can also increase sedentary behaviour leading to health risks.

The promotion of physical activity is often highlighted in the reviewed evidence as one of the most important elements of a healthy city approach. (Althoff et al., 2024). Besides physical activity, urbanization also affects physical health through pollution. For a long time, pollution has been shown to be a growing issue in an urban context. With an increase in motorized transport and a denser population, air pollution has increased. Air pollution is often connected to cardiometabolic diseases while also impacting quality of life and general life satisfaction (Stankova et al., 2020; Stappers et al., 2023)

In addition to physical health concerns, urbanisation has significant implications for mental health. As cities in Northwestern Europe and Anglo-Saxon countries grow and undergo redesigns, the built environment can either enhance or hinder mental health and well-being. A major factor highlighted as

influencing mental health in urban areas is sedentary behaviour, which can be exacerbated by poor urban planning. Urban redesigns that promote active transport and physical activity can therefore improve health-related quality of life, potentially reducing stress, anxiety, and depression. On the other hand, cities with insufficient green spaces, heavy traffic, and poor walkability tend to contribute to a more sedentary lifestyle, which can negatively affect both physical and mental health (Stappers et al., 2020; Benton et al., 2021; Ram et al., 2020). Promoting urban designs that facilitate movement and interaction with the environment is therefore critical in mitigating mental health risks associated with urbanisation. Urban planning that integrates opportunities for active living, such as through the creation of parks, walking paths, and safe public spaces, is essential for fostering a healthier, more connected urban population.

Urbanisation not only affects physical and mental health but also plays a crucial role in shaping the social health of urban populations. Social health refers to the ability of individuals and communities to interact, form meaningful relationships, and engage in social activities that promote a sense of belonging and community. When urban planning is designed to promote social participation, it can help foster a sense of community and well-being (Anderson et al, 2020).

Whilst the urban surroundings can be a determinant of both physical, mental and social health, there are many other aspects for city planners to incorporate when designing or restructuring cities. Competing objectives such as carbon neutrality or financial development are also included in urban planning (Gehl & WHO, 2017). Promoting health and well-being in urban planning must therefore incorporate these different objectives and seek to accommodate and co-exist in this wider ecosystem of drivers.

In conclusion, urbanisation presents both opportunities and challenges for public health. The design and development of urban environments significantly impact a range of health factors, including physical activity, mental well-being, and social health. While well-planned cities can promote healthy lifestyles, reduce health disparities, and foster stronger communities, poor urban planning can contribute to a range of health risks, from physical inactivity to environmental stressors.

3.3 Methodology

The paper employs a three-fold approach to examine the impact of built environment interventions on public health. This approach is summarised below. Additional methodological details, including complete search strategies, quality assessment procedures, and detailed mapping approaches are available in Appendix A.

Rapid Evidence Assessment

A Rapid Evidence Assessment was conducted to systematically and efficiently synthesize existing research on built environment interventions and their impact on public health. REAs follow systematic review principles but with a more focused scope to provide timely evidence for decision-making.

The search focused on studies published in English between 2018-2025 from Northwestern European countries, Anglo-Saxon countries, and Singapore. Only quantitative studies examining actual built environment interventions and their physical, mental, or social health outcomes were included. The search was conducted in PubMed and Web of Science databases using structured search terms related to urban environments, health outcomes, and intervention methodologies. A full overview of the inclusion criteria can be found in Table 6.1.

From 11,035 initial studies identified, 29 met all inclusion criteria after a rigorous two-stage screening process (see Figure 7.1 in appendix). Each included study underwent quality assessment using appropriate tools based on the study design. To identify knowledge gaps, both the 29 included studies and the broader

set of 586 studies that passed initial screening were analysed. The frequency of key themes related to built environment interventions, health outcomes, and target populations were mapped to identify areas with limited research coverage.

Grey literature

To supplement the findings from academic literature, a targeted review of grey literature was conducted. This process involved mapping key actors across sectors (international organizations, planning bodies, research institutions), resulting in the identification of 71 potential resources. 17 resources were selected for detailed review, based on their geographic and thematic scope, prioritizing emerging areas not fully explored in the REA. This approach allowed us to identify contemporary strategies and trends in health-promoting urban design that may not yet be reflected in peer-reviewed research (detailed selection process in Appendix A, Section 7.3).

Expert consultation

An expert advisor panel was involved throughout the project. Their role involved qualifying the scope and the findings from the REA. The panel was also involved in qualifying the findings from the grey literature review and in highlighting the most important challenges and research opportunities for the field. The expert advisor panel consisted of a total of eight participants selected for their deep knowledge of the field and to ensure a diversity of perspectives, including specialisations in both research and practice and with focus areas including physical activity, urban health, urban planning and mobility, green and blue spaces, pollution, liveable cities and health inequalities.

4. KNOWLEDGE GAPS

In this chapter, the results of mapping the knowledge gaps are presented, following a methodology set out in further detail in Appendix A. The aim is to provide a broad overview of the existing literature on the built environment and its impact on health. By counting the occurrence of selected keywords in 586 study titles and abstracts, the mapping reveals patterns in research focus areas across built environment themes, health outcomes and target groups. This approach allows for the inclusion of a large volume of studies, making it possible to identify overarching trends and potentially underexplored areas in the field. These insights can guide future research by highlighting where additional attention may be most needed.

There are, however, considerations to keep in mind with this approach. While the keyword-based approach gives an indication of the focus areas within the literature, it does not capture the context in which the keywords are used, nor does it assess the credibility or direct relevance of each study to this research note. Only 29 studies met the inclusion criteria for this research note (described in detail in Appendix A), meaning the 586 studies included in this broader mapping of knowledge gaps did not fully meet one or more of these criteria, yet they remain relevant for studying the impact of built environments on health. Therefore, the presence of many studies within a particular theme, outcome, or target group does not imply that all these studies fall within the narrower scope of the research note or that they represent high-quality research. Instead, it suggests that the theme, outcome or target group has received more attention than others, providing an overview of research activity in certain areas and highlighting potential knowledge gaps that provide opportunities for further research to broaden the overall robustness of the field.

The chapter is divided into four sections. The first section revolves around knowledge gaps in relation to built environment themes, the second section focuses on knowledge gaps in relation to researched health outcomes, the third section explores the connection between each theme and health outcomes, and the fourth section centres on knowledge gaps in relation to target groups studied.

4.1 Knowledge gaps related to built environment themes

The literature was searched based on keywords associated with a range of different built environment themes (exact keywords are shown in Appendix A, Section 7.2). The themes are outlined below in figure 4.1, accompanied by illustrative examples of interventions within each theme.

Figure 4.1: Built environment themes and illustrative examples of interventions

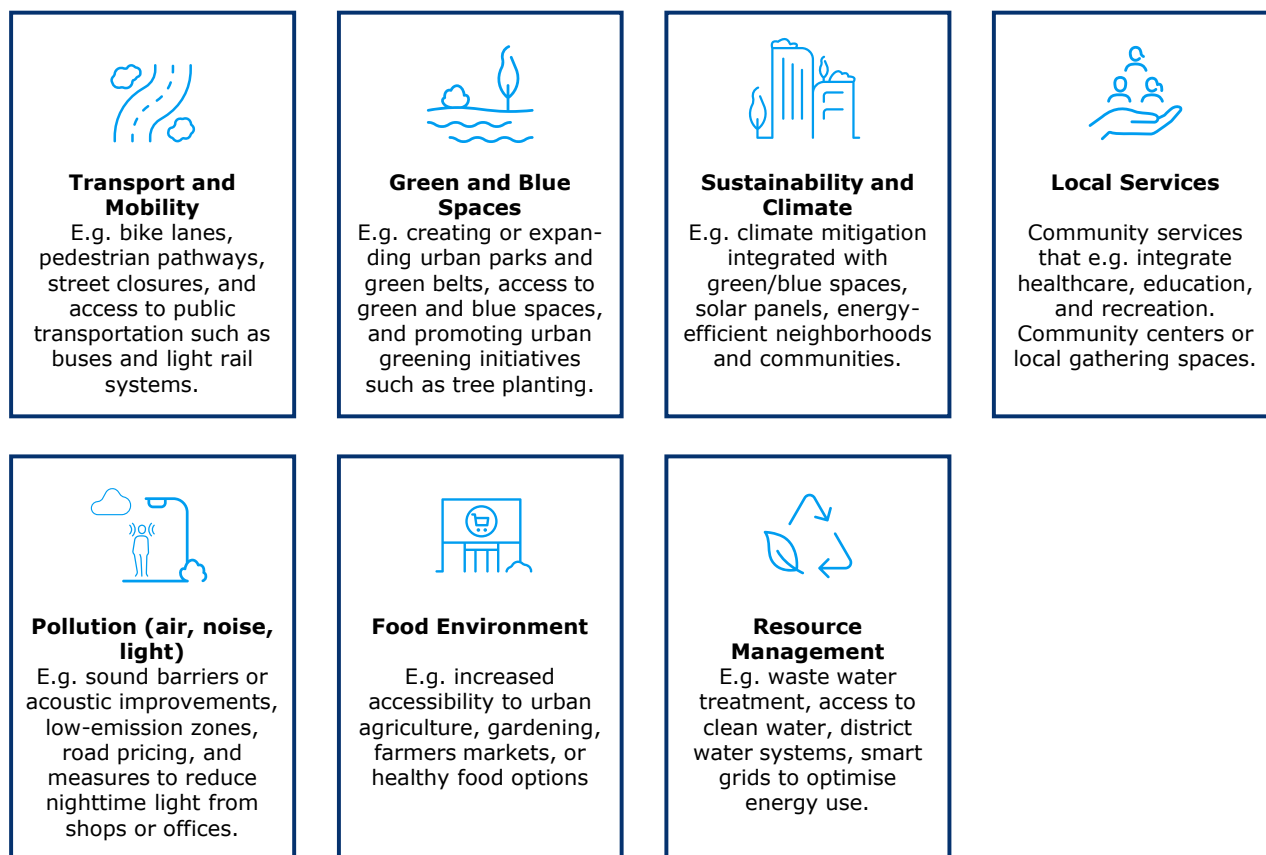
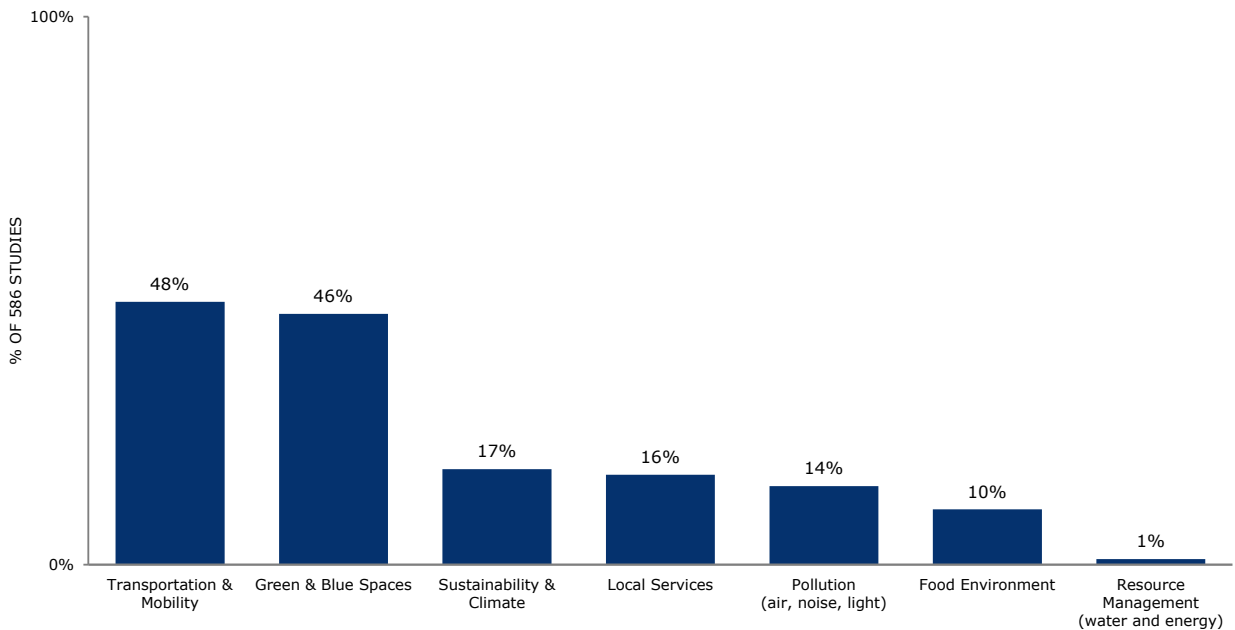


Figure 4.2. below shows the distribution of themes across the 586 studies. Some studies only contain keywords associated with a single theme, whereas most studies concern aspects of multiple themes. The mapping of knowledge gaps reveals a clear trend, indicating that a large proportion of the literature is focused on themes within Transportation and Mobility (48%) and Green and Blue Spaces (46%). In contrast, the mapping shows that few studies contain keywords associated with Resource Management (water and energy) (1%), which highlights a knowledge gap in understanding how this theme might impact health. The themes of Sustainability and Climate, Local Services, Pollution (air, noise and light), and Food Environment each account for between 10% and 17% of the studies. While several studies are associated with the themes, the volume of research is still far lower compared to Transportation and Mobility, and Green and Blue Spaces. This also suggests potential knowledge gaps in research on the impact of the built environment on public health, indicating potential future research areas.

Figure 4.2: Share of studies related to different built environment themes

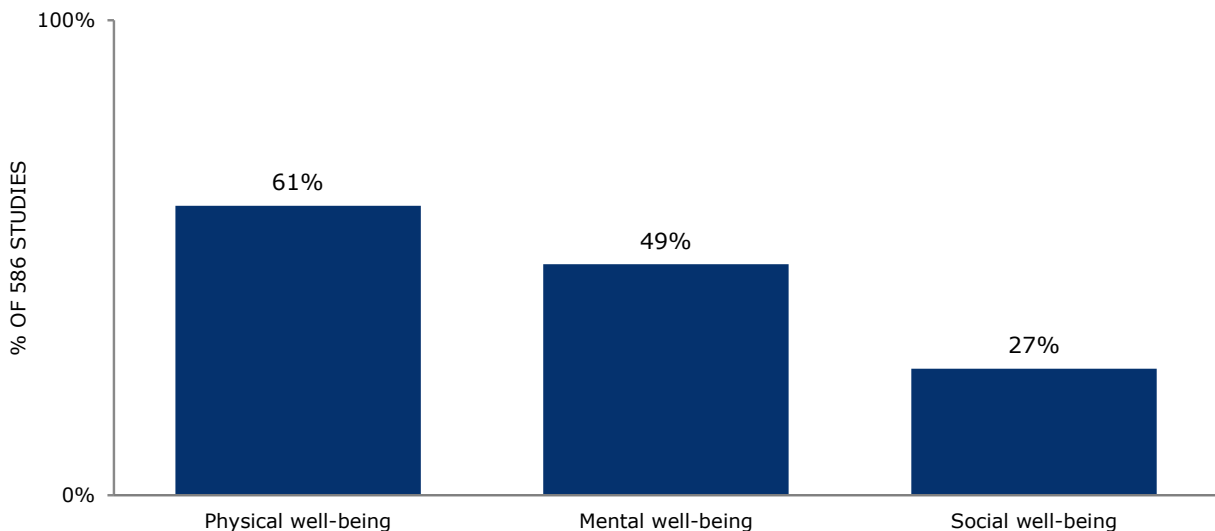


Note: Shares are based on 586 studies. The percentages do not sum to 100% because each study can contain keywords from multiple themes.

4.2 Knowledge gaps related to health outcomes

The mapping of knowledge gaps also provided opportunity for analysing health related outcomes in the included studies. Figure 3.2 illustrates the distribution of outcomes across the studies. More than half of the studies (61%) feature keywords associated with physical well-being and around half of the studies (49%) include keywords related to mental well-being. However, social well-being is less frequently documented, with only about a quarter of the studies (27%) using keywords associated with social well-being. This suggests a potential knowledge gap in research focusing on the impact of the built environment on social well-being.

Figure 4.3: Share of studies related to different health outcomes



Note: Shares are based on 586 studies. The percentages don't sum to 100% because each study can contain keywords from multiple outcomes.

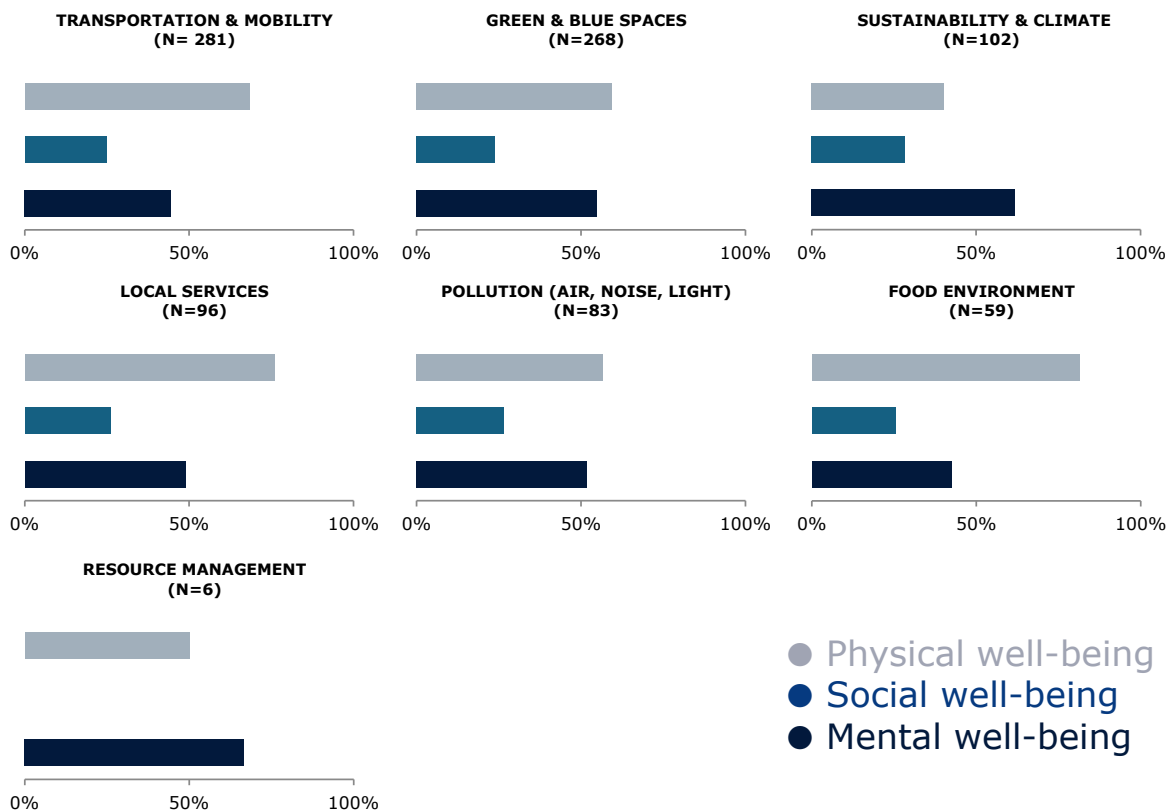
Based on the findings detailed in Chapter 5, which focus on the included studies within the narrow scope, there is a tendency for research to prioritize physical activity as the primary physical well-being outcome. Outcomes related to conditions or risk factors for cardiometabolic disease – such as heart attacks, arrhythmia, diabetes, obesity, and hypertension – are less commonly studied.

To further explore this pattern, the broader mapping of knowledge gaps examines the distribution of different subcategories within physical well-being. The analysis shows an imbalance between studies focusing on physical activity and those addressing cardiometabolic conditions or risk factors (excluding physical inactivity). While 61% of physical well-being studies include keywords related to physical activity, only 34% reference cardiometabolic disease or its risk factors without also mentioning physical activity. This indicates a stronger research emphasis on promoting physical activity than on understanding how built environment interventions affect broader cardiometabolic health. These findings align closely with the findings in Chapter 5, where studies within the narrower scope also tend to focus more on physical activity outcomes. Together, this points to a potential knowledge gap in research exploring the impact of built environment interventions and cardiometabolic health beyond physical activity.

4.3 Knowledge gaps in connections between built environment themes and health outcomes

In the mapping of knowledge gaps, the distribution of research across themes and outcomes has so far been investigated. To understand how the built environment themes might be linked to specific health outcomes, the literature was searched for studies that included keywords for both a theme and an outcome. The findings are presented in Figure 4.4.

Figure 4.4: Distribution of health outcomes within built environment themes



Note: The percentages do not reflect how many studies within a theme investigate each health outcome, as a single study may address multiple outcomes. The percentages therefore also don't sum to 100% because each study can contain keywords from multiple outcomes.

Overall, the findings suggest a relatively balanced focus on physical and mental well-being across the identified themes, aligning with the general patterns observed in Section 4.2. However, there is a clear knowledge gap in research on social well-being, as it is the least studied outcome across all built environment themes. This gap is particularly evident in the 'Resource Management' theme, where no studies include keywords related to social well-being.

Physical well-being accounts for the largest share of research connections in five out of seven themes (Transport and Mobility, Green and Blue Spaces, Food Environment, Local Services, and Pollution (air, noise and light)), while mental well-being is more prominent in two themes (Sustainability and Climate, and Resource Management). These findings compound the tendency noted in Section 4.2 where physical well-being appears to be a more frequently studied outcome in built environment research when compared to mental well-being.

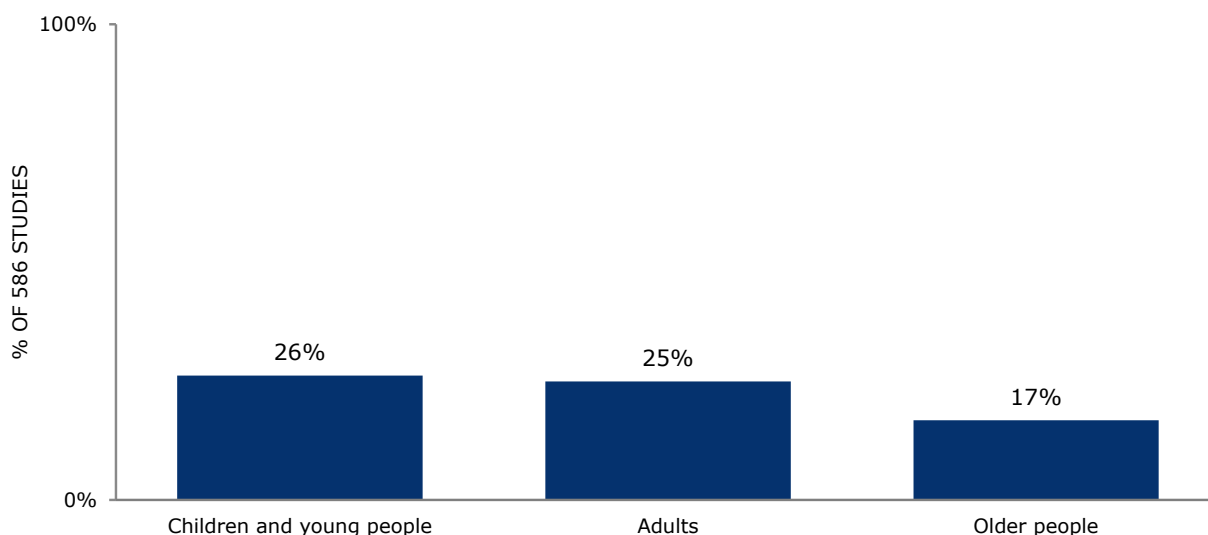
The mapping shows a clear underrepresentation of social well-being. This gap is important to address, as increased focus on this area can help ensure that built environment interventions not just support individual health, but also the social fabric of communities and neighbourhoods.

4.4 Knowledge gaps related to target groups

The focus now shifts from specific built environment themes and health outcomes to explore the research activity related to different target groups, specifically distributed by age, vulnerability and gender.

As shown in the figure below, the mapping of knowledge gaps reveals variations across age groups. 26% of studies include terms related to children and young people, 25% focus on adults, and only 17% target older people. This distribution highlights a gap in research concerning older people, suggesting that the impact of the built environment on public health for this demographic is slightly underexplored compared to other age groups.

Figure 4.5: Share of studies related to different age groups

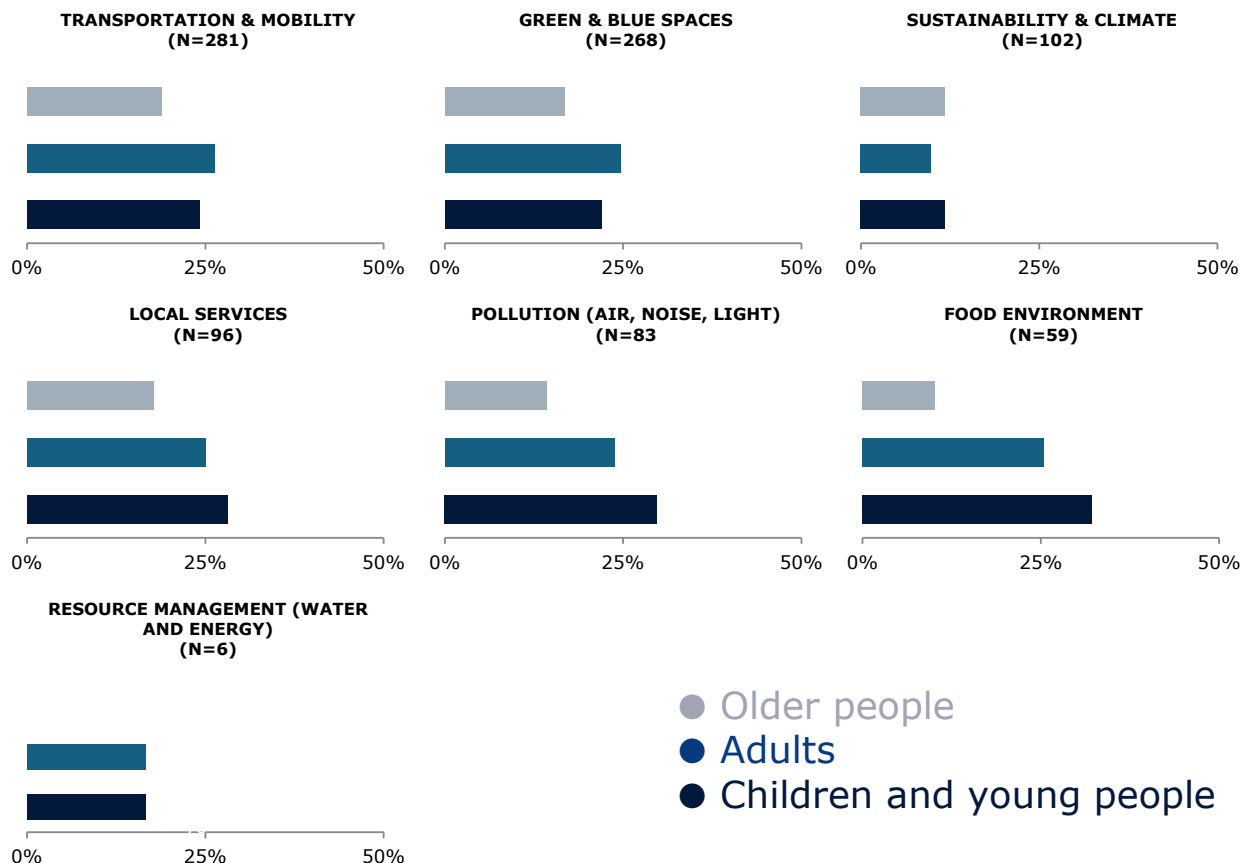


Note: Shares are based on 586 studies. The percentages don't sum to 100% because some studies focused on target groups unrelated to age.

As shown below, the variations across age groups continue when studies are broken down to the specific environment themes. While older people seem to be less represented compared to the other age groups for most of the themes, they are the most represented group for Sustainability and Climate. For other

themes such as local services, pollution and food environment, the disparity is larger compared to the rest of the themes.

Figure 4.6: Distribution of age groups within built environment themes



Note: The percentages do not reflect how many studies within a theme investigate each age group, as a single study may address multiple groups. The percentages don't sum to 100% because each study can contain keywords from multiple groups or because some studies focused on target groups unrelated to age.

Another key finding is the focus on vulnerable populations, with 32% of studies including terms related to marginalized or at-risk groups, such as minorities, low-income individuals, the disadvantaged, unemployed, disabled, and those with mental, social, or physical health issues. This indicates some awareness in the literature of the built environment's potential to address the health needs of vulnerable groups, though there is still scope to increase attention to this area.

Regarding gender inequalities, only one of the 586 studies included terms related to gender inequality, highlighting a significant knowledge gap. This study focused on urban liveability and gender-based violence.

Overall, the mapping of knowledge gaps highlights the need for more high-quality research focusing on the differential impacts of built environment interventions on various target groups. While the broader literature acknowledges these groups to some extent, the studies within the narrow scope (presented in Chapter 5) highlight a clear gap in both intervention-focused and methodologically rigorous research that specifically examines or reports results for different target groups. This gap can be problematic because age, gender, and vulnerability are closely linked to different health challenges and needs. Without research

that explores these differences, it becomes difficult to design built environment interventions that reduce health inequalities. Instead, there is a risk of creating one-size-fits-all solutions that may unintentionally overlook, or even worsen, existing health gaps in cities and communities.

5. BUILT ENVIRONMENT INTERVENTIONS

In this chapter, the synthesis of the Rapid Evidence Assessment based on 29 included studies is presented (the full list of studies is shown in Appendix B). The studies investigate interventions in the built environment that can be divided into four categories: Transport and Mobility, Green and Blue Spaces, Food Environment and Urban Planning and Regeneration. They are each described in separate sections below. However, the chapter starts with a general characterisation of the included studies.

5.1 General characteristics of included studies





Consistent with the findings in Chapter 4, Transport and Mobility and Green and Blue Spaces are the most examined categories of built environment interventions among the included studies, with 59% and 34% of studies focusing on these areas respectively. In contrast, only 10% of studies investigate interventions related to the food environment.

Similarly, as highlighted in Chapter 4, physical well-being is the most frequently examined health outcome, featured in 90% of the included studies, followed by mental well-being (41%) and social well-being (24%). Studies investigating physical well-being typically focus on physical activity alone, with limited or no attention to cardiometabolic disease risk factors or conditions such as heart attacks, arrhythmia, diabetes, obesity, and hypertension. Assessment of physical well-being commonly relies on self-reported dietary habits, body mass index (BMI) measurements, and evaluations of physical activity levels. Dietary assessments focus on the self-reported consumption of specific food groups or overall diet quality, while BMI is measured both objectively and through self-reports. Physical activity is evaluated using both objective tools, such as accelerometers and GPS tracking, and subjective measures, including self-reported walking, cycling and sports participation. Mental well-being is often measured through self-reported surveys. Some studies use validated psychological scales, such as the Kessler-6 Psychological Distress Scale (K6), the Hospital Anxiety and Depression Scale (HADS), and the Warwick-Edinburgh Mental Well-being Scale, while others use broader indicators, such as life satisfaction, perceptions of safety, and psychological distress. Social well-being is the least frequently studied outcome and is typically measured using self-reported indicators such as sense of community and social cohesion.

Less than half (41%) of the 29 studies are secondary research, while the majority (59%) are primary research. The primary research studies are predominantly based on research designs using quasi-experiments or natural experiments (76%), with only a small proportion (18%) utilizing randomised controlled trials (RCTs) and one study taking an observational approach (6%). The quasi-experiments often leverage non-random changes or interventions in the built environment to construct non-random treatment and control groups. Typically, they measure outcomes before and after an intervention, either by comparing treatment and control groups based on proximity or access to the intervention, or by tracking within-person changes over time. One study, for example, examines individuals before and after they relocate to areas with different walkability scores, while others evaluate the impact of urban policies or infrastructure investments by comparing health outcomes in areas where the policy is implemented with those where it is not. A small number of studies, particularly RCTs, manage to establish a more randomised approach, such as randomly assigning interventions (e.g., neighbourhood clean-ups) to different areas, or studying groups whose relocation patterns are externally determined.

Despite these efforts, the study quality of the included studies is in general of moderate to moderately high quality as shown in Table 5.1.

Table 5.1: Credibility of evidence for different built environment interventions

 Transport & Mobility	17 studies	7 primary studies of moderately high quality	10 secondary studies of moderate quality
 Blue & Green Spaces	10 studies	5 primary studies of moderately high quality	5 secondary studies of moderate quality
 Food Environment	3 studies	0 primary studies	3 secondary studies of high quality
 Urban Planning & Regeneration	9 studies	7 primary studies of moderately high quality	2 secondary studies of moderate quality

Note: The credibility of evidence scores ranges from low, moderately low, moderate, moderately high and high

The included studies highlight the methodological challenges involved in evaluating the health impacts of built environment interventions. These challenges, which make it difficult to draw clear causal conclusions, reflect broader issues within the field. They underscore the need for rigorous study designs, robust analytical techniques, and careful data collection to isolate the impact of interventions on public health. The key challenges include:

- **Complex urban settings limit traditional causal designs:** The dynamic and interdependent nature of urban environments, combined with the influence of numerous confounding factors, makes it difficult to isolate the effect of a single intervention. This complexity often makes randomized controlled trials (RCTs) more difficult to carry out, limiting the broader use of gold-standard methods for establishing causal inference.
- **Small sample sizes:** Many of the included studies have relatively few participants. For instance, the RCTs often involve fewer than 400 people, and the quasi-experimental or natural experiment studies rarely exceed 1,000 participants, reducing statistical power and the ability to generalize findings.
- **Assumed rather than measured exposure:** Exposure is frequently inferred based on proximity – assuming that individuals are affected by an intervention because they live nearby – without verifying actual engagement or use, leaving a key gap in understanding the intervention’s real impact.
- **Limited documentation of implementation:** There is often a lack of focus on how well and to what extent interventions are implemented in practice. Without this information, it’s difficult to assess whether outcomes are driven by the intervention itself or by variation in its delivery – making it harder to understand why an intervention succeeded or failed.

In the following sections, the most important findings from the synthesis of the included studies are presented. However, the described variation in both study designs and outcome measurements does challenge synthesising findings within and across categories of built environment interventions.

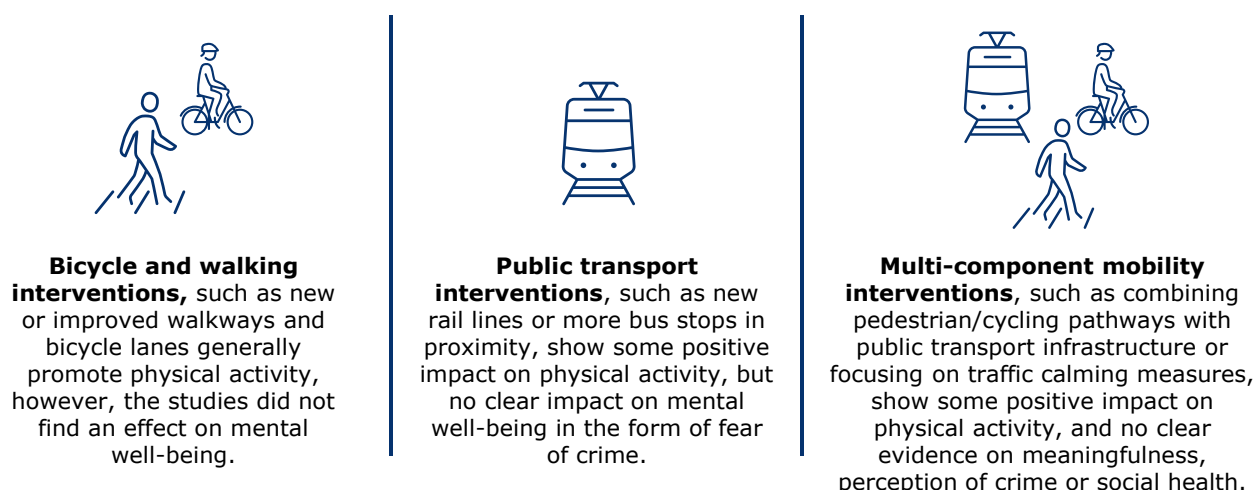
The included studies are, in the following sections, marked with a "P" or "S" in superscript to indicate whether the study is primary or secondary.

5.2 Transport and Mobility

Transport and mobility interventions are a central part of urban development and public well-being. The way people move within and between urban spaces profoundly affects health outcomes through its influence on lifestyle and behaviour. Interventions aimed at enhancing transport and mobility, such as improving road safety, expanding public transport networks, and creating pedestrian and cycling infrastructures, can significantly reshape urban environments. Effective transport and mobility strategies can improve access to essential services, promote physical activity, and reduce environmental pollution, thereby supporting healthier lifestyles. Conversely, inadequate transport and mobility planning can exacerbate health disparities and contribute to poor living conditions. Therefore, transport and mobility interventions are crucial for fostering environments that enhance public health and mitigate risks associated with inefficient or inaccessible transportation systems.

Figure 5.1 below summarises the key insights from this research note regarding transport and mobility interventions, categorised into three types: 1) interventions targeting vulnerable road users, 2) public transport interventions, and 3) multi-component mobility interventions. Overall, the chapter synthesises findings from 17 studies, including seven primary research studies and ten secondary research studies. The primary research studies are, overall, considered of **moderately high** credibility, while the secondary research studies are rated with overall **moderate** credibility.

Figure 5.1: Key insights related to Transport and Mobility interventions



5.2.1 Vulnerable road users

Bicycling and walking infrastructure constitutes an essential element in creating healthier, more connected, and sustainable urban environments. Active transportation options like walking and cycling can encourage daily movement and increase physical health. Additionally, well-designed infrastructure enhances mobility and connectivity within a city, making it easier for people to navigate urban spaces efficiently without relying on cars. From an environmental perspective, expanding cycling and pedestrian networks supports urban sustainability by cutting carbon emissions, reducing air pollution, and decreasing traffic congestion. By prioritizing walking and biking infrastructure, cities can foster healthier lifestyles, enhance urban mobility, and contribute to a more sustainable future.

Credibility of evidence

This section synthesises findings from nine studies: Six secondary research and three primary research. The secondary research studies have a **moderately high** credibility score, while the primary research studies are rated with overall **high** credibility. The credibility assessment is further explained in appendix C.



9
studies

3 primary studies of **high quality**

6 secondary studies of **moderately high quality**

Intervention

This research note identifies six studies that identify or examine the effect of bicycle and walking interventions designed to increase physical health and mental well-being (Hunter et al., 2019^S; Mölenberg et al., 2019^S; MacMillan et al., 2018^S; Stankova et al., 2020^S; Hooper et al., 2020^P; Acciai et al., 2023^P). These interventions typically include improving walking and cycling trails or implementing new bicycle lanes (Stankova et al., 2020^S; Hunter et al., 2019^S). Moreover, two studies found a group of research articles which examined street-related upgrades, including complete street², sidewalk, and bicycle lane upgrades (Acciai et al., 2023^P; Hooper et al., 2020^P). Similarly, Althoff et al. (2024)^P focused specifically on walkability. The study is a natural experimental study on whether moving between cities with different Walk Scores can influence a person's physical activity. The authors used the publicly available and systematically developed Walk Score on a scale of 1 to 100 (100 = most walkable) to measure the walkability of a city. The score considers the distance to amenities and measures of friendliness to pedestrians.

Three systematic reviews focus on whether establishing or modifying cycling or walking lanes can encourage active transport and increase physical activity (Mölenberg et al., 2019^S; MacMillan et al., 2018^S; Hernández et al., 2023^S). Ortegon-Sanchez et al. (2022)^S investigated an alternative intervention to increase walking among children. The intervention included changes to the local environment around schools by adding 'beat box' sensors³ on the route to and from school. The participants were given a swipe card and asked to touch the sensor with their card on the walk to school. The intervention was supported by competitions between schools to motivate the participants to partake in the intervention.

Health outcomes

The included studies investigating interventions targeting vulnerable road users primarily focus on physical health, with physical activity being the most common measure. Physical health is measured by subjective and objective tools. The majority of the included studies used subjective tools to measure physical activity, such as questionnaires, self-reports, activity diaries, and observations reporting usage of the intervention (MacMillan et al., 2018^S; Mölenberg et al., 2019^S; Stankova et al., 2020^S; Hernández et al., 2023^S; Hooper et al., 2020^P; Accai et al., 2023^P). In some studies, physical activity is operationalized as a measurement of Moderate-to-Vigorous Physical Activity (MVPA) (Ortegon-Sanchez et al., 2022^S; Hernández et al., 2023^S). MVPA is often measured by subjective tools such as self-reports and questionnaires. One study used questionnaires like the International Physical Activity Questionnaire (IPAQ) (Hernández et al., 2023^S).

² Complete Streets is an approach to planning, designing and building streets that enables safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities.

³ Contactless sensors called Beat Boxes are placed on lamp posts around the area. Developed by Beat the Street

Moreover, several studies describe or measure physical activity using objective tools (Hernández et al., 2023^S; Hunter et al., 2019^S; Stankova et al., 2020^S; Althoff et al., 2024^P). Objective measurements include pedometers, accelerometers, heart rate monitors, and physiological changes (e.g., aerobic fitness, BMI, blood pressure). For instance, Althoff et al. (2024)^P used a device-based measurement methods of physical activity, recording step counts over time via smartphone accelerometers and the Azumio Argus app's proprietary step-counting algorithms.

In the investigation of interventions targeting vulnerable road users, one study examines mental well-being as an outcome (Hooper et al., 2020^P). The study identifies subjective tools to measure mental well-being (psychological distress and positive mental well-being).

Results

The research note shows that bicycle and walking interventions generally promote physical activity (Hernández et al., 2023^S; Stankova et al., 2020^S; Acciai et al., 2023^P; Hooper et al., 2020^P). Additionally, the research found no effect of bicycle lanes or sidewalks on mental well-being (Hooper et al., 2020^P).

Two systematic reviews by Hernández et al. (2023)^S and Stankova et al. (2020)^S found that implementing bicycle lanes increases the duration of active travel and overall physical activity levels. Similarly, Acciai et al. (2023)^P reported that street-related upgrades – specifically complete street, sidewalk, and bicycle lane improvements – were positively associated with children's physical activity. Hooper et al. (2020)^P further supported this by identifying a positive association in 59% (30/56) of studies between design features of movement networks – including pedestrian infrastructure, sidewalks, and street connectivity – and health-supportive behaviours and well-being outcomes. Specifically, pedestrian infrastructure, such as sidewalks, was linked to health-promoting behaviours like transport and recreational walking, however, the study found no association between bicycle lanes or sidewalks and mental well-being (Hooper et al., 2020^P). In line with these findings, Althoff et al. (2024)^P find that increases in neighbourhood walkability are significantly associated with higher physical activity levels following relocation. These effects were consistent across subpopulations of different genders, ages, and body mass index (BMI) categories and remained sustained for at least three months after moving.


The impact of bicycle lanes on cycling behaviour was also examined in the systematic review by Mölenberg et al. (2019)^S, which found that most studies reported an increase in the number of cyclists using new or modified bicycle lanes. However, the extent to which these changes influenced overall cycling behaviour – such as trip frequency or duration – was less consistent. In contrast, a review examined the impact of walking and cycling route interventions on physical activity, finding varied results. However, despite focusing on natural experiments, many of the included studies had a high risk of bias due to reliance on self-reported data and lack of objective measures, which undermines the reliability of the findings (MacMillan et al., 2018^S).

Another approach to increasing physical activity, explored in the systematic review by Ortegon-Sanchez et al. (2022)^S, is a walk-to-school program. This intervention involved modifying the local environment around schools by installing sensors along the route to and from school. Pupils were given swipe cards and instructed to touch the sensors during their walk to school, aiming to encourage physical activity. The review found that active participation in the intervention, along with reminders, led to increased levels of moderate and vigorous physical activity among the pupils.

5.2.2 Public transport

This section synthesises findings from four studies: one primary research study and three secondary research studies. The primary research study is rated with **moderately high** credibility, while the

secondary research studies have a **moderate** credibility score. The credibility assessment is further explained in appendix C.

	4 studies	1 primary study of moderately high quality 3 secondary studies of moderate quality
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Interventions

The investigated interventions included in this chapter concern single-component interventions focusing on public transport infrastructure and access. The interventions typically consist of the building of either a full light rail line or rapid bus system line (Hooper et al., 2020^P; MacMillan et al., 2018^S; Tseng et al., 2018^S; Barradas et al., 2022^S) or the extension of an existing system through one or several light rail or bus stops (Hooper et al., 2020^P; MacMillan et al., 2018^S).

Health outcomes

The included studies mainly measure the effects of public transport interventions on physical health (MacMillan et al., 2018^P; Tseng et al., 2018^S, Barradas et al., 2022^S), while both physical, mental and social health outcomes are being assessed by Hooper et al. (2020^P).

Physical health is evaluated using various indicators across the studies, with a common focus on physical activity. Some reviews describe their way of measuring physical activity on a general level, such as “walking” or “cycling” (MacMillan et al., 2018^S, Barradas et al., 2022^S). Others measure physical activity more precisely, using objective methods like accelerometers (Barradas et al., 2022^S; Hooper et al., 2020^P) and GPS location tracking (Hooper et al., 2020^P). Subjective measurement methods are also employed, with self-reported physical activity including walking, cycling, and general time spent outside (Hooper et al., 2020^P). One review specifically assesses physical well-being through changes in Body Mass Index (BMI) (Tseng et al., 2018^S). Hooper et al. (2020^P) assess mental well-being through self-reported responses on positive mental well-being and perceptions of crime and safety.

Results

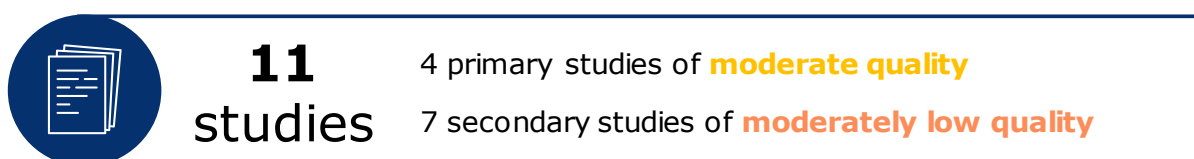
Overall, the reviews find some positive associations between public transportation interventions and physical health, while no or negative associations are identified for mental well-being. One study (Hooper et al., 2020^P), that is based on the most rigorous individual studies, finds that an increased number of available bus stops or train stations increases walking activity but finds no association with perceived crime risk (mental well-being). Additionally, the study finds that the presence (vs. absence) of a public transport stop within 400 metres increased fear of crime. Other studies (MacMillan et al., 2018^S; Tseng et al., 2018^S) draw less robust conclusions due to the low quality of included studies, but indicate that the creation of light rail stops or full lines reduces weight/BMI (Tseng et al., 2018^S) and has mixed effects on walking and cycling activity, with MacMillan et al. (2018^S) reporting that some included studies identify a positive effect, while others find no effect. Another study (Barradas et al., 2022^S), which scores critically low in credibility and should be interpreted with caution, finds some positive effects on cycling and walking activity in its review of public transport interventions. Two of the included studies by Barradas et al. (2022^S) find positive effects on cycling activity, one finds positive effects on overall physical activity, and the final study finds mixed effects on walking activity. In addition, one of the included studies by Barradas et al. finds that participants living closer to busway stops have higher cycling activity and lower walking activity, and as the distance from the busway increases, this relationship reverses.

5.2.3 Multi-Component Mobility Interventions

Multi-component mobility interventions impact the dynamics of urban movement and accessibility. By integrating various infrastructure elements such as pedestrian pathways, cycling infrastructure, public transport enhancements, and traffic calming measures, these interventions aim to create a cohesive mobility plan that supports diverse modes of transportation. Such comprehensive strategies are vital for public health as they encourage active lifestyles, reduce traffic-related injuries, and mitigate environmental pollution.

Credibility of evidence

This section synthesises findings from 11 studies: four primary research studies and seven secondary research studies. The primary research studies are rated with a **moderate** credibility score, while the secondary research studies have a **moderately low** credibility score. The credibility assessment is further explained in appendix C.



Interventions

This section groups a diverse mix of multi-component mobility interventions: one group of interventions in the included studies focuses on multi-component interventions where different elements of public mobility infrastructure are combined to generate effects, while another group of interventions focuses more narrowly on changes to public infrastructure aspects of traffic usage and street design.

In the first, broader group of multi-component interventions, four studies examine the impact of creating greenways in urban settings (Frank et al., 2019^P; Auchincloss et al., 2019^P; Stappers et al., 2023^P; Hunter et al., 2019^S). In the study by Frank et al. (2019^P) a two-kilometre active transportation corridor is designed in Vancouver, Canada to make cycling more attractive by combining cycling facilities with three streetscape improvements (one-way shared on-street with counterflow lanes, one-way protected lanes, and two-way shared on-street lanes). Auchincloss et al. (2019^P) assess the impact of creating a greenway along streets in Pennsylvania, USA, by retrofitting sidewalks and street segments into a wide, tree-lined asphalt-paved greenway. The intervention also included intersection improvements (sidewalk bump-outs, pedestrian signals, and ramps), bus stop shelters, street trees, and bicycle racks. The greenway approach is likewise assessed by Stappers et al. (2023^P), as they investigate the impact of redesigning the space on top of a tunnelled highway, through semi-paved middle paths for pedestrians, bicyclists, and recreation, along with one-way streets for local traffic on either side. The middle path is separated from the one-way streets by trees and greenery. In the review by Hunter et al. (2019^S), they assess the effect of combining greenway interventions with promotion and marketing programmes to create more attention and thereby physical activity for the interventions.

The broader group of multi-component interventions also includes three reviews that assess the effect of combining public transport with infrastructure for vulnerable road users. The reviews are based on four different studies that all investigate a purpose-built track with guided technology for buses, with accompanying tracks for cycling, walking, horse riding and emergency vehicles, that links Cambridge with local towns and villages (Stankova et al., 2020^S; Moore et al., 2018^S; Hernández et al., 2023^S).

The group of narrowly focused multi-component interventions consists of more diverse elements. Two reviews investigate the effects of street closure (temporary or permanent blocking of a street to vehicle

traffic) on physical activity (Ortegon-Sanchez et al., 2022^S) and mental health (Moore et al., 2018^S). Ortegon-Sanchez et al. (2022^S) focus on a target group of children (below 18 years) for street closure interventions and find that interventions are characterised by being closed at regular intervals, e.g., at a specific time-interval each week, most often in the summertime, and mainly concentrated in residential blocks, although one study reports city wide street closures. Temporary street closures are often complemented by different activities (e.g., sports activities for children or entertainment equipment such as bouncy castles) to encourage physical activity, while the assessed studies with permanent street closure do not include additional activities (Ortegon-Sanchez et al., 2022^S). Moore et al. (2018^S) include a study that assesses the noise reduction effects on mental health by diverting traffic away from three towns. A third study (Sinharay et al., 2018^P) examines the impact on physical health of walking in two different environments: a busy, traffic-polluted street (Oxford Street) and a traffic-free urban park (Hyde Park).

Finally, a different group of narrow interventions focuses on street design, where streets are redesigned for different purposes. Some interventions focus on traffic-calming effects (Ortegon-Sanchez et al., 2022^S; Barradas et al., 2022^S; de Sá et al., 2024^S), e.g., through the construction of buildouts (Ortegon-Sanchez et al., 2022^S). Other interventions aim to increase the attractiveness and safety of areas through lower curbs, planters, benches, and lights (Moore et al., 2018^S; de Sá et al., 2024^S), and a third intervention creates a permanent decoration for street games to encourage children's play (Ortegon-Sanchez et al., 2022^S).

Health outcomes

The included studies measure health from physical, mental, and social perspectives, with a predominant focus on indicators of physical well-being.

Physical well-being is assessed through various indicators across the studies, with a common emphasis on physical activity. Two reviews only describe their way of measuring physical activity on a general level, such as "walking" or "cycling" (Stankova et al., 2020^S; de Sá et al., 2024^S), while others measure physical activity more precisely (Ortegon-Sanchez et al., 2022^S; Hernández et al., 2023^S; Stappers et al., 2023^P; Barradas et al., 2022^S; Frank et al., 2019^P; Auchincloss et al., 2019^P). This includes objective measures such as accelerometers (Ortegon-Sanchez et al., 2022^S; Hernández et al., 2023^S; Stappers et al., 2023^P; Barradas et al., 2022^S), GPS location tracking (Hernández et al., 2023^S; Stappers et al., 2023^P) or infrared sensors tracking activity (Hunter et al., 2019^S) and subjective measures through self-reported physical activity (e.g. walking and cycling) through questionnaires (Hunter et al., 2019^S; Frank et al., 2019^P; Auchincloss et al., 2019^P; Hernández et al., 2023^S; Barradas et al., 2022^S) such as the International Physical Activity Questionnaire (IPAQ) (Frank et al., 2019^P), the EQ-5D-3 L questionnaire (Hernández et al., 2023^P) or the SOPARC systematic observation method, where people are logged based on MVPA and lower intensity activity (Auchincloss et al., 2019^P).

Four studies measure mental well-being when assessing the impact of interventions in public transport infrastructure. The review by Hunter et al. (2019^S) examines mental well-being on a general level but does not specify the exact measurement outcomes. Auchincloss et al. (2019^P) and Moore et al. (2018^S) use objective measures as they measure changes in crime rates before and after the greenway intervention (Auchincloss et al., 2019^P) and traffic noise reduction (Moore et al., 2018^S), while Stappers et al. (2023^P) rely on subjective measures through a questionnaire, which includes questions on meaningfulness.

Social well-being is less frequently used as an outcome measurement method, with only one study evaluating interventions based on self-reported answers to questions on social activities and size of social network (Stappers et al., 2023^P).

Results

Overall, this chapter finds mixed evidence that the diverse mix of multi-component mobility interventions significantly impact physical, mental and social health for residents. The literature identifies multi-component approaches to public mobility interventions categorised into two primary groups: multi-component interventions where different elements of public mobility infrastructure are combined to generate effects, and a narrower group of interventions focused more on changes to public infrastructure aspects of traffic usage and street design.

The effects of the broader multi-component interventions are mixed when it comes to greenways. The study by Auchincloss et al. (2019^P), that is considered of high credibility, finds that the construction of a greenway did not significantly increase physical activity compared to a similar reference area. In contrast to this, Frank et al. (2019^P) find that retrofitting an urban greenway in Vancouver resulted in an increase in MVPA and reduced sedentary behaviour for residents within 300 metres, compared to the control group of 500 metres. Stappers et al. (2023^P) find positive effects of a greenway intervention on lighter active transportation behaviour, but no effects on moderate-to-vigorous activity, social health or meaningfulness (mental health). However, these two studies should be interpreted with some caution due to incomplete data and a vaguely defined control group (Frank et al., 2019^P), a high drop-out rate and the impact of covid-19 on outdoor activity (Stappers et al., 2023^P). Another interesting finding is identified by Hunter et al. (2019^S) in their systematic review, as they conclude that combining greenway interventions with promotion and marketing programmes can have a positive effect on physical activity by assessing six different studies. But here, again, the robustness of their conclusions is considered of a low credibility due to methodological heterogeneity of the included studies.

The interventions that combine public transport with infrastructure for vulnerable road users show more positive effects in the included studies. One review (Stankova et al., 2020^S), based on the most rigorous individual studies, finds a positive association between the installation of bicycle lanes and/or bus rapid transit infrastructure in 12 of 23 outcomes. It should be noted that this conclusion is drawn from studies conducted in five countries, one of which (Colombia) falls outside the scope of this review. Hernández et al. (2023^S) also find that participants' physical activity increases when exposed to multi-component interventions, though these conclusions are less robust due to the risk of bias and lack of control groups in some included studies. Finally, Moore et al. (2018^S) were unable to observe any effects on mental health, as the included study did not directly compare the intervened and non-intervened areas.

For the narrower group of public infrastructure focusing on traffic diversion interventions, there are mixed results of closing or diverting streets. The review by Ortegon-Sanchez et al. (2022^S) concludes that some studies report a significant increase in children's steps and outdoor play, and decreases in sedentary behaviour, from street closures. In contrast, Moore et al. (2018^S) find no effects on traffic noise (and thereby mental health) following the introduction of a road bypass. These conclusions are, however, less robust, as the two reviews are considered of low credibility due to low to moderate quality of included studies (Ortegon-Sanchez et al., 2022^S; Moore et al., 2018^S) and high risk of bias (Moore et al., 2018^S). Finally, a more robust study, in the form of Sinharay et al. (2018^P), reports positive respiratory and cardiometabolic effects of walking in a traffic-free park compared to a traffic-polluted street, thereby indicating positive effects of decreasing traffic.

The narrower group of public infrastructure interventions focusing on street design points to positive effects on primarily physical health. The review by de Sá et al. (2024^S), which is considered of high credibility, combines traffic-calming schemes with benches and lower curbs and finds a positive effect on physical activity. Barradas et al. (2022^S) only assess traffic-calming activities and likewise find positive effects on physical activity (walking and cycling). Finally, Ortegon-Sanchez et al. (2022^S) report a greater chance of observing active play on decorated footpaths, but no increase in users. The results of Barradas

et al. (2022^s) and Ortegon-Sanchez et al. (2022^s) should be interpreted with some caution, as the authors do not report the statistical significance of the effects.

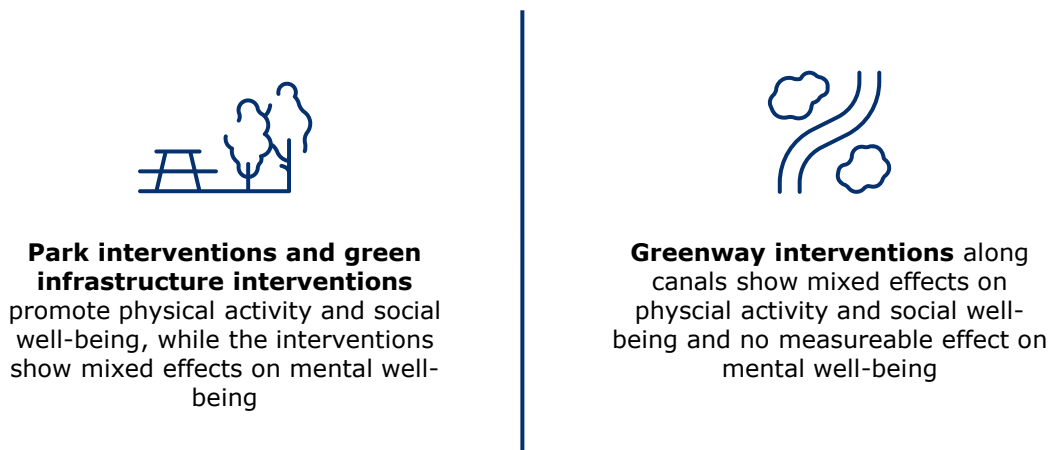
5.3 Green and Blue Spaces

How green and blue space interventions in urban areas impact physical, mental, and social well-being is a central question for urban development. With increasing urbanisation, more people live in dense cities where access to green spaces is often limited. As a result, researchers and planners recognise that improving access to these spaces could play a vital role in enhancing health and well-being in urban areas.

There are multiple ways in which green and blue spaces can promote health and well-being. The following chapter will explore several of these, including how green and blue infrastructure can provide spaces for physical activity, thereby promoting physical and mental well-being. Furthermore, green and blue spaces serve as public spaces within a community, and they can play a role in promoting social well-being.


Figure 5.2 below summarises the key insights from this research note regarding green and blue space interventions, categorised into two types: 1) park interventions and green infrastructure, and 2) greenway interventions along canals.

Figure 5.2: Key insights related to green and blue Spaces



Credibility of evidence

This section synthesises findings from ten studies: Five secondary research and five primary research. The secondary research studies have a **moderate** credibility score, while the primary research studies are rated with overall **moderately high** credibility. The credibility assessment is further explained in appendix C.



10
studies

5 primary studies of **moderately high quality**

5 secondary studies of **moderate quality**

Interventions

Interventions in green and blue spaces can be grouped into two main types. First, park interventions and green infrastructure are the most common, involving modifications to existing parks, the establishment of new parks or generally establishing green infrastructure. Second, greenways focus on developing or improving greenways, walking or cycling trails along canals. The following section will explore the identified types of interventions within green and blue spaces.

A number of studies examine the first type of intervention - park interventions and green infrastructure. Two reviews examine, among other interventions, the establishment of parks and access to parks. Hunter et al. (2019)^S identify park interventions as changes to the physical environment of the park. Furthermore, the review includes research that applies a dual approach to park interventions. A dual approach consists of combining changes to the physical environment of the park with programming or marketing events to promote the use of the park. Anderson et al. (2024)^P further explore a dual-approach to park interventions. Their study examines how co-designed, sustainable park improvements can influence well-being behaviour and increase walking in the United Kingdom. The park interventions include play and activity facilities, infrastructure such as tables and benches, and a community garden. The park intervention features a co-design element, allowing the community to influence design decisions. For instance, the community prioritized children and young persons in the design – the co-design process aimed to harness local knowledge and needs and facilitate symbolic ownership. Hooper et al. (2020)^P similarly examine park features such as parkland facilities, amenities, and quality, measured by a composite score of a mix of facilities and amenities. Four studies further explored park interventions and how these variations can increase the usability of green areas and physical activity. The intervention includes remodelling and renovating parks to increase their use, particularly for children, by establishing playgrounds or fitness and recreation facilities (Padiál-Ruz et al., 2021^S; MacMillan et al., 2018^S; Hernández et al., 2023^S; Nicosia et al., 2018^P). For two studies, green infrastructure interventions entail greening vacant lots, providing street trees, and installing rain gardens, green roofs, and other green infrastructure for stormwater management and cooling (Hunter et al., 2019^S; Moore et al., 2018^S).

The second identified type of intervention is greenways. Two quasi-experimental/natural experimental studies investigated the effects of a new urban greenway along canals on physical health and mental well-being. Benton et al. (2021)^S evaluated the impacts of renovating an urban canal in England, where the goal was to enhance the existing recreational area. The intervention consisted of establishing and resurfacing footpaths, enhancing the existing green elements, and improving park infrastructure such as benches, signage, and informal play equipment. Similarly, Hunter et al. (2021)^P utilized a renovation project of three rivers in Northern Ireland. Compared to the canal project in England, the greenways in Northern Ireland included multiple elements such as large, upgraded parks, multiple game areas, and park infrastructure such as bridges, toilets, and signage.

Well-being outcomes

In examining the relationship between green and blue spaces and health outcomes, the majority of the included studies focus either solely or partly on physical health (Hunter et al., 2019^S; Macmillan et al., 2018^S; Hunter et al., 2021^P; Padiál-Ruz et al., 2021^S; Benton et al., 2021^P; Anderson et al., 2024^P; Nicosia et al., 2018^P; Hernández et al., 2023^S; Hooper et al., 2020^P), where most of these measured physical health by physical activity. The measurements of physical activity include both subjective and objective methods. Subjective measurements consist of validated questionnaires and self-reports (Hernandez et al., 2023^S; Nicosia et al., 2018^P), as well as systematic observations such as the Method for Observing Health and Well-being activities (MOHAWk) or SOPARC (Anderson et al., 2024^P; Padiál-Ruz et al., 2021^S). Tools for objective measurements include accelerometers, GPS, and pedometers (MacMillan et al., 2018^S; Hernández et al., 2023^S).

A few studies examine mental health or well-being, either solely or alongside physical health (Hunter et al., 2019^S; Hunter et al., 2021^P; Hooper et al., 2020^P; Moore et al., 2018^S), using self-reports in questionnaires with validated mental health measurements or single survey questions. Mental health is operationalized as psychological distress and positive mental well-being, or as psychological functioning and subjective well-being (Hunter et al., 2021^P; Moore et al., 2018^S; Hopper et al., 2020^P).

Finally, a number of studies investigate social well-being within the theme of green and blue spaces (Hooper et al., 2020^P; Anderson et al., 2024^P; Hunter et al., 2021^P; Moore et al., 2018^S; Benton et al., 2021^P) However, social well-being is operationalized in multiple ways. In one study, social well-being is measured as a sense of community (Hooper et al., 2020^P), evaluated through self-reports in surveys. In two other studies, the focus is on neighbourhood social capital, which is operationalized as civic engagement, neighbourliness, social networks, and a sense of support (Hunter et al., 2021^P; Moore et al., 2018^S) or as connection, operationalized through social interaction with others within the immediate vicinity measured through, for instance, validated direct observation tools (Anderson et al., 2024^P; Benton et al., 2021^P).

Results

This research note finds that park interventions and green infrastructure generally promote physical activity and social well-being, while the effect of park interventions and green infrastructure on mental well-being varies. On the other hand, greenway interventions along canals indicate mixed effects on physical activity and social well-being and no effect on mental well-being.

The first type of intervention identified within green and blue areas - park interventions and green infrastructure - can promote physical activity and social well-being, but their observed effects on mental well-being remain inconsistent (Hunter et al., 2019^S; Anderson et al., 2024^P; Hooper et al., 2020^P; Moore et al., 2018^S). The two studies applying a dual approach to the park-intervention find positive effects on mental and social well-being and physical health. Anderson et al. (2024)^P examine a dual-approach intervention using a quasi-experimental/natural experimental study of a newly developed park that was co-designed by the community. The study finds an increase in walking at both 3- and 15-months post-intervention compared to the comparison site. Additionally, at 3 months post-intervention, the study identifies improvements in well-being behaviours, specifically an increase in "taking notice" (awareness of one's immediate external environment) and "connecting" (social interactions with others in the vicinity). Similarly, Hunter et al. (2019)^S highlight the effectiveness of a dual approach to park interventions, where physical improvements are combined with promotional efforts such as community engagement programs. Their review finds that five out of seven studies report increased park use and physical activity, particularly when playgrounds, active equipment, or walking paths are added. However, the credibility of Hunter et al.'s (2019)^S review scores low due to the absence of a pre-registered research protocol, which might have led to a less rigorous approach than a systematic review requires. Hooper et al. (2020)^P identify 32 studies that report a positive association between parkland design features in Living Neighbourhood such as access to green areas and quality of parkland facilities and recreational walking. However, only two of the 32 studies find a positive association between parkland design features — specifically park facilities, amenities, and quality — and improved mental well-being. Moore et al. (2018)^S examine six controlled before-and-after studies focusing on green infrastructure interventions, such as the addition of trees, parks, and lawns. The studies included in the review indicate that enhancing green infrastructure has positive effects on physical activity. However, there is no significant impact on mental health, but a positive effect on social well-being was observed, particularly concerning social isolation, which was mainly attributed to increased supportive interactions among neighbours. The studies focusing only on park infrastructure find positive effects on physical activity (Padial-Ruz et al., 2021^S; Nicosia et al., 2018^P; Hernández et al., 2023^S; MacMillan et al., 2018^S). Three studies find that specific park design characteristics and modifications of parks, such as playground availability or active transportation

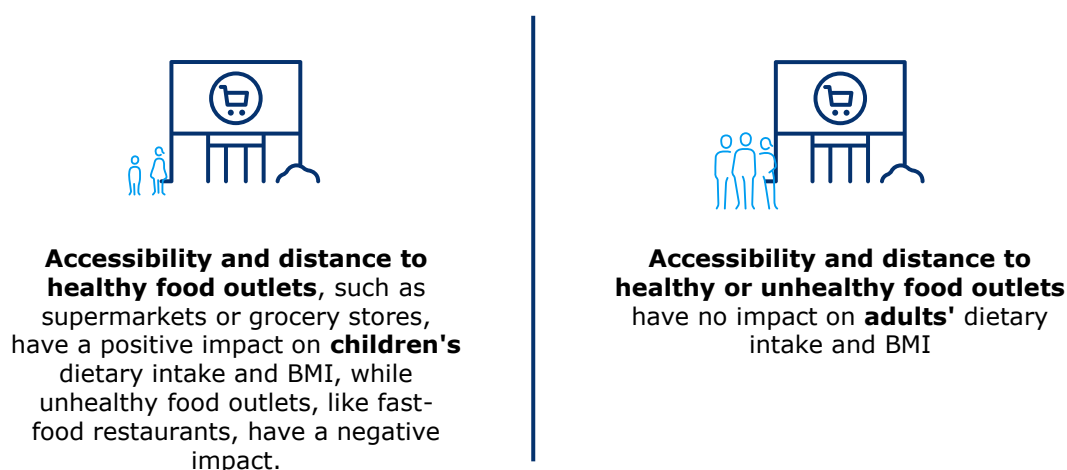
infrastructure, can enhance activity levels and lower childhood obesity rates (Nicosia et al. (2018)^P; Padial-Ruz et al., 2021^S; Hernández et al., 2023^S). The primary study by Nicosia et al. (2028) and review by Padial-Ruz et al. (2021)^S have a high credibility while Hernández et al. (2023)^S have moderate credibility. Arguably, threats to credibility may have influenced the included studies' results.

Finally, the two studies examining greenway interventions along canals find mixed effects on physical activity and social well-being and no effect on mental well-being (Benton et al., 2021^P; Hunter et al., 2021^P). Benton et al.'s (2021)^P natural experiment on an urban canal observes an increase in "connect" behaviour (social interactions with others) at 12 and 24 months post-intervention. Similarly, "take notice" (awareness of one's internal and external environment) increases at 24 months. Additionally, the study finds an increase in walking behaviour across all three follow-ups, while vigorous activity rises at 7 and 24 months. However, this research note identifies Benton et al.'s (2021)^P study as having moderate credibility due to a lack of a clearly defined population. In contrast, Hunter et al. (2021)^P find no evidence that a new urban greenway alongside three rivers in Northern Ireland increased physical activity. Similarly, they report no substantial differences in mental well-being, quality of life or social capital. The authors acknowledge that the seven-year gap between baseline and follow-up makes it difficult to account for confounding factors, such as demographic shifts and other societal changes, which might have affected the results. The moderate credibility of the two studies might explain some of the inconsistency in the effects on physical activity and social well-being.

5.4 Food Environment

Investigating the impact of urban food environments on health is a topic in the research literature related to urban planning and public health. Dietary habits play a key role in preventing chronic diseases like cardiometabolic disease, diabetes and obesity, and food environments in cities can be a factor shaping people's dietary behaviours. Urban planning decisions influence these food environments, as neighbourhood design, zoning policies, and infrastructure development affect people's access to fresh, nutritious food e.g. by determining the availability of food outlets such as supermarkets, grocery stores, and farmers' markets. Environments with greater availability of healthy food options can support healthier eating patterns, while areas dominated by fast-food outlets and convenience stores may contribute to unhealthy diets and increased obesity risk.

Figure 5.3: Key insights related to Food Environment interventions



Credibility of evidence

This section synthesises findings from 3 studies: zero primary research studies and three secondary research studies. The secondary research studies have a **high** credibility score. The credibility assessment is further explained in appendix C.



3
studies

0 primary studies

3 secondary studies of **high quality**

Interventions

The reviews primarily explore the impacts of opening food outlets such as supermarkets, farmers' markets, and grocery stores in neighbourhoods. An example from one of the reviews (Tseng et al., 2018^S) is a study examining the impact of introducing two farm stands in a community. These stands, located outside community centres, operated 2-3 hours one day a week over 12 weeks and sold only fruit and vegetables. They also accepted vouchers to help low-income families afford healthy food.

One review (Atanasova et al., 2022^S), however, takes a broader approach, considering food environments in terms of both the availability of and distance to healthy food outlets (e.g., supermarkets and grocery stores) and unhealthy food outlets (e.g., fast-food restaurants and convenience stores). Typically, intervention groups in the reviews are defined based on the distance between the citizens' homes or schools and food outlets, measured either as a straight-line radius or via actual travel distance along street networks.

Health outcomes

A common focus across the reviews is physical well-being, particularly self-reported dietary intake (such as consumption of fruit and vegetables, sugary drinks, or energy-dense foods) and BMI. Social well-being outcomes are not examined, and only one low-quality study within one of the reviews (MacMillan et al., 2018^S) reports on a mental well-being outcome related to psychological well-being. Since this is based on a single low-quality study, its results are not reported below

Results

Overall, the reviews provide limited evidence that food environments significantly impact dietary intake and BMI in adults (Atanasova et al., 2022^S; MacMillan et al., 2018^S; Tseng et al., 2018^S). However, one review (Atanasova et al., 2022^S), which includes the most rigorous individual studies, finds that greater availability and shorter distances to healthy food outlets have a positive effect on children's dietary intake and BMI. In contrast, proximity to and higher availability of unhealthy food outlets have a negative impact, regardless of the children's socioeconomic status.

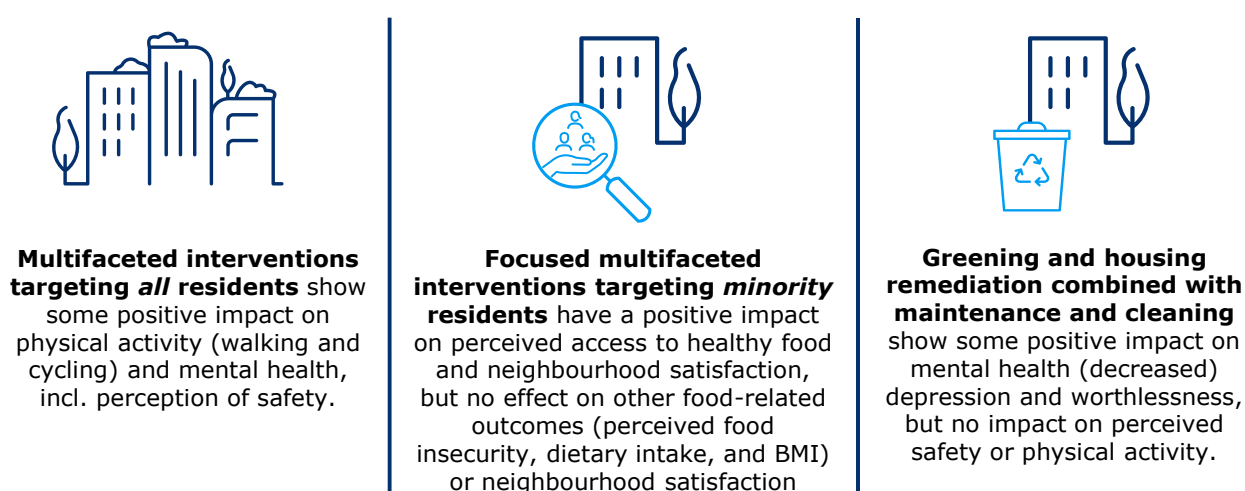
5.5 Urban Planning and Regeneration

Investigating the impact of urban planning and regeneration on public well-being is an important, albeit not thoroughly investigated, topic in the research literature related to the urban built environment and public well-being. The conditions in which people live play a crucial role in influencing health outcomes through their effects on lifestyle and behaviour. Urban regeneration efforts, such as renovating housing, improving public spaces, and upgrading infrastructure, can significantly alter the built environment in these neighbourhoods. Effective urban regeneration can enhance residents' access to essential services, such as healthcare, education, and recreational facilities, thereby supporting healthier lifestyles. Conversely, neglect or inadequate regeneration can perpetuate health disparities and poor living

conditions. Thus, urban regeneration serves as a critical component in shaping environments that promote public health and mitigate risks associated with degraded living conditions. Efficient urban planning can thus promote healthier communities by ensuring that the built environment facilitates positive health behaviours and reduces exposure to harmful factors.

Figure 5.4 below summarises the key insights from this research note regarding urban planning and regeneration interventions, categorised into three types: 1) multifaceted interventions targeting all residents, 2) focused multifaceted interventions targeting minority residents, and 3) interventions combining greening or housing remediation with cleaning and maintenance.

Figure 5.4: Key insights related to Urban Planning and Regeneration



Credibility of evidence

This section synthesises findings from nine studies: seven primary research studies and two secondary research studies. The primary research studies are rated with overall **moderately high** credibility, while the secondary research studies have an overall **moderate** credibility score. The credibility assessment is further explained in appendix C.



9 studies

7 primary studies of **moderately high quality**

2 secondary studies of **moderate quality**

Interventions

The literature identifies urban development and regeneration strategies categorised into three primary groups: large-scale, multifaceted neighbourhood interventions targeting all residents, focused neighbourhood interventions aimed at minority residents, and interventions combining greening or housing remediation with cleaning and maintenance.

Under the first theme, three primary research studies examine the impact of comprehensive urban interventions designed to enhance physical activity, mental well-being, and other health outcomes in deprived urban areas (Ruijsbroek et al., 2022^P; Hooper et al., 2020^P; Ram et al., 2020^P). These interventions typically combine enhancements in housing quality and availability, such as the construction

of new housing and the improvement of existing housing, alongside modifications to the surrounding environment, including the provision of food services, community centres, and commercial facilities. These initiatives are often components of broader municipal or national urban renewal policies. A systematic review further identifies similar multifaceted urban regeneration efforts, emphasising housing demolition and improvements, construction of new housing, improved access to amenities, and public space cleanup efforts (Moore et al., 2018^S).

Looking into the primary studies, Ruijsbroek et al. (2022^P) investigate interventions in 19 Dutch districts as part of a public health policy in the Netherlands, featuring capacity-building initiatives and environmental modifications. These interventions aim to promote physical activity and social interaction through small-scale sports fields, playgrounds, vegetable gardens, and enhanced public health access via a new health centre. Similarly, Hooper et al. (2020^P) evaluate urban development at a national policy level in Western Australia, focusing on the creation of compact, pedestrian-friendly neighbourhoods through three main interventions: 1) community design interventions aimed at establishing diverse activity hubs (e.g., mixed-use activity centres, land-use mix, and access to primary schools), 2) lot layout interventions to increase residential density and housing diversity, and 3) interventions focused on design, quality, aesthetic and safety (e.g., graffiti removal, traffic slowing, street lighting). In total, Hooper et al. (2020^P) synthesise the findings from 28 studies of the Australian policy. Additionally, Ram et al. (2020^P) examine the mental health effects of relocation to a newly built neighbourhood in London, characterised by improved access to public transportation, proximity to parks, and enhanced walkability compared to participants' former neighbourhoods.

Two studies examine the second group of large-scale, multifaceted interventions specifically designed for low-income areas with minority residents (Dubowitz et al., 2019^P; Dubowitz et al., 2024^P). Both studies explore the impact of community investments in two low-income neighbourhoods in Pittsburgh, where one received 2.6 times the investments of a similar neighbourhood over seven years. The investments included housing improvements, the construction of mixed-income and affordable housing, and enhancements to the built environment, such as food retail, green space renovations, and economic and commercial development. Another type of interventions targeting minority groups is identified in the review by de Sá et al. (2024^S), which includes two studies that aim at making public spaces safer and more accessible for elder citizens through the creation of barrier-free routes, installation of more benches, separation of cycle lanes and other safety risks, and lower curbs.

Finally, the third group of interventions investigates a distinct aspect of urban regeneration through regeneration interventions supplemented with cleaning efforts aimed at improving residents' mental health in low-income areas. South et al. (2018^P) compare two cleaning interventions in Philadelphia (US); one involving the greening of vacant land (grading, planting grass, and a small number of trees) combined with regular maintenance and trash removal, and another consisting solely of routine neighbourhood trash cleaning. Subsequently, South et al. (2023^P) examine new neighbourhood interventions in Philadelphia, comparing the effects of housing remediation paired with regular trash cleaning in front of houses to an intervention focusing solely on trash removal.

Health outcomes

The included studies measure well-being from physical, mental, and social perspectives, with a predominant focus on indicators of physical well-being.

Physical well-being is assessed through various indicators across the studies, with a common emphasis on physical activity. This is measured objectively using accelerometers (Dubowitz et al., 2019^P; de Sá et al., 2024^S) and subjectively through self-reported physical activity, including leisure-time walking, cycling, sport participation, and general time spent outside (Dubowitz et al., 2019^P; Ruijsbroek et al., 2022^P; South

et al., 2023^P; Hooper et al., 2020^P; de Sá et al., 2024^S). Another key metric involves food access and dietary intake. Measured aspects include self-reported food insecurity using the Adult Food Security Survey Module (Dubowitz et al., 2024^P), self-reported dietary intake focusing on quality through the Healthy Eating Index-2010 and sugar intake (Dubowitz et al., 2024^P; Hooper et al., 2020^P), as well as objectively measured BMI (Dubowitz et al., 2019^P; Dubowitz et al., 2024^P; Hooper et al., 2020^P) and self-reported overweight (Ruijsbroek et al., 2022^P). Additionally, one study assesses smoking status (Ruijsbroek et al., 2022^P).

Most studies on mental well-being rely on self-reporting using validated scales, such as the Kessler-6 Psychological Distress Scale (K6) (South et al., 2018^P; Dubowitz et al., 2019^P) and the Hospital Anxiety and Depression Scale (HADS) (Ram et al., 2020^P). Other measurement methods consist of selected items related to mental health, such as "life satisfaction", "feeling life is worthwhile", and "feeling happy" (Ram et al., 2020^P, Ruijsbroek et al., 2022^P), as well as perceptions of safety and psychological distress (Ram et al., 2020^P; Dubowitz et al., 2024^P; Hooper et al., 2020^P). Neighbourhood satisfaction and perceptions of neighbourhood quality and safety are also gauged through self-reported parameters (Dubowitz et al., 2024^P; Ram et al., 2020^P).

Social well-being is less frequently used as an outcome measurement with only one study evaluating interventions based on self-reported sense of community (Hooper et al., 2020^P).

Results

Overall, this chapter finds mixed evidence that urban planning and regeneration significantly impact physical, mental and social health for residents. The literature identifies urban development and regeneration approaches categorised into three primary groups: large-scale, multifaceted neighbourhood interventions targeting all residents, focused neighbourhood interventions aimed at minority residents, and interventions combining greening or housing remediation with cleaning and maintenance.

The effects of large-scale, multifaceted neighbourhood interventions targeting all residents point to some positive effects across the studies. The study by Hooper et al. (2020^P), which is considered of high credibility, finds some statistically significant effects of community design interventions on physical activity (increased walking and cycling), mental well-being (improved mental health and safety from crime), and social well-being (enhanced sense of community). Furthermore, interventions focused on design, quality, aesthetics, and safety also show positive impacts on the above indicators. However, interventions targeting lot layout have minimal effects on physical activity (walking and cycling), while they exhibit some influence on mental well-being (safety from crime) and social well-being (sense of community). Conversely, two other studies, considered of respectively moderately and moderately high credibility, (Ruijsbroek et al., 2022^P; Ram et al., 2020^P) report no strong evidence of improvements in physical and mental well-being from large-scale, multifaceted interventions, though Ram et al. (2020^P) note an increase in neighbourhood perception following relocation to a newly built neighbourhood. Finally, Moore et al. (2018^S) do not find strong evidence on physical and mental well-being, though these results should be interpreted with some caution as the review is considered of low credibility.

The effects of focused neighbourhood interventions on minority residents' well-being are mixed. The study by Dubowitz et al. (2024^P), which is considered of moderate credibility, finds significantly positive changes in perceived access to healthy food, a component of physical activity, but no effects on perceived food insecurity, dietary intake, and BMI. An earlier study by Dubowitz et al. (2019^P), which is likewise considered of moderate credibility, reports no effect on physical activity and BMI. Regarding mental well-being, Dubowitz et al. (2019^P) observe no improvement in psychological distress. For social well-being Dubowitz et al. (2024^P) note an increase in neighbourhood satisfaction, while no improvement is observed by the earlier study by Dubowitz et al. (2019^P). It should however be highlighted that both studies' control

groups received substantial, albeit smaller, investments in their built environments during the intervention period, which may complicate comparisons between treatment and control groups by making it difficult to isolate the effects of the intervention. For instance, Dubowitz et al. (2019^P) identify simultaneous significant improvements in each neighbourhood in mental well-being (perceptions of aesthetics and safety), and social well-being (social cohesion), thereby indicating that investments in both neighbourhoods have effects on residents' well-being. For the multi-facet interventions targeting elder citizens, the two relevant studies included in the review by de Sá et al. (2024^S) both find that interventions in public spaces to enhance safety and mobility have positive effects on elders' physical activity in the form of increased walking activity. It should however be noted, that de Sá et al. underline that one of these studies has "serious validity concerns overall due to moderate concerns regarding its result selection, outcome measurement, and missing data", and the conclusions of the review should therefore be interpreted with some caution.

Finally, some effects of interventions combining greening or housing remediation with cleaning and maintenance are identified across the studies. In the study by South et al. (2018^P), which is considered of high credibility, such interventions show positive effects on mental health, specifically lowering levels of depression and feelings of worthlessness. Conversely, a later study by South et al. (2023^P), which is considered of moderately high credibility, finds no impact on mental health (perception of safety) or physical activity (time spent outside) when combining housing remediation with regular cleaning and maintenance. Both studies report no significant effects on these indicators when solely implementing regular cleaning and maintenance interventions in neighbourhoods. Given the nature of these interventions, which involve modifications to specific aspects of residents' living environments, it is important to note that isolating and accurately estimating their exact effects from other variables in the overall living environment can be challenging

6. EMERGENT TRENDS AND POTENTIALS

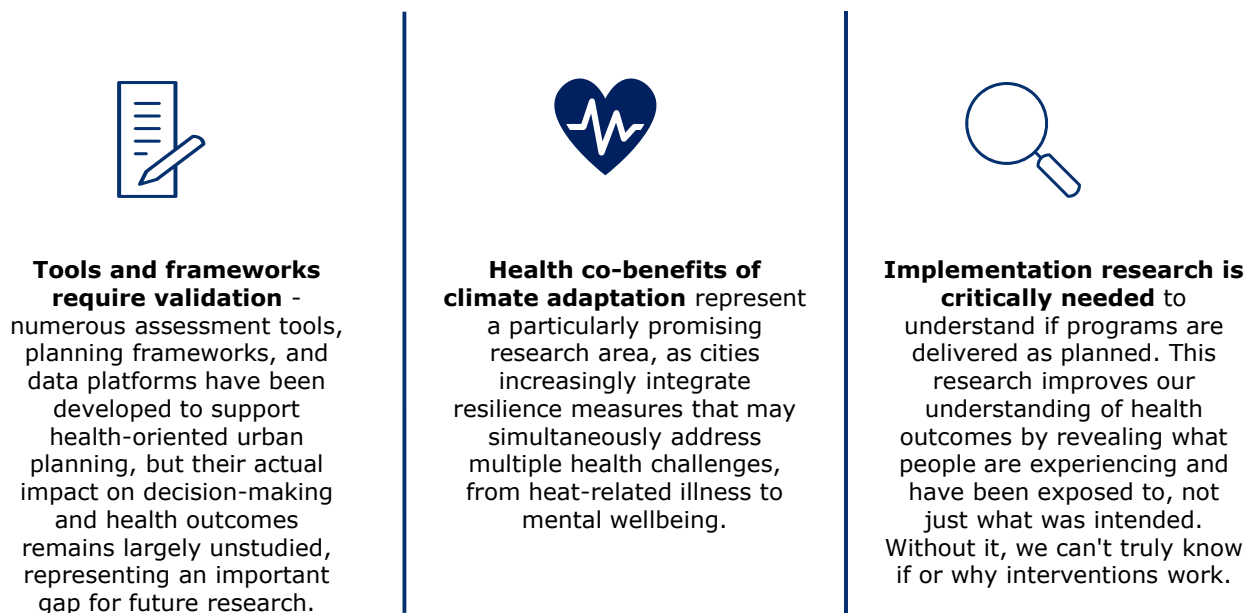
The previous chapters detail the fragmented evidence on interventions within the built environment that potentially influence health outcomes. There can be many reasons for the lack of solid evidence, not least the complexity that arises from the inherently interdisciplinary nature of urbanization and health research, compounded by the methodological challenges of establishing definitive causal relationships in urban contexts.

To supplement these findings, this chapter therefore synthesizes key trends and emerging approaches in health-promoting urban planning, with a specific focus on Northern Europe, Western Europe, and Anglo-Saxon regions. The analysis integrates diverse sources, including grey literature, policy briefings, and expert insights, to provide an overview of contemporary strategies for, and emergent trends in, promoting health through urban design. Many of these can be summarized as 'place-making' approaches in cities.

It is important to note that this chapter adopts a more flexible approach to inclusion criteria and review methodology compared to previous chapters, prioritizing comprehensive insight over strict methodological constraints.

Figure 6.1 below summarises the key insights from the grey literature.

Figure 6.1: Key insights related to emergent trends and potentials



6.1 Thematic intersections with built environment research themes

The analysis reveals significant overlap between the empirical evidence reviewed, and the trends and emergent areas set out in the body of grey literature:

- **Improving air quality and reducing environmental pollution**

It is highlighted in the grey literature that poor air quality represents a significant determinant of health outcomes, contributing to respiratory illnesses and other adverse conditions (C40, 2023a). Consequently, urban planning interventions aimed at reducing air pollution have become crucial for public health improvement efforts (C40, 2023a). The expansion of London's Ultra Low Emission

Zone (ULEZ), which restricts the most polluting vehicles, exemplifies this approach. This initiative has demonstrably improved air quality, leading to a nearly 50% reduction in NO₂ concentrations in central London. Driven by the C40 Accelerator program, London's experience highlights the potential impact of strategic zoning and regulation on urban air pollution levels and, consequently, on human health (C40, 2023a). There is scope to conduct robust research, not just on the impact of emission levels but also on the health impacts of low emission zones for different population groups and areas.

- **Transport and mobility: improving active transport and fostering healthy streets**

A dominant theme in the grey literature is how encouraging active modes of transportation like walking and cycling serves multiple objectives, including reducing reliance on motorized transport with its associated pollution while simultaneously promoting physical activity (WHO, 2018). Central to this trend is the reallocation of road space and improvement of infrastructure dedicated to active transport modes. In Flanders, Belgium, the development of a practical and objective tool for assessing neighbourhood "walkability" exemplifies efforts to create environments conducive to active transport (UN-Habitat & WHO, 2020). This tool, intended for use by local authorities, emphasizes the importance of high housing density, mixed land use patterns, and good street connectivity in promoting walking behaviours (UN-Habitat & WHO, 2020). Strategic urban planning principles, such as the "locate to co-locate" approach, which aims to integrate facilities to ease access by foot, bicycle, and public transport, are also increasingly promoted to create environments that naturally encourage physical activity and thereby improve health outcomes (WHO: 2018, Gehl Architects with WHO 2017). The implementation and health impact of such tools and principles could be researched further. In the literature and insights gathered from the project's expert advisors, it is also clear that concepts such as the 15-minute city, superblocks, car-free neighbourhoods, etc. have gained traction across the world but that the evidence on the actual impact of implementing these types of concepts is still in an early development phase.

- **Practical tools for green and blue spaces and biodiversity enhancement**

The grey literature highlights how nature-based solutions and access to green and blue spaces in cities can offer numerous potential health benefits, including improved physical and mental well-being, opportunities for recreation, and mitigation of the urban heat island effect⁴. Enhanced biodiversity and an increase of nature in cities further contribute to overall ecosystem health (Nordregio, 2024). The NORDGREEN project across Nordic countries focuses specifically on planning, designing, and managing health-promoting urban green spaces (Nordregio, 2024). It involves using sets of local and regional health and greenspace data, Public Participation Geographic Information Systems (PPGIS) applications and surveys, and analysis of ongoing planning and management, to create 'smart' tools to investigate the relationship between greenspace accessibility and public health outcomes. The framework developed through this project encompasses examples from cities like Täby and Vilhelmina (Sweden), Espoo (Finland), Aarhus (Denmark), and Stavanger (Norway), illustrating different aspects of this trend and the potential for promoting public health (Nordregio, 2024). The implementation and health impact of such tools and frameworks could be researched further.

- **Fostering healthy and sustainable food environments**

Urban planning strategies are increasingly focusing on shaping local food environments to encourage healthier eating patterns. The grey literature highlights growing concerns about the over-availability of unhealthy food options, particularly near schools (UN-Habitat & WHO, 2020).

⁴ According to MITs climate portal, the urban heat island effect is a phenomenon whereby cities experience higher air temperatures than the surrounding countryside

The Commission on Creating Healthy Cities similarly recommends consideration of regulations around fast-food restaurant density and locations (Commission on Creating Healthy Cities, 2022). While these represent emerging local policy directions rather than widely implemented practices, they signal an important trend in public health discussions and, in some cases, policy development (Commission on Creating Healthy Cities, 2022). Within this area, a growing recognition of the need to shift toward more plant-based diets and reducing food waste for both individual and planetary health has also emerged in recent years (C40, 2023b). The C40 "Good Food Cities Accelerator" represents one initiative working specifically to foster a focus on healthy and sustainable food environments at a city level. The accelerator encompasses several projects focused on initiatives such as aligning local food procurement, reducing food loss and waste and fostering community engagement to ensure that local stakeholders work together to implement measures inclusively and equitably (C40, 2023b).

- **Prioritizing resilience and climate adaptation**

Urban planning is evolving to incorporate climate adaptation and mitigation as a core health strategy. This involves creating green infrastructure, enhancing flood defences, and integrating climate adaptation measures into urban design (C40, 2023c). These efforts aim to help cities withstand environmental challenges while simultaneously promoting public health. For example, Paris prioritizes adaptation in its climate plans, focusing on protecting the most marginalized populations from the effects of overheating. The 'Heat Islands' programme ensures a high percentage of residents are within a short walk of cooling spaces, crucial for public health during heatwaves. Paris has also welcomed new and renovated green spaces and is working to improve tree canopy cover through the Tree Plan 2026 (ibid). These strategies can have potential health co-benefits on many areas of public health, including heat-related health issues, improved air quality and mental health. The expert advisers to this project have particularly highlighted the potential of researching the health co-benefits of climate adaptation in further detail.

6.2 Systemic approaches to urban health

Beyond specific thematic interventions, the grey literature and expert advisors emphasise the importance of holistic and assets-based approaches to support health through urban development, for and with the people who inhabit cities across the world:

- **Designing People-Centric Cities: Participatory design**

Modern urban planning has evolved to prioritise human needs and social equity, moving far beyond traditional infrastructure development. At the heart of this approach is the recognition that cities must be designed with and for their inhabitants, creating environments that support holistic well-being and address complex social dynamics. Participatory design has emerged as a critical strategy in this transformation – although expert advisors involved in this project highlight that funding constraints persist to interfere with a thorough design process that can help ensure genuine involvement and capacity building. Cities like Rotterdam demonstrate the power of directly involving citizens in urban planning processes (Robert Bosch Stiftung 2019). By engaging community members in decision-making, urban spaces can more effectively reflect the diverse needs of their residents, for example in the access to health facilities, community buildings etc. This approach goes beyond consultation, instead treating residents as active collaborators in shaping their living environments. Involving citizens in the design of new urban developments can also increase usability, thereby increasing the degree of exposure to an intervention that can subsequently be researched.

- **Equity and inclusion**

Social inclusion has also become a central focus of contemporary urban health strategies. Recognizing persistent disparities in health outcomes across different population groups, there is an increasing focus on creating inclusive urban environments that promote health equity (WHO, 2022). The Nordic City Network highlights that while Nordic countries have historically experienced low segregation levels, rising inequality necessitates a renewed focus on social inclusion through housing policies, inclusive dialogue processes, and feminist urbanism principles (Nordic City Network, 2023). For example, this report highlights a feminist architecture project at Buens Torv in Denmark which has developed a set of practical urban interventions such as wayfinding, urban furniture and community spaces to create a more inclusive urban space for women, thereby potentially boosting both mental health and physical health outcomes related to active transport choices.

In terms of evidence generation, researchers are exploring emerging areas that investigate inequalities and their impact on health outcomes, particularly focusing on understanding the relationship between changes to the built environment and health outcomes for specific groups such as migrants, older people, children and LGBTQ+ citizens, by providing a set of indicators and metrics for gauging progress (WHO, 2022; Gehl Architects and Robert Wood Johnson Foundation, 2017). However, evidence remains to be generated on the utilization and outcomes of such tools.

- **Innovation Infrastructure and Data-Driven Decision-Making**

Addressing complex urban health challenges requires innovative solutions that encompass technological advancements, changes in norms and institutions, and novel approaches to urban structures. The World Health Organization highlights approaches like Utrecht's comprehensive innovation strategy, which focuses on two top priority policy areas: healthy urban living for everyone, and transport/mobility. The work includes initiatives such as the Social Impact Factory, aimed at strengthening the innovation ecosystem for urban health by building cooperation among social entrepreneurs and increasing their visibility, and open data platforms to stimulate urban development innovation (WHO, 2024). A software tool developed by the 'Global Observatory of Healthy and Sustainable Cities' could also be highlighted here. This tool has been developed to measure, monitor and report on policy and spatial urban indicators for healthy, sustainable cities worldwide, using open or custom data⁵.

Effective health-promoting urban planning also requires a strong foundation of data and evidence to understand local contexts, identify specific needs, monitor progress, and evaluate intervention impacts (UN-Habitat & WHO, 2020). Practical examples of this development include London's expanded Ultra Low Emission Zone (ULEZ) implementation, which was supported by extended air quality measurements to create a robust data basis for interventions (C40, 2023a). Similarly, Copenhagen is recognized for its systematic data collection and evaluation practices that inform urban development and promote cycling (WHO Regional Office for Europe, 2017; Gehl Architects with WHO, 2017). The scope is to evaluate on usage and impact of such tools to further strengthen the field and ensure consistency in the measurement approaches taken in relation to the health benefits captured.

- **Practical Tools and Implementation Support**

The recognition that health is fundamentally linked to the built environment has driven a growing trend toward embedding health considerations into all stages of urban and territorial planning (Juul Frost Architects, 2022). The development of tools like checklists for planners or the

⁵ <https://global-healthy-liveable-cities.github.io/software/>

"Polyphonic Planning Tool" in Danish municipalities exemplifies efforts to facilitate multidisciplinary, needs-based planning that considers diverse social, physical, and mental health needs (ibid). The tool provides a framework for a planning approach that is centred on health-related building blocks such as: equity in health, quality of life, social neighbourhoods, green areas and active living. It has been developed in partnership with and piloted in two Danish municipalities to ensure usability – however the usage and effect of the tool has not yet been evaluated.

Achieving health-promoting urban environments requires robust governance structures that facilitate cross-sectoral collaboration and effective resource allocation (UN-Habitat & WHO, 2020). WHO policy briefs on governance and financing underscore the need for strategic coordination among stakeholders and exploration of innovative financing mechanisms such as combined budgets or repurposing existing assets and resources, to support urban health goals (WHO, 2024; WHO European Office, 2022). Robust evaluations of the usage or effects of such tools have not been identified, thereby also indicating a potential area for further research.

Several experts involved in the expert panel also highlight the lack of implementation research to understand where the implementation barriers for health-promoting urban development lie, including creating a better understanding of the most effective governance and financing structures.

6.3 Perspective

The final chapter has provided supplementary perspectives that complement and extend the more rigorous evidence review presented in preceding chapters. Although the methodological approach employed in this section differs from the systematic review methodology – with sources selected through a more exploratory and interpretive lens – the insights generated offer valuable nuance to the understanding of health-promoting approaches in urban planning. These emergent perspectives serve not as definitive conclusions, but as signposts indicating underexplored territories with potential for future academic and robust practical investigation.

7. APPENDIX A: METHODOLOGY

7.1 Rapid Evidence Assessment

To present a coherent understanding of how changes to or interventions in the built environment in urban areas influence public health, a Rapid Evidence Assessment (REA) was employed. This method is an efficient way to synthesize research, offering time and cost benefits crucial for swift decision-making in healthcare and policy domains. However, it is important to note that REAs, due to their expedited nature, may not encompass all studies and might offer a less exhaustive analysis compared to full systematic reviews. This limitation can impact the depth and certainty of the conclusions drawn. The effectiveness of an REA hinges on the existing research's quality and breadth.

The **understanding of the built environment** is based on Handy et al. (2002): The built environment encompasses urban design, land use, and transportation systems, shaping patterns of human activity within the physical surroundings. It includes the arrangement and appearance of cities, the distribution and density of activities (such as residential or commercial areas), and the infrastructure that supports movement, like roads, sidewalks, and bike paths.

Source: Handy, Susan L.; Boarnet, Marlon G.; Ewing, Reid; Killingsworth, Richard E. (2002). "How the Built Environment Affects Physical Activity"

The **understanding of public health** aligns with WHO's overarching definition of health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.' While WHO does not explicitly define physical, mental, and social well-being, it was interpreted as follows:

- Physical well-being: The body's ability to function efficiently and stay free from illness.
- Mental well-being: The mind's ability to manage thoughts, emotions, and stress effectively.
- Social well-being: The ability to build positive relationships and engage in society

In relation to physical well-being, particular interest was given to health outcomes related to cardiometabolic health. The **understanding of cardiometabolic health** is drawn from WHO's definitions of cardiovascular diseases and their associated risk factors. Cardiometabolic health refers to the optimal functioning of the cardiovascular and metabolic systems, encompassing healthy blood pressure, cholesterol, blood glucose levels, body weight, and waist circumference. These factors collectively reduce the risk of conditions such as heart disease, stroke, and type 2 diabetes.

An REA involves several key steps. First, criteria for selecting studies must be established. Second, a search strategy for scientific papers and articles needs to be developed. Third, once the initial search is

complete, the articles should be evaluated and screened for relevance based on inclusion criteria (see Section 7.1.1). Finally, decisions must be made regarding what to extract from the articles and how to assess the quality of the evidence they present.

7.1.1 Inclusion criteria

In the REA, a broad thematic focus on the built environment's impact on public health was initially adopted. However, the scope was narrowed down by including only studies that examined actual changes or interventions in the built environment. This approach enabled the use of higher-quality methodological designs while also limiting the number of studies to a manageable scale within the constraints of the assignment. The specific criteria for inclusion are presented in the table below.

Table 7.1: Inclusion criteria

Parameter	Criteria
Publication language	English
Publication year	From 2018 up to and including 2025
Country of data collection*	<ul style="list-style-type: none"> Northwestern Europe: Belgium, Denmark, Finland, Northern France, Germany, Ireland, Iceland, Luxembourg, the Netherlands, Norway, Sweden, the United Kingdom Anglo-Saxon countries (not part of Northwestern Europe): Australia, Canada, New Zealand and the United States Singapore
Type of studies	<ul style="list-style-type: none"> Primary quantitative research Secondary research based solely on quantitative research
Design	Investigate a change to or an intervention in the built environment either by using <ul style="list-style-type: none"> control and treatment groups (e.g. Randomized controlled trials, natural experiments or quasi-experiments) or longitudinal within-subject designs allowing comparisons within the same individual over time.
Interventions	<ul style="list-style-type: none"> The study must focus on changes or interventions related to the built environment in urban areas. Local policies impacting the built environment are included, while national policies are excluded. Changes or interventions affecting individual buildings are not considered.
Outcome	The study must investigate one or several outcomes related to the citizens' physical, social or mental health

Note: * Reviews were permitted to include up to 20% of studies with data from countries outside the inclusion criteria.

7.1.2 Search strategy

The literature search was conducted using two primary databases: PubMed and Web of Science. PubMed, known for its extensive collection of medical and life sciences literature, provided in-depth resources, primarily within these disciplines. Web of Science, with its wide-ranging scope covering social sciences, urban planning, geography and humanities, complemented PubMed by offering insights into the broader impacts of the built environment on public health. This strategic combination of databases enabled us to compile a rich and diverse array of research, ensuring a comprehensive mapping of the subject.

The search used a combination of targeted terms designed to identify studies — both primary and secondary research — examining health outcomes in urban areas, with a focus on those applying an

experimental design logic. This approach allowed for a broad scope without predefining specific types of built environment interventions.

The complete search string consisted of three search blocks (see Table 6.2). The first block captured the urban context of the studies. The second block included keywords related to health outcomes, ensuring the focus remained on public health impacts. The third block aimed to enhance the likelihood of identifying empirical studies — both primary and secondary research — that applied experimental design logic to assess the causal effects of interventions or changes in the built environment.

While extensive, the search strategy was not designed to be exhaustive; there are possibly relevant studies in other databases or that could be found using alternative search terms. However, the approach was developed to strike a balance between depth and breadth. This planning ensured that key studies in both specialized medical fields and broader interdisciplinary areas were covered. Such a comprehensive search was essential to understand the complex relationships between characteristics in the built environment and the broad aspects of public health, allowing for a holistic analysis of the impact on citizens’ health when making changes to the built environment.

Table 7.2: Keywords used in Rapid Evidence Assessment

Block 1: Urban areas	"city" OR "citi*" OR "urban*" OR "built environment*" OR "neighborhood*" OR "neighbourhood*" OR "housing"
AND	
Block 2-1: Outcome (keywords linked to Mental Health)	"mental health" OR "health" OR "psychological health" OR "depression" OR "psychological well-being" OR "psychological well-being" OR "mental well-being" OR "mental well-being" OR "quality of life" OR "safe mobility" OR "safe transit" OR "lonely" OR "loneliness" OR "isolation" OR "isolated" OR "well-being" OR "well-being"
OR	
Block 2-2: Outcome (keywords linked to Physical Health)	"physical health" OR "cardiovascular disease*" OR "vascular disease*" OR "cardiometabolic disease" OR "cardiometabol*" OR "heart disease*" OR "infarction*" OR "ischemic heart disease*" OR "transient ischemic attack" OR "coronary artery disease*" OR "coronary occlusion*" OR "heart failure" OR "cerebrovascular disease*" OR "cerebrovascular accident*" OR "cerebrovascular event*" OR "aortic disease*" OR "aortic aneurysm*" OR "arrhythmia*" OR "angina pectoris*" OR "hypertensive heart disease*" OR "rheumatic heart disease*" OR "pulmonary heart disease*" OR "heart attack*" OR "heart arrest*" OR "obese" OR "obesity" OR "overweight" OR "blood pressure" OR "physical activit*" OR "physical inactivit*" OR "hypertension" OR "stroke" OR "coronary heart disease" OR "myocardial infarction" OR "CVD mortality" OR "non-communicable disease*" OR "NCD*" OR "weight gain" OR "insulin resistance" OR "excess weight" OR "cholesterol" OR "prediabetes" OR "diabetes" OR "diet" OR "nutrition" OR "food system*" OR "smoking" OR "exercise*" OR "alcohol*" OR "sedentary lifestyle*"
OR	
Block 2-3: Outcome (keywords linked to Social Health)	"social health" OR "social well-being" OR "social well-being" OR "social cohesion" OR "social capital" OR "social support" OR "social connected*" OR "social equity" OR "social bond" OR "social trust" OR "neighborhood safety" OR "inclusion" OR "social inclusion" OR "social justice"
AND	

Block 3: Methods and type of study

"association*" OR "intervention*" OR "land use" OR "design*" OR "longitudinal" OR "plan*" OR "configuration" OR "initiative*" OR "develop*" OR "layout" OR "relationship*" OR "follow*" OR "effect*" OR "impact*" OR "randomized controlled trial*" OR "RCT" OR "experiment*" OR "evaluat*" OR "evidence" OR "link*" OR "influenc*" OR "before-after" OR "time-series" OR program* OR "prospective stud*" OR "meta analys*" OR "meta-analys*" OR "meta synthes*" OR "meta review" OR "meta-review" OR "systematic review" OR "scoping review" OR "umbrella review" OR "narrative review" OR "integrative review" OR "literature review" OR "critical review" OR "comprehensive review" OR "rapid review" OR "evidence synthesis" OR "rapid evidence assessment"

7.1.3 Study selection

In the initial search, 11,035 studies were identified (PubMed: 5,027; Web of Science: 6,008) and removed 281 duplicate publications. The list was then refined by prioritising studies whose titles and abstracts contained key terms relevant to the research focus. Specifically, all studies were screened in relation to 1) the built environment⁶, 2) urban planning⁷, 3) interventions at the local scale⁸ and 4) interventions within specific thematic areas⁹ (as detailed in table 7.3).

Table 7.3: Keyword search for study selection

Intervention	Keywords
Transportation & Mobility	"bicycle", "bik", "cycl", "path", "lane", "trail", "route", "school", "connectivity", "infrastructure", "naked street", "pedestrian", "public transport", "public transit", "road environment", "road traffic noise", "shared space", "sidewalk", "street connect", "street environment", "streetscape", "sustainable safety", "traffic", "road", "travel", "mobility", "transport", "walk"
Green/blue	"blue space", "green infrastructure", "green space", "greenspace", "nature-based solutions", "NBS", "NDVI", "park", "recreational facilit", "tree cover", "tree canopy", "forest", "greening", "vegetation", "green corridor", "green belt", "greenbelt", "green way", "greenway", "garden", "urban agriculture", "living wall", "urban wetlands", "green-blue", "coast", "river", "lake", "bay", "canal", "harbor", "harbour", "waterfront", "waterway", "bioswale", "stormwater", "rain", "natural playground"
Sustainability/climate	"biodivers", "carbon neutral", "circular economy", "climate", "eco-city", "ecosystem", "energy effic", "green interventions", "low-carbon", "resilien", "sustain", "emission"

⁶ Studies with titles or abstracts containing: "built environment"

⁷ Studies with titles or abstracts containing: "urban typology", "urban type", "urban study", "urban environment", "urban morphology", "urban configuration", "urban form", "urban area", "urban planning", "urban development", "urban design", "urban factor", "urban feature", "urban characteristic", "urban density", "urban land use", "urban land cover", "urban infrastructure"

⁸ Studies with titles or abstracts containing both interventions ("intervention", "initiative", "program", "policy", "policies", "configuration", "redevelopment", "modification", "revitalization", "retrofitting", "transformation", "conversion", "development", "construct") AND local scale ("neighborhood", "neighbourhood", "street", "district")

⁹ Studies with titles or abstracts containing both interventions ("intervention", "initiative", "program", "policy", "policies", "configuration", "redevelopment", "modification", "revitalization", "retrofitting", "transformation", "conversion", "development", "construct") AND at least one word from themes: transport/mobility, blue/green spaces, food systems, supply, sustainability/climate, air and noise pollution, lightning, local services. Words associated with theme are listed in table 7.3.

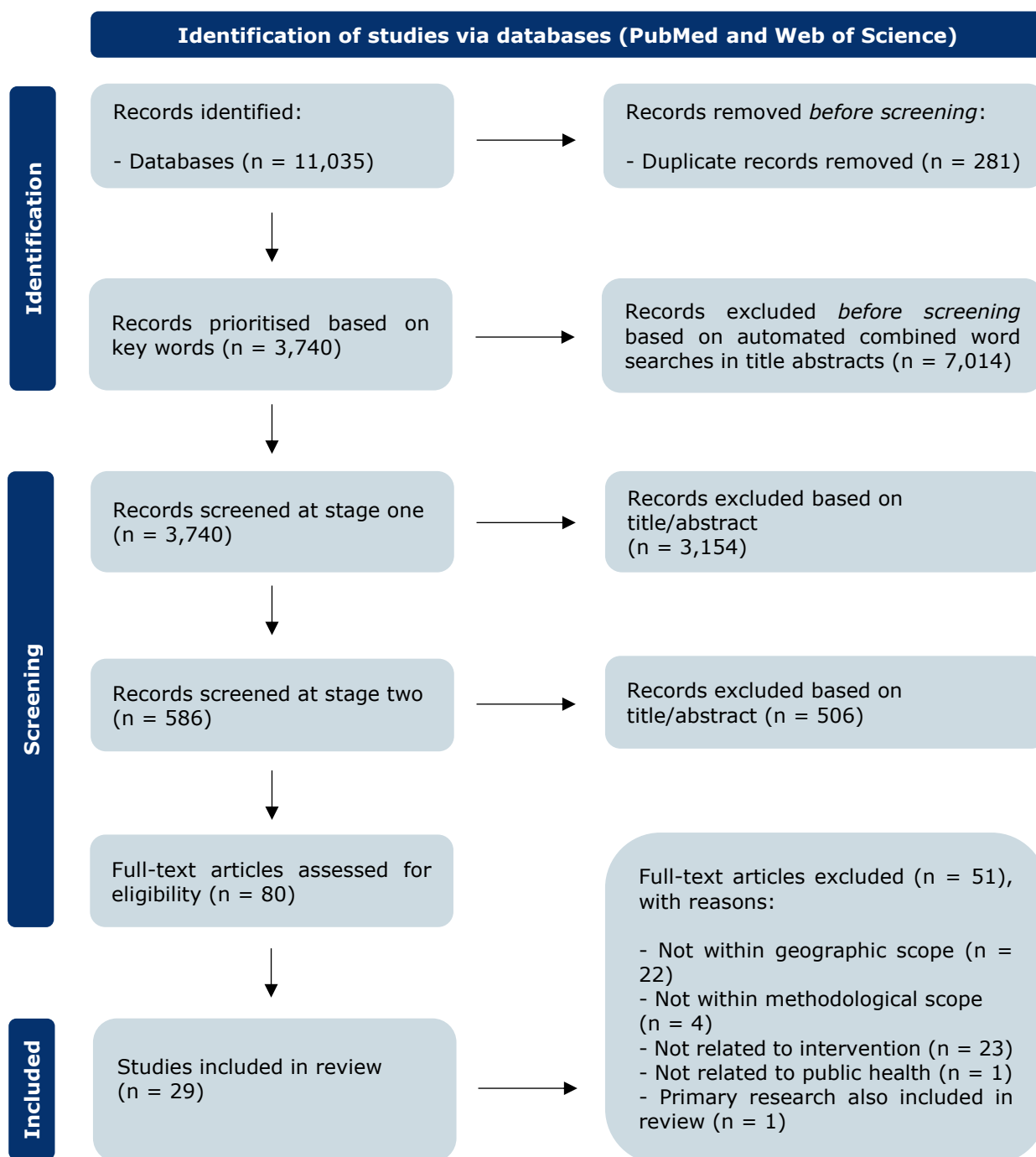
Air and noise pollution	"air pollut", "air quality", "carbon monoxide", "fine particulate matter", "PM2.5", "PM10", "nitrogen dioxide", "nitrogen oxide", "NO2", "NOx", "ozone", "sulfur dioxide", "SO2", "VOC", "volatile organic compound", "noise", "noise pollut", "environmental noise", "soundscape", "urban noise management", "noise regulation", "noise mitigation", "noise annoyance", "perceived noise", "sound barriers", "noise control", "quiet areas", "acoustic comfort"
Light	"artificial light", "illumination", "lamp post", "light environment", "light exposure", "light intensity", "light pollu", "lightning condition", "nighttime lightning", "outdoor lightning", "public lightning", "street light", "urban lightning", "visibility"
Food systems	"aquaponic", "garden", "agriculture", "CSA", "edible landscaping", "farmers market", "food access", "food desert", "food distribution", "food environment", "food insecurity", "food policy", "food production", "food scape", "food security", "food sovereignty", "food supply", "food system", "hydroponic", "local food", "locally grown produce", "market", "peri-urban agriculture", "horticulture", "farming"
Supply	"supply system", "resource distribution", "utilities", "water supply", "energy supply", "supply chain", "water quality", "resource manag", "supply network", "water access", "resource availability", "sanitation", "supply disruption", "resource access", "clean water"
Local services	"local services", "community services", "public services", "neighborhood services", "welfare services", "social services", "amenities", "urban amenities", "neighborhood amenities", "shop", "supermarket", "retail services", "community center", "community hous", "meeting place", "local gathering space", "shared space", "facilities", "cultural center", "market", "store"

Based on this prioritisation, a two-stage screening was conducted. In the first stage, the titles and abstracts of 3,740 studies were reviewed, focusing on criteria such as the country of data collection, publication year, study type, and relevance to the impact of built environment on public health. In the second stage, a more detailed screening of the 586 studies that passed the initial review was conducted, applying the inclusion criteria (see Table 7.1) and paying particular attention to whether the study examined health impact of an actual intervention or change in the built environment.

Following this process, 80 studies were selected for full-text assessment. After a final, thorough review, 29 unique articles met all inclusion criteria and were included in the final analysis.

Figure 7.1 presents the identification of articles.

Figure 7.1: Study Selection



7.1.4 Quality assessment

Our review analysed studies with different methodological approaches, from quantitative research focusing on specific aspects of the built environment and outcome measures, to review articles that encompass a broader theme within the areas of the built environment and public health. To evaluate the strength of each study's design, the credibility of the evidence was assessed based on the study's methodological paradigm. Recognizing the inherent differences in expectations for primary and secondary research, each study was evaluated against the standards typically applied to its specific design.

To organize the evaluation, the studies were categorized into the following groups:

- **Primary Research**
 - Randomized controlled trials
 - Quasi-experimental/natural experiment
 - Observational (e.g. longitudinal studies)

- **Secondary review studies**
 - Systematic review
 - Non-systematic review

In Chapter 5, the included studies are marked with a "P" or "S" in superscript to indicate whether the study is primary or secondary.

A thorough quality assessment for each article was subsequently carried out. For primary research, the *Mixed Methods Appraisal Tool* (MMAT) was utilized. This tool is used to assess five key criteria in various studies, including randomized controlled trials and non-randomized studies. The criteria concern dimensions such as methodological appropriateness, analytical rigor, confounding variables, bias control, comparability between groups, exposure to intervention, and data completeness. For secondary review articles, the assessment tool utilised was the *A MeaSurement Tool to Assess systematic Reviews* (AMSTAR-2), which is used to assess 16 key items, with four being particularly crucial to evaluating review quality. Using MMAT and AMSTAR-2 emphasises the assessment of methodological rigor rather than the quality of the content. For example, a review may receive a high AMSTAR-2 rating due to systematic and transparent methods, even if it relies on low-quality studies (according to the standards of the MMAT assessment or content quality), affecting the overall validity of its conclusions. These broader validity concerns are noted when presenting studies in Chapter 5.

While MMAT and AMSTAR-2 stress that they are not designed to produce a single overall quality score, it was deemed necessary to calculate a credibility of evidence score to provide a structured, comparable overview of the research landscape. Assessing each study in isolation without a summarising metric makes it difficult to draw meaningful conclusions about the strength of evidence within and across built environment interventions (e.g. green and blue). For AMSTAR-2, its own overall confidence rating was used¹⁰, while for MMAT, the proportion of fulfilled criteria was calculated¹¹. Within each theme of built environment interventions (e.g. green and blue spaces), an average credibility of evidence score for primary and secondary research separately was calculated. Scores range from low, to moderately low, moderate, moderately high, and high¹².

¹⁰ Critically low, low, moderate, high according to <https://amstar.ca/Amstar-2.php>

¹¹ If it is unclear whether a study has met a criterion, it is considered not fulfilled for a more cautious assessment. Criteria that are not relevant to the specific study are excluded from the score, such as the comparability of groups at baseline, which is irrelevant if the study investigate within-subject variation.

¹² For MMAT, the credibility of evidence is categorised as follows: High (100–85%), Moderately High (84–70%), Moderate (69–50%), Moderately Low (49%–30%), and Low (below 30%). For AMSTAR-2, studies are assigned a value from 1 (critically low) to high (4) based on the original rating. The average

It is important to note that quality ratings were not used to exclude studies. The goal was to include all relevant research, regardless of its quality score, to provide a comprehensive overview of the available research.

7.2 Mapping knowledge gaps

The research note identifies knowledge gaps by using both a narrow and a broad understanding of the field of study. The narrow scope follows the approach outlined in Section 7.1, where only 29 out of 3,740 screened studies met the inclusion criteria (Section 7.1.1). The absence of certain built environment themes or health outcomes in these studies indicates potential knowledge gaps, as relevant studies would have been included if they met the criteria. While the selection process for these studies has already been outlined, this section focuses on the methodological approach employed to mapping knowledge gaps within the broader scope.

Instead of focusing solely on the final 29 included studies, the broader mapping of knowledge gaps examines the 586 studies that passed the initial screening but were later excluded in the more detailed second screening. In the first screening, these 586 studies were assessed – based on a review of their titles and abstracts – as meeting the broader scope (e.g., country of data collection, publication year, study type, and relevance to the impact of the built environment on public health) but they did not necessarily investigate an actual built environment intervention or change, as required by the narrower scope.

To examine knowledge gaps in the literature, we applied a keyword search (using Microsoft Excel) within the titles and abstracts of the 586 studies that fall within the broader scope. This approach enabled us to identify and quantify the presence of relevant built environment themes, outcomes and target groups in the studies. However, since the mapping relies solely on the occurrence of specific words rather than a systematic screening and coding of titles and abstracts into themes and outcomes, the context in which these words appear, the study’s evidence of credibility, and their relevance to this research cannot be determined. In other words, the presence of the word ‘lane’ in a study does not necessarily mean it investigates the impact of implementing a bike lane in an urban area in a relevant country using an experimental or quasi-experimental study design. Nonetheless, this method provides an overview of research activity in certain areas and offers insight into potential themes of knowledge gaps.

Table 7.4 presents the keywords used in title and abstract searches to identify studies linked to the specified built environment themes. Table 7.5 outlines the keywords used to identify studies with the specified health outcomes, while Table 7.6 presents keywords related to target groups.

Table 7.4: Keywords associated with built environment themes

Themes	Keywords
Transport & Mobility	"bicycle", "bik", "cycl", "path", "lane", "trail", "route", "school", "connectivity", "active travel", "active commute", "connectivity", "infrastructure", "naked street", "pedestrian", "public transport", "public transit", "road environment", "road traffic noise", "shared space", "sidewalk", "street connect", "street environment", "streetscape", "traffic", "road", "travel", "mobility", "transport", "walk"

credibility of evidence score is categorised as follows: High (4), Moderately High (between 3 and 4), Moderate (3), Moderately Low (between 2 and 3), Low (2 or below).

Green & blue spaces	"blue space", "green infrastructure", "green space", "greenspace", "nature-based solutions", "NBS", "NDVI", "park", "recreational facilit", "tree cover", "tree canopy", "forest", "greening", "vegetation", "green corridor", "green belt", "greenbelt", "green way", "greenway", "garden", "urban agriculture", "living wall", "urban wetlands", "green-blue", "coast", "river", "lake", "bay", "canal", "harbor", "harbour", "waterfront", "waterway", "bioswale", "stormwater", "rain", "natural playground"
Sustainability & climate	"biodivers", "carbon neutral", "circular economy", "climate", "eco-city", "ecosystem", "energy effic", "green intervention", "low-carbon", "resilien", "sustain", "emission"
Pollution (air, noise, light)	"air pollut", "artificial light", light environment", "light exposure", "light intensity", "light pollu", "nighttime light", "air quality", "carbon monoxide", "fine particulate matter", "PM2.5", "PM10", "nitrogen dioxide", "nitrogen oxide", "NO2", "NOx", "ozone", "sulfur dioxide", "SO2", "VOC", "volatile organic compound", "noise", "noise pollut", "environmental noise", "soundscape", "urban noise management", "noise regulation", "noise mitigation", "noise annoyance", "perceived noise", "sound barriers", "noise control", "quiet areas", "acoustic comfort"
Food Environment	"aquaponic", "garden", "agriculture", "CSA", "edible landscaping", "farmers market", "food access", "food desert", "food distribution", "food environment", "food insecurity", "food policy", "food production", "food scape", "food security", "food sovereignty", "food supply", "food system", "hydroponic", "local food", "locally grown produce", "market", "peri-urban agriculture", "horticulture", "farming"
Resource management (water and energy)	"supply system", "resource distribution", "utilities", "water supply", "energy supply", "supply chain", "water quality", "resource manag", "supply network", "water access", "resource availability", "sanitation", "supply disruption", "resource access", "clean water"
Local services	"local services", "community services", "public services", "neighborhood services", "welfare services", "social services", "amenities", "urban amenities", "neighborhood amenities", "shop", "supermarket", "retail services", "community center", "community hous", "meeting place", "local gathering space", "shared space", "facilities", "cultural center", "store"

Table 7.5: Keywords associated with health outcomes

Outcome	Keywords
Mental well-being	"happiness", "mental health", "mental fatigue", "stress", "stress response", "psychological stress", "burn-out", "depression", "psychological well-being", "psychological safety", "safety", "well-being", "well-being", "quality of life", "anxiety", "crime prevention", "community safety", "urban safety", "public safety", "environmental safety", "security", "personal security", "perceived safety", "safety perception", "injury prevention", "emergency preparedness", "trauma", "safety-related stress", "safe mobility", "safe transit"
Social well-being	"social health", "social well-being", "social well-being", "social cohesion", "social capital", "social support", "social isolation", "social connectedness", "sense of community", "sense of belonging", "social equity", "social bond", "social trust", "inclusion", "social inclusion", "social justice"
Physical well-being	"cardiovascular disease", "vascular disease", "cardiometabolic disease", "cardiometabol", "heart disease", "infarction", "ischemic heart disease", "transient ischemic attack", "coronary artery disease", "coronary occlusion", "heart failure", "stroke", "cerebrovascular disease", "cerebrovascular accident", "cerebrovascular event", "aortic disease", "aortic aneurysm", "arrhythmia", "Exercise", "angina pectoris", "hypertensive heart disease", "rheumatic heart disease", "pulmonary heart disease", "heart attack", "heart arrest", "obese", "obesity", "overweight", "physical activ", "physical inactiv", "hypertension", "coronary heart disease", "myocardial infarction", "CVD mortality", "health inequal", "inequity"
Physical well-being: Physical activity	"physical activ", "physical inactiv", "exercise", "sedentary lifestyle", "sedentary activ", "sedentary behavi"

Physical well-being: Condition and risk factors of cardiometabolic disease	"angina pectoris", "aortic aneurysm", "aortic disease", "arrhythmia", "cardiometabolic disease", "cardiometabol", "cardiovascular disease", "cerebrovascular accident", "cerebrovascular disease", "cerebrovascular event", "coronary artery disease", "coronary heart disease", "coronary occlusion", "CVD mortality", "heart arrest", "heart attack", "heart disease", "heart failure", "hypertensive heart disease", "infarction", "ischemic heart disease", "myocardial infarction", "pulmonary heart disease", "rheumatic heart disease", "stroke", "transient ischemic attack", "vascular disease", "alcohol", "blood pressure", "cholesterol", "diabetes", "diet", "hypertension", "insulin resistance", "NCD", "non-communicable disease", "nutrition", "obese", "obesity", "overweight", "prediabetes", "smoking", "weight gain"
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Table 7.6: Keywords associated with target groups

Outcome	Keywords
Children and young people	"adolescents", "child", "children", "infants", "juveniles", "kid", "minors", "pediatric", "school-age", "students", "teenagers", "toddlers", "young people", "youth"
Adults	"adult", "grown-up", "working-age"
Older people	"aging", "elderly", "geriatric", "gerontology", "older adults", "older people", "pensioner", "retired", "retirement", "senior"
Vulnerable citizens	"at-risk", "chronic illness", "chronic disease", "depriv", "disability", "disabled", "disadvantage", "disparit", "excluded communities", "homeless", "immigrant", "indigenous", "insecur", "isolation", "low education", "low-income", "marginalized", "mental issue", "mental health issue", "migrant", "minorit", "physical issue", "physical health issue", "poverty", "refugees", "substance abuse", "unemployed", "vulnerab"
Gender inequalities	"gender equality", "gender equity", "gender inequality", "gender disparities", "gender gap", "gender-based", "women empowerment", "women's rights", "feminism", "women leadership", "sexual harassment", "sexual violence", "gender justice"

7.3 Selecting grey literature for mapping emergent trends and potentials

Given the extensive body of grey literature in this field of urban health and the built environment, a mapping of key actors was conducted to identify and select relevant sources. This broad-scoped approach encompassed:

- International organizations
- National health and urban planning bodies
- Professional networks
- Non-governmental organizations
- Research institutions
- Think tanks
- Philanthropic organizations
- Private foundations and companies

This mapping was further enriched by insights from a panel of expert researchers. The analysis identified several influential actors at the intersection of urban health and built environment, including:

- World Health Organization (WHO)
- UN-Habitat
- C40 Cities Climate Leadership Group
- Realdania Foundation (Denmark)
- Nordregio
- Jan Gehl Architects
- Juul Frost Architects

After the key actors were mapped, key resources were compiled for further review. Through this process, the following steps were taken:

- Identification of 71 potential grey literature reports and materials
- Review of 31 additional recommendations for grey literature resources, and 16 suggestions for key research articles from the expert panel

Ultimately, 17 resources were selected on the basis of the breadth of their geographic and thematic scope and their focus on trends or emerging areas not fully explored in the previous chapters.

8. APPENDIX B: REFERENCES

Table 8.1: List of included studies, REA

Article	Author	Year	Country	Type of study
Environmental, health, well-being, social and equity effects of urban green space interventions: A meta-narrative evidence synthesis	Hunter et al.	2019	USA, Australia, and the UK	Systematic Review
Respiratory and cardiovascular responses to walking down a traffic-polluted road compared with walking in a traffic-free area in participants aged 60 years and older with chronic lung or heart disease and age-matched healthy controls: a randomised, crossover study	Sinharay et al.	2018	UK	RCT
Effect of Greening Vacant Land on Mental Health of Community-Dwelling Adults: A Cluster Randomized Trial	South et al.	2018	USA	RCT
The effects of changes to the built environment on the mental health and well-being of adults: Systematic review	Moore et al.	2018	UK (8), USA (3), Netherlands (1), Norway (1)*	Systematic Review
The impact of the consumer and neighbourhood food environment on dietary intake and obesity-related outcomes: A systematic review of causal impact studies	Atanasova et al.	2022	USA (40), UK (2), Canada (2), Netherlands (2), Australia (1), New Zealand (1)*	Systematic Review
A systematic review of the effect of infrastructural interventions to promote cycling: strengthening causal inference from observational data	Mölenberg et al.	2019	US (8), UK (6), Australia (3), Finland (2), Germany (2), New Zealand (1), Netherlands (2), Singapore (1), Denmark (1)*	Systematic Review

Do Natural Experiments of Changes in Neighborhood Built Environment Impact Physical Activity and Diet? A Systematic Review	MacMillan et al.	2018	US (10), UK (3), New Zealand (1)	Systematic Review
Causal evaluation of urban greenway retrofit: A longitudinal study on physical activity and sedentary behavior	Frank et al.	2019	Canada	Quasi-experimental/natural experimental
A systematic review of empirical and simulation studies evaluating the health impact of transportation interventions	Stankova et al.	2020	United States (11), United Kingdom (9), Australia (4), Canada (1), Denmark (1)*	Systematic Review
Effectiveness of Policies and Programs to Combat Adult Obesity: a Systematic Review	Tseng, Eva et al.	2018	USA (11), UK (3), Australien (2)*	Systematic Review
Changes in physical activity after building a greenway in a disadvantaged urban community: A natural experiment	Auchincloss et al.	2019	USA	Quasi-experimental/natural experimental
Investigating the physical activity, health, well-being, social and environmental effects of a new urban greenway: a natural experiment (the PARC study)	Hunter et al.	2021	Northern Ireland, UK	Quasi-experimental/natural experimental
Determining Factors in the Use of Urban Parks That Influence the Practice of Physical Activity in Children: A Systematic Review	Padial-Ruz et al.	2021	Australia, USA, London, Netherlands, Denmark, Sweden, and New Zealand*	Systematic Review
A natural experimental study of improvements along an urban canal: impact on canal usage, physical activity and other well-being behaviours	Benton et al.	2021	UK	Quasi-experimental/natural experimental
Shaping Pathways to Child Health: A Systematic Review of Street-Scale Interventions in City Streets	Ortegon-Sanchez et al.	2022	USA (4), UK (3), Belgium (1), Germany (1)*	Systematic Review
Large walking and well-being behaviour benefits of co-designed sustainable park improvements: A natural experimental study in a UK deprived urban area	Anderson et al.	2024	UK	Quasi-experimental/natural experimental

Results from a natural experiment: initial neighbourhood investments do not change objectively-assessed physical activity, psychological distress or perceptions of the neighbourhood	Dubowitz et al.	2019	USA	Quasi-experimental/natural experimental
Evaluating the effect of change in the built environment on mental health and subjective well-being: a natural experiment	Ram et al.	2020	UK	Quasi-experimental/natural experimental
Neighborhood Environments and Physical Activity: A Longitudinal Study of Adolescents in a Natural Experiment	Nicosia et al.	2018	USA	Quasi-experimental/natural experimental
Impact of structural-level environmental interventions on physical activity: a systematic review	Hernández et al.	2023	USA (8), Canada (2), UK (2), Denmark (2), Finland (1), Netherlands (1), Australia (5), New Zealand (1)*	Systematic Review
Effects of major urban redesign on sedentary behavior, physical activity, active transport and health-related quality of life in adults	Stappers et al.	2023	Netherlands	Quasi-experimental/natural experimental
Community Investments and Diet-Related Outcomes: A Longitudinal Study of Residents of Two Urban Neighborhoods	Dubowitz et al.	2024	USA	Quasi-experimental/natural experimental
Built environment interventions and physical activity levels: A systematic review	Barradas et al.	2022	USA (3), UK (3)*	Systematic Review
The relationship between changes in neighborhood physical environment and changes in physical activity among children: a prospective cohort study	Acciai et al.	2023	USA	Observational
Do inhabitants profit from integrating a public health focus in urban renewal programmes? A Dutch case study	Ruijsbroek et al.	2022	Netherlands	Quasi-experimental/natural experimental

The impact of transport, housing, and urban development interventions on older adults' mobility: A systematic review of experimental and quasi-experimental studies	de Sá et al.	2024	USA (4), UK (2), Australia (2), Canada (2), France (1), Sweden (1), Netherlands (1)*	Systematic Review
Countrywide natural experiment reveals impact of built environment on physical activity	Althoff et al.	2024	USA	Quasi-experimental/natural experimental
Effect of Abandoned Housing Interventions on Gun Violence, Perceptions of Safety, and Substance Use in Black Neighborhoods: A Citywide Cluster Randomized Trial	South et al.	2023	USA	RCT
Living liveable? RESIDE's evaluation of the Liveable Neighborhoods planning policy on the health supportive behaviors and well-being of residents in Perth, Western Australia	Hooper et al.	2020	Australia	Quasi-experimental/natural experimental

Table 8.2: List of grey literature sources

Title	Author /organization	Year
C40 Accelerator Progress Report 2023	C40	2023a
C40 Good Food Cities Accelerator: How cities are achieving the planetary health diet for all	C40	2023b
C40 Urban Nature Accelerator: How cities are becoming greener and more resilient	C40	2023c
What creates healthy cities?	Commission on Creating Healthy Cities: Global Centre on Healthcare and Urbanisation (GCHU), Kellogg College, University of Oxford, and The Prince's Foundation	2022
Towards More Physical Activity in Cities	Gehl Architects with WHO	2017
A Guide to Inclusion and Health in Public Spaces	Gehl Architects with Robert Wood Johnson Foundation	2017
The urban health culture of the future: Holistic tools to promote physical, mental and social health in the built environment.	Juul Frost Architects	2022
Health and Social Inclusion in Nordic Cities	Nordic City Network	2023
Green and healthy Nordic cities: How to plan, design, and manage health-promoting urban green space.	Nordregio: Borges, L. A., Rohrer, L., & Nilsson, K. (Red.).	2024
Participatory design of people-centered cities Mapping of scientific research and relevant theories, scientists and actors	Robert Bosch Stiftung	2019
Integrating health in urban and territorial planning: a sourcebook. Geneva	UN-Habitat, & World Health Organization	2020
Urban planning for resilience and health: key messages Summary report on protecting environments and health by building urban resilience	WHO European Region	2022
Healthy Cities and the City Planning Process: A Background document on the links between health and urban planning	WHO Regional Office for Europe	1999

Towards more physical activity in cities: Transforming public spaces to promote physical activity – a key contributor to achieving the Sustainable Development Goals in Europe.	WHO Regional Office for Europe	2017
Global action plan on physical activity 2018–2030: more active people for a healthier world	World Health Organization (WHO)	2018
Setting global research priorities for urban health.	World Health Organization (WHO)	2022
Innovation for urban health: policy brief.	World Health Organization (WHO)	2024

9. APPENDIX C: CREDIBILITY ASSESSMENT

9.1 Credibility assessment of studies related to vulnerable road users

Based on the AMSTAR-2 appraisal, three of the six systematic reviews scored high credibility (Stankova et al., 2020^S; MacMillan et al., 2018^S; Mölenberg et al., 2019^S). Hernández et al. (2023)^S examined active transport interventions on physical activity levels and scored moderate credibility due to not conducting duplicated data extraction, where two independent assessors perform data extraction, and compare their results. Three reviews were rated low credibility: Hunter et al. (2019)^S, which examined cycling and walking path interventions on physical activity, and Ortegon-Sanchez et al. (2022)^S, which looked at street-level built environment interventions for children's health. Both lacked a pre-registered research protocol, affecting methodological rigor.

In addition to the secondary research, this research note identified three primary research papers. Hooper et al. (2020)^P aimed to summarize the RESIDE project's findings on the impact of the "Liveable Neighbourhoods" planning policy on health-supportive behaviours and well-being outcomes. The planning policy consists of 6 elements with targeted design features such as cycling and pedestrian infrastructure. Since this study reviewed research within the RESIDE project rather than conducting a systematic review, the MMAT appraisal tool for quasi-experimental studies was deemed more appropriate for evaluating its credibility. Based on the MMAT appraisal, Hooper et al. (2020) scored moderately high due to a high drop-out rate among participants in the RESIDE project studies. Similarly, Acciai et al. (2023)^P scored moderately high due to incomplete data. Finally, Althoff et al. (2024)^P scored high credibility.

9.2 Credibility assessment of studies related to public transport

This chapter includes one primary research study that examines the influence of public transport on public well-being in the form of a quasi-experiment/natural experiment by Hooper et al. (2020)^P. The study is considered of moderately high credibility based on the MMAT criteria, and only receives the second-highest rating due to a high participant drop-out percentage. It should be noted that the study by Hooper et al. is a synthesis of several quasi-experimental studies that each investigate different aspects of an Australian neighbourhood planning policy and are thus treated as a quasi-experimental study while sharing characteristics with the systematic reviews.

Additionally, three systematic reviews examine the influence of public transport on public well-being, with much variation in their credibility of evidence. Based on the AMSTAR-2 appraisal, two reviews are considered highly credible (MacMillan et al., 2018^S; Tseng et al., 2018^S), though both are constrained by the low quality of the studies they include, which affects the robustness of their findings. Finally, one review is considered critically low as it does not assess risk of bias for the studies or the findings of these and does not explain all steps of the exclusion process (Barradas et al., 2022^S).

9.3 Credibility assessment of studies related to multi-component mobility interventions

Four studies are primary research studies in the form of three quasi-experimental/natural experimental studies (Auchincloss et al., 2019^P; Frank et al., 2019^P; Stappers et al., 2023^P) and one randomized control trial (Sinharay et al., 2018^P). The study by Auchincloss et al. (2019^P) is considered of high credibility based on the MMAT criteria. The study by Frank et al. (2019^P) is considered of moderate credibility due to incomplete data and, furthermore, because proximity to intervention as a measure for treatment exposure leaves risk for confounding variables. The study by Stappers et al. (2023^P) is considered of moderately low credibility due to a high drop-out rate (62 per cent), no assessment of population representativity, and the intervention taking place during covid-19, possibly acting as a confounding factor

on the outcome effects of participants' well-being. The randomized control trial by Sinharay et al. (2018^P) is considered moderately credible due to missing information on completeness of outcome data and blinding for treatment exposure. Furthermore, treatment and non-treatment groups are relatively modest with 40 participants in each group.

Seven systematic reviews included in this research note examine the influence of public mobility infrastructure on public health with a varied credibility of evidence. Based on the AMSTAR-2 appraisal, two of the reviews are considered highly credible (Stankova et al., 2020^S; de Sá et al., 2024^S). One review is considered of moderate credibility due to including studies with risk of bias and lack of control groups in some studies, which impacts the robustness of the conclusions (Hernández et al., 2023^S). The studies by Hunter et al. (2019^S), Moore et al. (2018^S) and Ortegon-Sanchez et al. (2022^S) are considered of low credibility, while the seventh review (Barradas et al., 2022^S) is considered of critically low credibility. The generalisability of the findings in the review by Hunter et al. (2019^S) is negatively affected by the included studies' methodological heterogeneity and lack of long-term follow-up after interventions. Moore et al. (2018^S) do not reflect on publication bias in the included studies, there is significant heterogeneity in the interventions and quality of the included studies, and many studies score high in their risk for bias. Ortegon-Sanchez et al. (2022^S) include studies of moderate quality and especially the methodological quality is limited. Barradas et al. (2022^S) do not assess risk of bias for the studies or their findings and do not explain all steps of the exclusion process.

9.4 Credibility assessment of studies related to Green and Blue Spaces

Five secondary studies investigate whether changes in green and blue spaces in the built environment can impact health outcomes. Overall, the credibility of these systematic reviews is moderate. Two systematic reviews are assessed to have high credibility (MacMillan et al., 2018^S; Padiál-Ruz et al., 2021^S). The systematic review by Hernández et al. (2023^S) is of moderate credibility due to not performing data extraction in duplicate, which involves two independent assessors conducting the data extraction. The review aims to determine the effectiveness of (re)construction of parks regarding changes in physical activity levels. Two systematic reviews that focus on the environmental, health, well-being, and social benefits of urban green space interventions, are assessed to have low credibility (Hunter et al., 2019^S; Moore et al., 2018^S). Hunter et al. (2019) adopted a meta-narrative review due to heterogeneity in the identified research papers, but did not present a pre-registered research protocol, which can create reliability issues. Secondly, Moore et al. (2018^S) aimed to assess how changes to the built environment impact on mental health, well-being, quality of life, and social inclusion. The review receives a low credibility as it did not consider publication bias in the included studies, there is significant heterogeneity in the interventions and quality of the included studies, and many studies score high in their risk for bias.

This research note identifies five primary studies that apply a quasi-experimental or natural experimental research design to examine the effect of establishing a green-blue area on health outcomes. Based on the MMAT appraisal, the overall credibility of these included studies is moderately high. One study evaluates the impact of green space improvements along an urban canal on canal usage, physical activity, and well-being behaviours. The study is of moderate quality due to a lack of sampling from a defined population (Benton et al., 2021^P). Two studies are highly credible (Anderson et al., 2024^P; Nicosia et al., 2018^P). Hooper et al. (2020^P) aim to summarize the RESIDE project's evidence regarding the impact of the "Liveable Neighbourhoods" (LN) planning policy on health-supportive behaviours (e.g. physical activity, diet, sense of community) and well-being outcomes. The study is assessed to have moderately high credibility due to a high drop-out rate among participants (Hooper et al., 2020^P), while Hunter et al.'s (2021^P) study on the impact of the development of an urban greenway on physical activity and mental and social well-being is assessed to have moderate credibility due to issues with accounting for confounders in a seven-year gap between baseline and follow-up

9.5 Credibility assessment of studies related to Food Environment

Three systematic reviews included in this research note examine the influence of urban food environments on physical well-being. All three reviews are considered **highly credible**. However, two of the reviews (MacMillan et al., 2018^S; Tseng et al., 2018^S) are constrained by the low quality of the studies they include, as their assessments revealed a high risk of bias. For example, some studies lacked a comparison group, did not measure outcomes objectively, or had incomplete data. This impacts the validity of their findings, making it challenging to draw clear conclusions about effects or associations – something the authors acknowledge in their analysis and presentation of results. Additionally, much of the research focuses on an American context, limiting its broader applicability.

9.6 Credibility assessment of studies related to Urban Planning and Regeneration

Two of the primary research studies are designed as randomized control trials and focus on how changes to vacant lots and abandoned houses can impact the mental health and levels of violence experienced by residents (South et al., 2018^P; South et al., 2023^P). The first study by South et al. (2018^P) is considered of high credibility as it lives up to the MMAT criteria. The other study by South et al. (2023^P) is considered of moderately high credibility due to a drop-out rate of around 40 per cent of participants in the post-intervention interviews and, while still reaching a statistically meaningful number of 172 interviewed participants, it can lead to issues of systematic dropout, which in turn can introduce selection bias to the conclusions.

Five of the primary research studies are designed as quasi-experimental/natural experimental studies with distinct intervention and control groups, but where randomisation of participants has not been possible. Two studies (Ruijsbroek et al., 2022^P; Hooper et al., 2020^P) are considered of moderately high credibility based on the MMAT criteria and due to the timing of a follow-up survey (Ruijsbroek et al., 2022^P) and high participant drop-out percentage (Hooper et al., 2020^P). It should be noted that the study by Hooper et al. (2020) is a synthesis of several quasi-experimental studies that each investigate different aspects of an Australian neighbourhood planning policy and is thus evaluated based on the MMAT-criteria. Finally, three studies are considered moderately credible (Dubowitz et al., 2019^P; Dubowitz et al., 2024^P; Ram et al., 2020^P) due to issues of sample representativity in the assessed neighbourhoods. Furthermore, the studies by Dubowitz et al. (2019^P; 2024^P) acknowledge that the control neighbourhood received investments, though to a lesser degree, during the intervention period, while the interventions in the study by Ram et al. (2020^P) are implemented gradually during the observation period, which may prevent the study from capturing the full effects of the interventions. These methodological issues illuminate the challenges of measuring and controlling the effects of urban development in a natural experiment.

This section includes two secondary review studies, which examine the influence of changes to the built environment (“urban regeneration”) on mental health and well-being (de Sá et al., 2024^S; Moore et al., 2018^S). Based on the AMSTAR-2 appraisal, the review by de Sá et al. (2024^S) is considered highly credible, though it should be noted that only two of the review’s included studies are relevant to this section, and the authors describe “serious validity concerns” in one of the two studies due to “moderate concerns regarding its result selection, outcome measurement, and missing data”. The review by Moore et al. (2018^S) is considered of low credibility as it does not reflect on publication bias in the included studies, though this does not necessarily invalidate the findings. More importantly, the authors emphasise that there is significant heterogeneity in the interventions and the quality of the included studies, and many studies score high in their risk for bias, all impacting the overall quality of the evidence of this review. Given these considerations, the findings from this review should be read with some caution and are therefore mainly used to supplement and nuance other studies’ findings in this chapter.

