



Public Health
England

Protecting and improving the nation's health

Spatial Planning for Health

An evidence resource for planning
and designing healthier places

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-class science, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health, and are a distinct delivery organisation with operational autonomy to advise and support government, local authorities and the NHS in a professionally independent manner.

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This report has been prepared by André Pinto, on behalf of PHE, with assistance and support from Jacy McGaw-Césaire and Carl Petrokofsky, based on an original report commissioned by PHE and developed by Paul Pilkington, Emma Bird and Janet Ige (Faculty of Health and Applied Sciences, University of the West of England) and Jilla Burgess-Allen, André Pinto (PHE), with diagrams prepared by Will Morris (www.bywillmorris.com).

The conceptual framework used for this review and the presentation of findings were inspired by the BC Centre for Disease Control (2014). *Healthy Built Environment Linkages Toolkit: making the links between design, planning and health, Version 1.0*. Vancouver, B.C., Canada: Provincial Health Services Authority, Population and Public Health.

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A decent home, a job and friends are more important to good health than the NHS. This report highlights how we can build places and communities that encourage healthier choices

Duncan Selbie
Chief Executive
Public Health England



Project overview

The aim of the project was to develop a series of practical diagrams that illustrate the linkages, and strength of evidence, between spatial planning and health based on the findings from an umbrella literature review of the impacts of the built environment on health. The objectives were:

1. To undertake an umbrella literature review to assess the impact of the built and natural environment on health concentrating on five key built environment topics: neighbourhood design, housing, healthier food, natural and sustainable environment, and transport
2. To appraise the quality and strength of the available evidence, using an agreed grading system
3. To use the findings of the review to develop a series of diagrams illustrating the linkages between planning principles, impact and positive health related outcomes
4. To illustrate, where possible, the linkages set out in the diagrams with evidence and case studies coming from the UK

Purpose of the project

Although there is a multitude of guidance supporting and advocating action on the built and natural environment to improve health outcomes, the evidence base underpinning these principles is still a matter of debate amongst the scientific and practitioner communities. The unique and individual nature of the built and natural environment make it difficult to develop evidence-based approaches that can be universally applied, and successful practices in one community setting may not always be transferrable to another.

This project was commissioned by PHE to address the need for a UK-centric evidence review that analyses and demonstrates the links between health and the built and natural environment. This review attempts to provide an overview, based on the umbrella review methodology outlined in this document, of the strength of the evidence of the impacts on health of the built and natural environment with the purpose to inform action and policy.

Intended audience

The primary target audience is local public health professionals, but also planners working in local authority settings. The findings are designed to be suitable for both public health practitioners and planning professionals, facilitating two-way communication between disciplines.

Introduction

The built and natural environment is a key environmental determinant of health and wellbeing. In this report 'built and natural environment' refers to the characteristics (objective and subjective) of a physical environment in which people live, work and play, including: schools, workplaces, homes, communities, parks/recreation areas, green (ie visible grass, trees and other vegetation) and blue spaces (ie visible water).

Built environment and health

The linkages between health and the built and natural environment have long been established and the role of the environment in shaping the social, economic and environmental circumstances that determine health is increasingly recognised and understood.

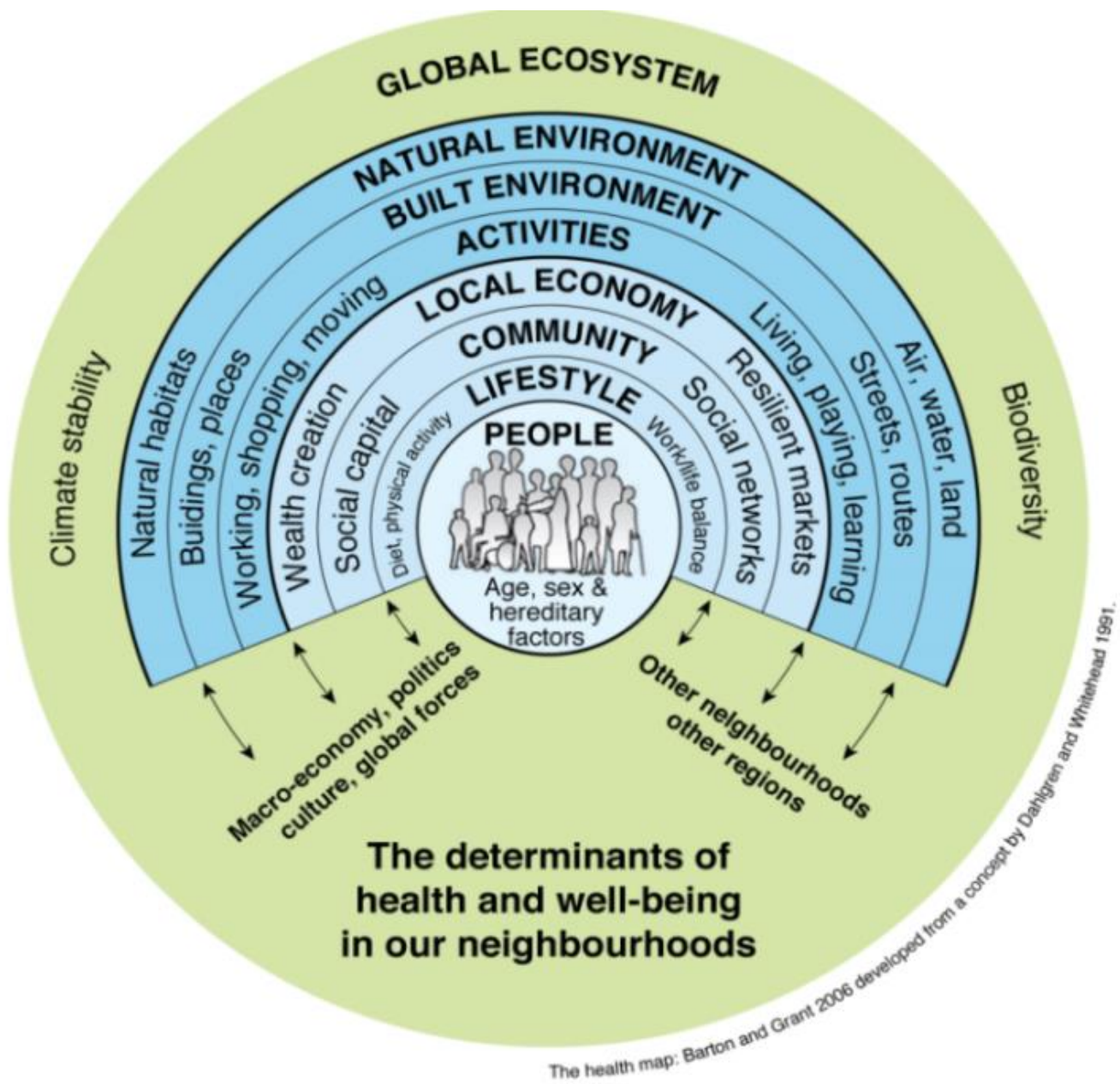
An ever-increasing body of research indicates that the environment in which we live is inextricably linked to our health across the life course. For example, the design of our neighbourhoods can influence physical activity levels, travel patterns, social connectivity, mental and physical health and wellbeing outcomes.

However, it is important to recognise that the causal links between built environment and health are often complex, in that they are influenced by numerous, sometimes conflicting, factors.

Although it is difficult to quantify, with precision, the impact of the built and natural environment on health, research does seem to consistently report that the majority of our health outcomes are explained by factors other than healthcare (Kuznetsova, 2012; McGuinness, Williams-Russo & Knickman, 2002).

To aid understanding of the built and natural environment and health, Barton and Grant (2006), drawing upon the work of Dahlgren and Whitehead (1991), devised the Health Map (Figure 1). The map is focused on the role of neighbourhood and planning, and emphasises the importance of the built and natural environment's contribution to health and wellbeing outcomes, in line with the socio-ecological approach to health (Orme et al., 2010).

Figure 1: The Health Map



Umbrella review methodology

The University of the West of England conducted an umbrella literature review to examine the health and built environment evidence base, identifying relevant built environment topics, planning principles and characteristics that are associated, or thought to have an association with, health outcomes.

Umbrella reviews have emerged in recent years as an attractive strategy for assessing existing review level evidence. Unlike traditional systematic reviews, umbrella reviews involve a 'rapid review' approach to evidence synthesis and aim to produce an overview of the evidence in a short space of time (Joanna Briggs Institute, 2014; Khangura et al., 2012).

Umbrella reviews are increasingly used in public health research and practice, bringing together a wide range of evidence to explore what is known about a topic, in an attempt to guide the decisions of policy makers (Bambra et al., 2009; Bambra et al., 2010; Horodyska et al., 2015; Theodoratou et al., 2014).

This umbrella review identifies, critically appraises and summarises existing review level evidence of associations between the built and natural environment and health outcomes. The review is centered on five aspects of the built and natural environment:

- neighbourhood design
- housing
- healthier food
- natural and sustainable environment
- transport

These five aspects of the built and natural environment were identified as the main characteristics that can be influenced by local planning policy. These aspects of the lived environment can be designed and shaped, by planners, in order to promote certain health outcomes.

Traditionally, umbrella reviews focus on existing systematic review level evidence alone (Becker & Oxman, 2008; Ioannidis, 2009). However, as the findings of this review are targeted at public health and built environment practitioners, whose understanding of 'evidence' may differ according to professional context, we have also examined relevant stakeholder organisation documentation (eg, non-systematic evidence reviews by professional bodies), in addition to the systematic review level evidence. A detailed description of the methods applied to this review is provided in the full evidence report <http://eprints.uwe.ac.uk/31390/>

In some cases, the research team identified 'gaps' in the evidence (ie areas/issues for which there was no eligible review-level evidence that met the inclusion criteria for this umbrella review, despite anecdotal awareness of primary studies relating to the area/issue). It is important to note that, although for some built environment issues no review level evidence was found and/or been systematically reviewed, this does not mean that the issue is not important and/or relevant to the objectives and aims of the paper.

In response to this, where we identified an apparent 'gap' in the review level evidence, we report selected findings from relevant empirical studies to highlight that the built environment area/issue may be important for consideration, despite a lack of review-level evidence.

Notably, however, caution is advised when viewing these studies as they were hand-picked examples and they were not subject to the same quality assessment procedures as the review level evidence.

How to use this document

This resource was developed by Public Health England based on the umbrella literature review conducted by the University of the West of England, in order to appeal to a wide range of audiences with different backgrounds and levels of understanding of public health and spatial planning issues.

The use of technical language is often cited as a barrier by both public health and planning specialists when trying to promote action on the built and natural environment to improve health. We have taken care to synthesise key messages from the evidence review in a way that will more easily speak to both public health and spatial planning practitioners, and those who have an interest in this agenda.

We anticipate that different individuals or groups may use certain parts of this document differently. For example, planners and those with a built environment background may find the diagrams particularly useful to understand which planning principles and built environment features should be promoted to improve health outcomes. Public health specialists and those with a health background may find the summary of the evidence more useful and may want to explore in detail the evidence used to inform the report: <http://eprints.uwe.ac.uk/31390/>.

The diagrams included for each one of the 5 key sections of the document were developed as communication pieces to assist discussions and better articulate the many ways in which the natural and built environment, as influenced by planning decisions, can contribute to health.

The diagrams also serve to represent, in visual form, the strength of evidence and how it links to different aspects of the built and natural environment.

PHE also recognises that neither health outcomes nor planning issues can be looked at in isolation. Both health and the built and natural environment are complex, multi-dimensional systems, with a multitude of interdependent factors. To harness the health

benefits identified and reported within the evidence review, a holistic and integrated approach is required, that looks at how our environment shapes and influences our choices and behaviours.

Therefore the role of this document is to also encourage joint working and the sharing of expertise between public health and built environment experts.

This resource does not aim to guide national, regional or local policy and targets. It aims to inform the design of places from a health improvement perspective.

It is also worth re-iterating that this resource focuses on associations and that the evidence is not equally strong, or of equal quality, across all of the associations identified. This point is also the subject of further consideration under: Discussion (page 61).

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Neighbourhood design

Neighbourhoods are places where people live, work, and play and have a sense of belonging. The design of a neighbourhood can contribute to the health and well-being of the people living there. Several aspects of neighbourhood design (walkability and mixed land use) can also maximise opportunities for social engagement and active travel. Neighbourhood design can impact on our day-to-day decisions and therefore have a significant role in shaping our health behaviours.

Principles for building healthy neighbourhoods

1. Enhance neighbourhood walkability:

- improved street connectivity, mixed land use and compact residential design are considered to be important features of a walkable neighbourhood (Hajna et al., 2015)
- there is evidence to suggest that walkable neighbourhoods can encourage active travel and thereby promote physical activity
- improving neighbourhood walkability, and access to recreational and non-recreational destination (such as grocery stores, schools and other amenities) can also impact positively upon social interaction among older adults (Beard & Petitot, 2010; McCormack & Sheill, 2011)
- evidence suggests that investing in infrastructure to support walking can increase levels of physical activity among all age groups (Carlin et al., 2015; D’Hease et al., 2015; Grasser et al., 2013; Larouche et al., 2014; Mueller et al., 2015; Wanner et al., 2012)



Enhance Neighbourhood Walkability

2. Build complete and compact neighbourhoods:

- compact neighbourhoods, ie neighbourhoods with higher street connectivity (typically designed using finer grid patterns) with diverse land use mixes and greater residential densities are generally more conducive to non-motorised transport (Durand, 2001; Gomez, 2015; McCormack, 2011; WHO, 2007)
- long distance trips for travel or recreation, steep inclines, and increased proximity to amenities have been identified as having a negative impact on walking and cycling



Build Complete and Compact Neighbourhoods

(Fraser et al., 2011)

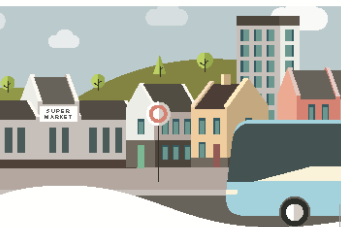
- provision of local amenities can improve mobility and social engagement among older adults (Laevsseur, 2015). Mixed land use developments that prioritise access to schools, recreational centres and social amenities can increase physical activity among children, adolescents and older adults

3. Enhance connectivity with safe and efficient infrastructure:

- enhancing street connectivity via provision of walking and cycling infrastructure and improving access to public transportation, can help reduce perceptions of long distance trips and provide alternative routes for active travel (Hajna et al., 2015)
- public realm improvements such as provision of street lighting in residential areas can prevent road traffic collisions (RTCs) (Beyer & Ker, 2009), and increase pedestrian activity. General environmental improvements have the potential to reduce fear of crime (McCormack, 2011)



Enhance connectivity with safe and efficient infrastructure



Neighbourhood Design

Quality of Evidence:

- ▲ Improved
 - ▼ Reduced
 - High Quality
 - Medium Quality
 - Low Quality
 - NR (Not reported):
- Methodological quality of the original research is unclear and should be treated with caution.

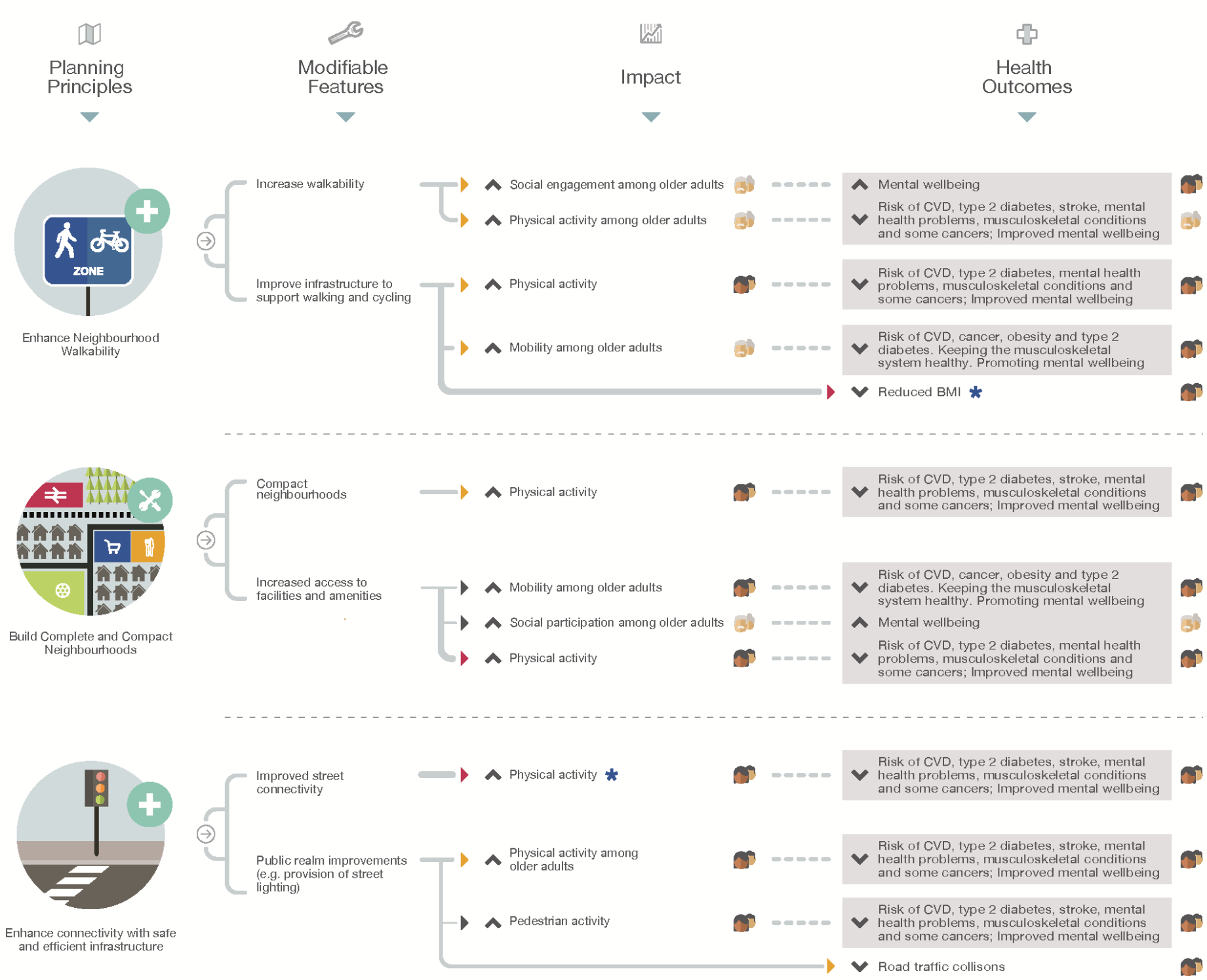
Greyed Out Text
 Association between a health impact & health outcome not obtained as part of the umbrella review.

Best Available Evidence:
 * In some instances, more than one piece of review-level evidence reporting on the same health impacts and/or outcomes was identified as part of this umbrella review. In such instances this table highlights findings of the review(s) which reported evidence of the best methodological quality.

Population Groups:

- General Population
- Older Adults
- Children & Adolescents

Disclaimer:
 This diagram has been produced as part of a wider evidence resource, commissioned by Public Health England and developed by the University of the West of England. Please see the document Spatial planning for health: an evidence resource for planning and designing healthier places for further information.



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Neighbourhood design: Case study 1 – Fitter for Walking



PLANNING PRINCIPLE: Enhance connectivity with safe and efficient infrastructure

BACKGROUND & SETTING

The Living Streets' Fitter for Walking project was a Lottery funded project that ran from 2008 to 2012. It aimed to improve particular walking routes and promote walking in 12 areas across 5 regions of England: London (Barking & Dagenham, Redbridge), North East England (Gateshead, Sunderland, Newcastle), North West England (Blackburn with Darwen, Bolton), West Midlands (Dudley, Sandwell, Wolverhampton) and Yorkshire (Doncaster, Rotherham).

WHAT WAS THE INTERVENTION?

The intervention involved improving walking infrastructure and sharing information about both the improvements and the benefits of walking with local communities. A project coordinator was employed for each of the 5 regions. No two projects were the same. Each was differentiated by the needs identified by the community. For example, in Bolton a route that links two housing estates across fields to the town and schools was improved with better path, signage and artwork designed with help from the local school.

POPULATION CHARACTERISTICS

The improvements were made in neighbourhoods where physical activity levels were low and obesity rates high.

MAIN OUTPUTS AND OUTCOMES

An increase in the number of pedestrians using the improved routes was observed in six out of seven of the case studies evaluated, and 25% of route users perceived that

they had used the route more often in the last 12 to 18 months. Benefit to cost ratios were positive at between 0.9 and 46:1 for all but one of the interventions using at least one measure of walking level (distance or duration).

The role of the co-ordinators was critical to the success of the project, liaising between the communities and the local authorities, and maintaining the focus of the project on walking.

Engaging communities in making these types of environmental improvements to key routes in local neighbourhoods may be an effective, low-cost strategy for increasing walking for transport.

WHAT WERE THE KEY SUCCESS FACTORS?

Fitter for Walking was supported by a £1.7M grant from the Big Lottery Fund's Wellbeing Fund, with £450,000 match funding from local authorities.

The approach used to engage with and work through communities is integral to the way in which Living Streets works. Experience has consistently shown that engaging with local residents is the best way to understand the issues where they live.

WHAT BARRIERS TO EFFECTIVE IMPLEMENTATION WERE FACED?

One of the challenges faced by the project was the timescale involved, for example, where a community had to wait 2 years for physical improvements to be delivered following a community street audit. The issue then was how to keep up momentum. Prioritising actions that communities could do themselves – such as a litter pick-ups or bulb planting, promotional and awareness-raising activities, for instance, themed walks (eg a bat walk or nature walk), the development of walking maps and street parties – kept people interested.

Environmental improvements were match funded by participating local authorities. Cuts in local government funding meant a reduction in the budgets available for use in the project. The relationship between the project coordinator and the local authority was crucial to managing local expectations and understanding why some environmental changes could not be made.

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Neighbourhood design: Case study 2 – Walkable neighbourhoods (IPEN Adult Study)



PLANNING PRINCIPLE: Enhance neighbourhood walkability

BACKGROUND & SETTING

Physical inactivity has been linked to diabetes, heart disease and some cancers. It is a global problem, estimated to account for more than 5 million deaths per year worldwide. Adults tend to be more physically active when they live in areas that have higher density of people, and are near shops, services, restaurants, public transport, and parks, compared to residents of less-walkable areas. But the evidence showing the link between walkable features (the built environment) and physical activity has not always been consistent.

This study included participants from 14 cities and surrounding regions in 10 countries: UK (Stoke-on-Trent), Belgium (Ghent), Brazil (Curitiba), Colombia (Bogota), Czech Republic (Olomouc), Denmark (Aarhus), China (Hong Kong), Mexico (Cuernavaca), New Zealand (North Shore, Waitakere, Wellington, and Christchurch), and the United States (Seattle and Baltimore).

STUDY DESIGN

The purpose of this international cross-sectional study of 6,822 adults was to improve the quality of the evidence on activity-friendly neighbourhoods. The neighbourhoods sampled in this study varied in socio-economic status and walkability. The study used geographic information systems (GIS) to measure residential density, street connectivity, public transport stops, number of parks, mixed land use, and nearest public transport points. Physical activity was measured with small electronic devices, called accelerometers, worn around the waist for one week, to record movement every minute. Because this type of study takes a 'snapshot' in time, it is difficult to tell whether

the neighbourhood may have stimulated physical activity or whether people already physically active are more likely to reside in such neighbourhoods.

POPULATION CHARACTERISTICS

The Stoke-on-Trent study consisted of 843 adults from which 135 wore accelerometers and provided ≥ 4 days of valid physical activity data. In comparison with the study as a whole Stoke-on-Trent participants had: a similar mean age of 44 (compared to 43 for all cities); a greater proportion of participants with less than high school education (38% compared to 12.3%); fewer people in employment (64% compared to 79%); mean accelerometer wear time of 14.6 hours per day with a mean of 36.7 minutes of moderate or vigorous physical activity per day (compared to 14.4 hours and 37.3 minutes respectively).

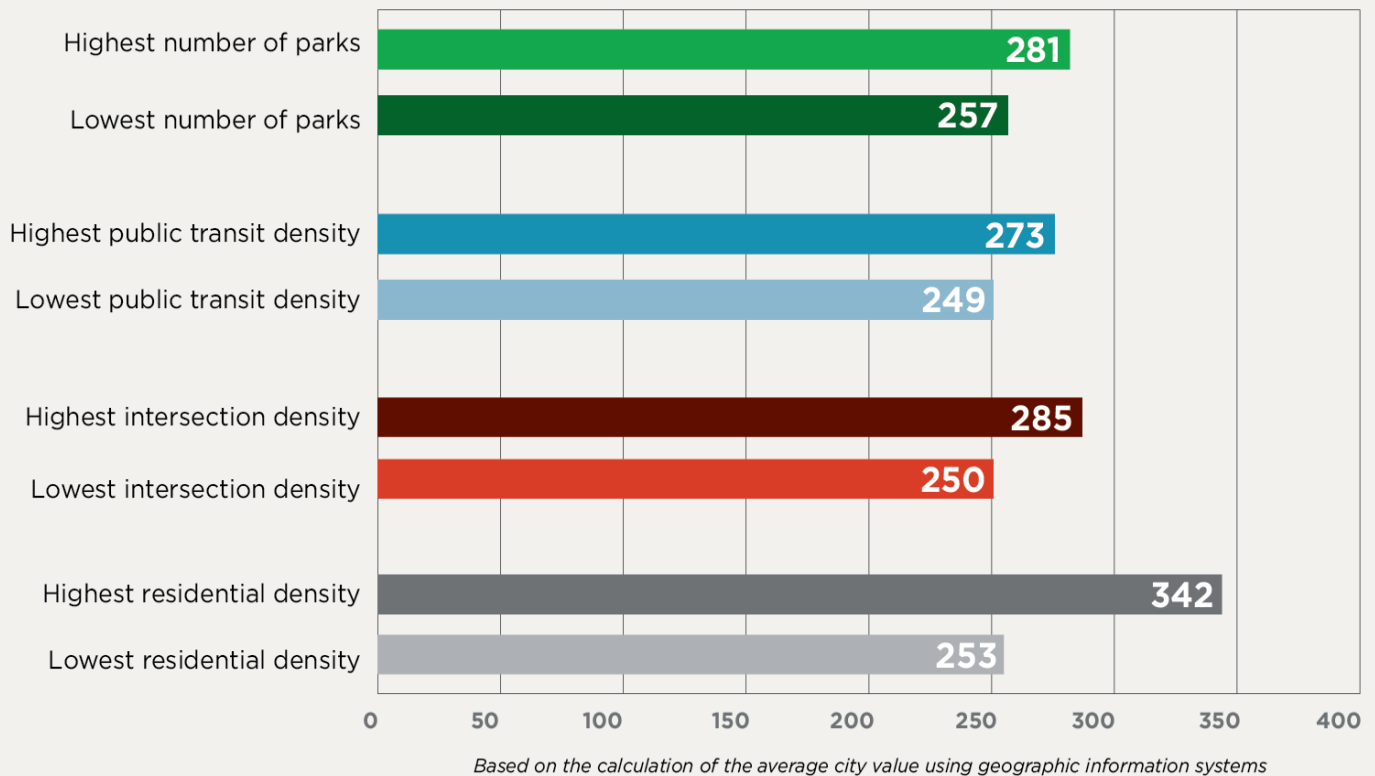
The Stoke-on-Trent participants were selected from across 16 neighbourhoods that varied in terms of built environment and area-level deprivation. Eight of the neighbourhoods fell in the 20% most deprived nationally based on the Index of Multiple Deprivation and only four neighbourhoods were within the 40% least deprived nationally.

MAIN FINDINGS

The overall findings across all 14 cities were:

- residential density, number of public transport stops, number of street intersections/street connectivity and number of parks within walking distance were found to be the most activity-friendly characteristics of a neighbourhood
- adults who lived in the most activity-friendly neighbourhoods did 48 to 89 minutes more physical activity per week than those in the least activity-friendly neighbourhoods. This difference is much larger than has been reported in other studies
- each of these activity-friendly characteristics was independently related to physical activity. The relationships with physical activity were also linear; for example, the higher the level of residential density, the higher the level of physical activity
- the relationships between a neighbourhood's characteristics and the physical activity of residents were generally similar across diverse cities
- mixed land use and nearest public transit point were not, however, significantly related to physical activity levels
- overall, the unique use of objective measures of neighbourhood characteristics and physical activity increase the precision and credibility of this study's findings

Weekly minutes of moderate-to-vigorous physical activity by neighborhood characteristics



IMPLICATIONS FOR PUBLIC HEALTH AND PLANNING PROFESSIONALS:

- the similarity of findings across various cities and various socio-economic groups suggest that changing the built environment is a solution that can be applied to improve health internationally
- this study adds strength to previous calls to approach the prevention of major chronic diseases through policy changes in urban planning, public transport, and development of parks and recreational facilities that will increase physical activity
- living in an activity-friendly neighbourhood can provide 32-59% of the 150 minutes of weekly physical activity that is recommended for adults to maintain good health
- because the relationships between activity-friendly neighbourhood characteristics and physical activity were linear, this would suggest that improvements in the built environment may be expected to increase physical activity, irrespective of whether the residents of that city are starting at a low or high level
- the large differences in physical activity between participants living in the most and least activity-friendly neighbourhoods provide strong justification for public health agencies to work with other agencies – particularly the urban planning, parks and recreation, and transport sectors – in order to create healthier cities

- making cities more activity-friendly could be an important part of substantial long-term and sustainable solutions to the global problems of death and disease associated with physical inactivity
- a comprehensive approach that increases as many walkable features as possible is needed to design activity-friendly neighbourhoods

References

The case study is based on: Sallis, James F., et al. "Physical activity in relation to urban environments in 14 cities worldwide: a cross-sectional study." *The Lancet* (2016). The International Physical Activity and Environment Network (IPEN) developed this study. The U.S. National Cancer Institute of the National Institutes of Health provided funding for coordination. Studies in each country were funded by different sources. The UK study was funded by the Medical Research Council under the National Prevention Research Initiative.

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For more information on IPEN, please see: www.ipenproject.org

Housing

A considerable amount of time is spent daily in the home. Housing is a basic human right and the quality and affordability of houses can determine the health status of residents. It is estimated that 20% of the UK's housing stock does not meet decent home standard and that the cost to the NHS of poor quality housing is £2.5 billion per annum (BRE, 2010). Living in good quality and affordable housing is associated with numerous positive health outcomes for the general population and those from vulnerable groups.

Principles for healthy housing

1. Improve quality of housing:

- there is evidence to suggest that living in a warm and energy efficient property can improve general health outcomes, reduce respiratory conditions, improve mental health and reduce mortality (Gibson et al., 2011; Krieger et al., 2014; Thomson et al., 2009; Thomson et al., 2013; WHO 2005). Retrofitting modifications to improve housing warmth and energy efficiency may help to reduce health inequalities among those from low-income groups, notably older adults and those living with chronic pre-existing conditions (Gibson et al., 2011)
- good quality housing can also reduce the risk of unintentional injury or death. For example, improvements to residential lighting and interventions to reduce hazards in the home can lead to improved social outcomes and reduce fall-related injuries among older adults (Bambra et al., 2010; McClure et al., 2008).
- evidence suggests that housing refurbishment, including damp proofing, re-roofing, and new window installation is associated with improvements in general health outcomes (Clark et al., 2007; Gibson et al., 2011, Thomson et al., 2013) and reduce health inequalities (Gibson et al., 2011)
- the impact of living in fuel poverty on health was outside the remit of this umbrella review. However, in a report produced by the Marmot Review Team, fuel poverty was shown to be associated with excess winter deaths, increased prevalence of chronic conditions, and poorer mental health outcomes (Marmot Review Team, 2011)
- although this review did not identify any eligible evidence relating to daylight and ventilation and health outcomes, the linkages between poor indoor air quality and ill



Improve Quality of Housing

health, particularly CVD, respiratory symptoms, sensory irritation, lung cancer and other cancers, are well established (WHO, 2010; RCP & RCPCH, 2016). Ventilation can help control air contaminants and humidity thereby improving indoor air quality

2. Increase provision of affordable and diverse housing:

- provision of diverse forms and types of housing has been associated with increased physical activity (Durand, 2011)
- the provision of mixed land use and affordable housing is strongly associated with improved safety perceptions in the neighbourhood, particularly among individuals from low-income groups (Bambra et al., 2010). However, the impact of such housing provision on improving health outcomes and reducing health inequalities is unclear



Increase Provision of Affordable and Diverse Housing

3. Increase provision of affordable housing for groups with specific needs:

- there is broad agreement that the provision of affordable housing for vulnerable groups (including adults with intellectual disability and adult substance users) can lead to improvements in social, behavioural and health-related outcomes (Fitzpatrick-Lewis et al., 2011; Reif et al., 2014)
- evidence shows that the provision of secure and affordable housing for those with some chronic medical conditions, such as HIV/AIDS, can increase engagement with healthcare services which has been shown to lead to improved health-related outcomes. Furthermore, provision of secure and affordable housing has also been shown to reduce engagement in risky health-related behaviours (Aidala et al., 2016; Fitzpatrick-Lewis et al., 2011; Leaver et al., 2007)
- the provision of affordable housing for the homeless has consistently been shown to increase engagement with healthcare services, improve quality of life and increase employment. It has also been shown to contribute to improvements in mental health status (Bassuk et al., 2014)



Increase Provision of Affordable Housing for Groups with Specific Needs



Housing

Quality of Evidence:

- ▲ Improved
- ▼ Reduced
- ▶ High Quality
- ▶ Medium Quality
- ▶ Low Quality
- ▶ NR (Not reported):
Methodological quality of the original research is unclear and should be treated with caution.

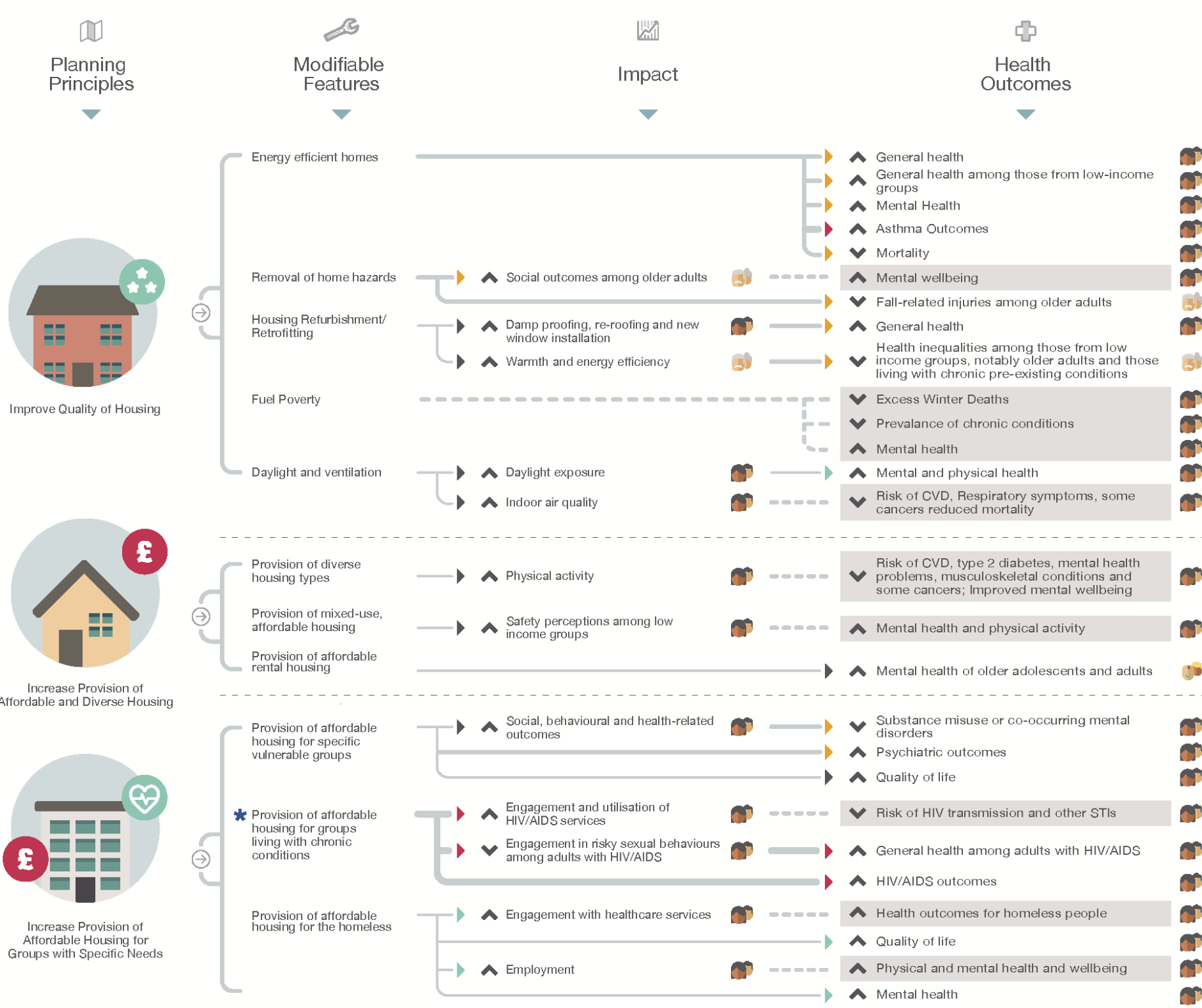
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Best Available Evidence:
* In some instances, more than one piece of review-level evidence reporting on the same health impacts and/or outcomes was identified as part of this umbrella review. In such instances this table highlights findings of the review(s) which reported evidence of the best methodological quality.

Population Groups:

- ▶ General Population
- ▶ Older Adults
- ▶ Children & Adolescents

Disclaimer:
This diagram has been produced as part of a wider evidence resource, commissioned by Public Health England and developed by the University of the West of England. Please see the document Spatial planning for health: an evidence resource for planning and designing healthier places for further information.



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Housing: Case study 1 – CHARISMA: Housing improvements and childhood asthma

PLANNING PRINCIPLE: Improve quality of housing

BACKGROUND & SETTING:

One in 11 children in the UK has asthma and it is the most common long-term medical condition in childhood. The NHS spends around £1 billion a year treating and caring for people with asthma. The CHARISMA project aimed to improve the asthmatic health and overall quality of life of children with moderate or severe asthma in Wrexham, by improving their housing conditions. Studies to evaluate the project examined both the effectiveness and cost-effectiveness of enhancing home ventilation in the homes of 177 children with 'moderate' or 'severe' asthma in Wrexham, North Wales.

WHAT WAS THE INTERVENTION?

Each child's household was visited by a local authority housing officer, who assessed the improvements needed. Ventilation systems were installed in the roof space of houses. Improvements were made to bring central heating systems to a defined standard; new systems were installed if none existed. There was no cost to the families for these improvements. There was a 'waiting list control' group who received the intervention after the study was completed.

POPULATION CHARACTERISTICS:

The intervention covered all housing types and all geographical areas across Wrexham according to need, this was to address inequalities (with respect to deprivation, ethnicity and rurality etc). The patient group consisted of asthma sufferers aged 5 to 15.

MAIN OUTPUTS AND OUTCOMES:

Tailored ventilation and heating modifications led to a 17% shift of children in the intervention group from 'severe' to 'moderate' asthma, as compared with a 3% shift for the control group, at an average cost to the council of £1718 per child; but the package had no apparent effect on health-service costs.

At £234 per point improvement on the asthma-specific scale, this package of measures was deemed likely to be a cost-effective use of resources. Sensitivity analysis showed that cost-effectiveness differed between children with more severe asthma and those with less severe asthma. Hence the case for improving the housing of children with 'severe' asthma is even more cogent than for children with 'moderate' asthma.

WHAT WERE THE KEY SUCCESS FACTORS?

This was the first rigorous cost-effectiveness analysis of housing modifications to address childhood asthma.

Commitment from partners over several years was key to the project's success. Partners wanted to make a difference and saw the potential for this intervention to positively affect children's health and well-being and that of their family.

WHAT BARRIERS TO EFFECTIVE IMPLEMENTATION WERE FACED?

The research team were only able to follow up children for 1 year after the housing improvements, and did not assess the impact on other household members of the improvements. Benefits in terms of respiratory health and quality of life would be expected to continue beyond this period.

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Food environment

The food environment plays an important role in promoting a healthy diet, but this is a complex system influenced and determined by a series of factors, including a person's proximity to food retail outlets and the type of food available. Vulnerable groups, including those on a low income, children, young people, those who are overweight or obese, and those of certain ethnicities, are less likely to achieve a healthy and balanced diet. To date, there is relatively limited good quality review level evidence on the influence of the food environment on health and wellbeing outcomes. However, existing evidence indicates that making healthier foods more accessible and increasing provision of low cost healthier food could be effective interventions, but these are likely to be more effective as part of a whole system approach to diet and obesity.

Principles for healthier food environments

1. Healthy, affordable food for the general population:

- research of moderate quality indicates that increased access to healthy, affordable food for the general population (e.g., food in schools, neighbourhood retail provision) is associated with improved attitudes towards healthy eating and healthier food purchasing behaviour (Gannan et al., 2014). It also indicates that improved dietary behaviours, such as increased fruit and vegetable consumption, are associated with increased access to healthy, affordable food vegetables (Bambra et al., 2010; Calancie et al., 2015)
- research indicates that increased access to unhealthier food retail outlets is associated with increased weight status in the general population, and increased obesity and unhealthy eating behaviours among children residing in low income areas (Cobb et al., 2015; Giskes et al., 2010; Kent & Thompson, 2014) a consistent body of evidence suggests that provision of healthy, affordable food in schools is associated with improved healthier food sales, dietary behaviours and nutritional outcomes (Driessen et al, 2014). Evidence suggests that multi-component interventions, and taking an integrated, whole school approach, are effective in improving children's diet and food choices in schools (Davies, 2010)



Provision of healthy, affordable food for the general population

- some evidence indicates that increased access to retail outlets selling healthier food is associated with improvements in dietary behaviours and adult weight status (Giskes et al., 2010)
- the impact of access to unhealthy food in the workplace on health was outside the remit of this umbrella review. However, a UK based empirical study found that exposure to takeaway food outlets was positively associated with consumption of takeaway food, particularly around the workplace (Burgoine et al., 2014). Evidence from primary studies conducted in Northern Europe suggests environmental strategies at worksites may help towards a more healthy diet (Lassen et al., 2012; Lassen et al., 2011; Lassen et al., 2004)

2. Enhance community food infrastructure:

- there is limited, newly emerging evidence showing a positive association between urban agriculture, as defined by Kent & Thompson 2014, and improved attitudes towards healthier food, increased opportunities for physical activity and social connectivity, and increased fruit and vegetable consumption. The overall evidence base for these associations is relatively small and is based on and requires further research to clarify causal links (Kent & Thompson, 2014; McCormack et al., 2010)
- the impact of provision and access to allotments and adequate garden space on health was outside the remit of this umbrella review. However, findings from a recent non-systematic literature review suggest that gardening in an allotment setting in the UK may result in numerous positive physical and mental health-related impacts and outcomes (Garden Organic & Sustain, 2014)



Enhance community food infrastructure



Healthier Foods

Quality of Evidence:

- ▲ Improved
 - ▼ Reduced
 - High Quality
 - Medium Quality
 - Low Quality
 - NR (Not reported):
- Methodological quality of the original research is unclear and should be treated with caution.

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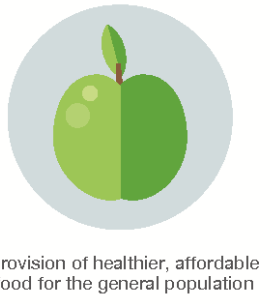
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Population Groups:

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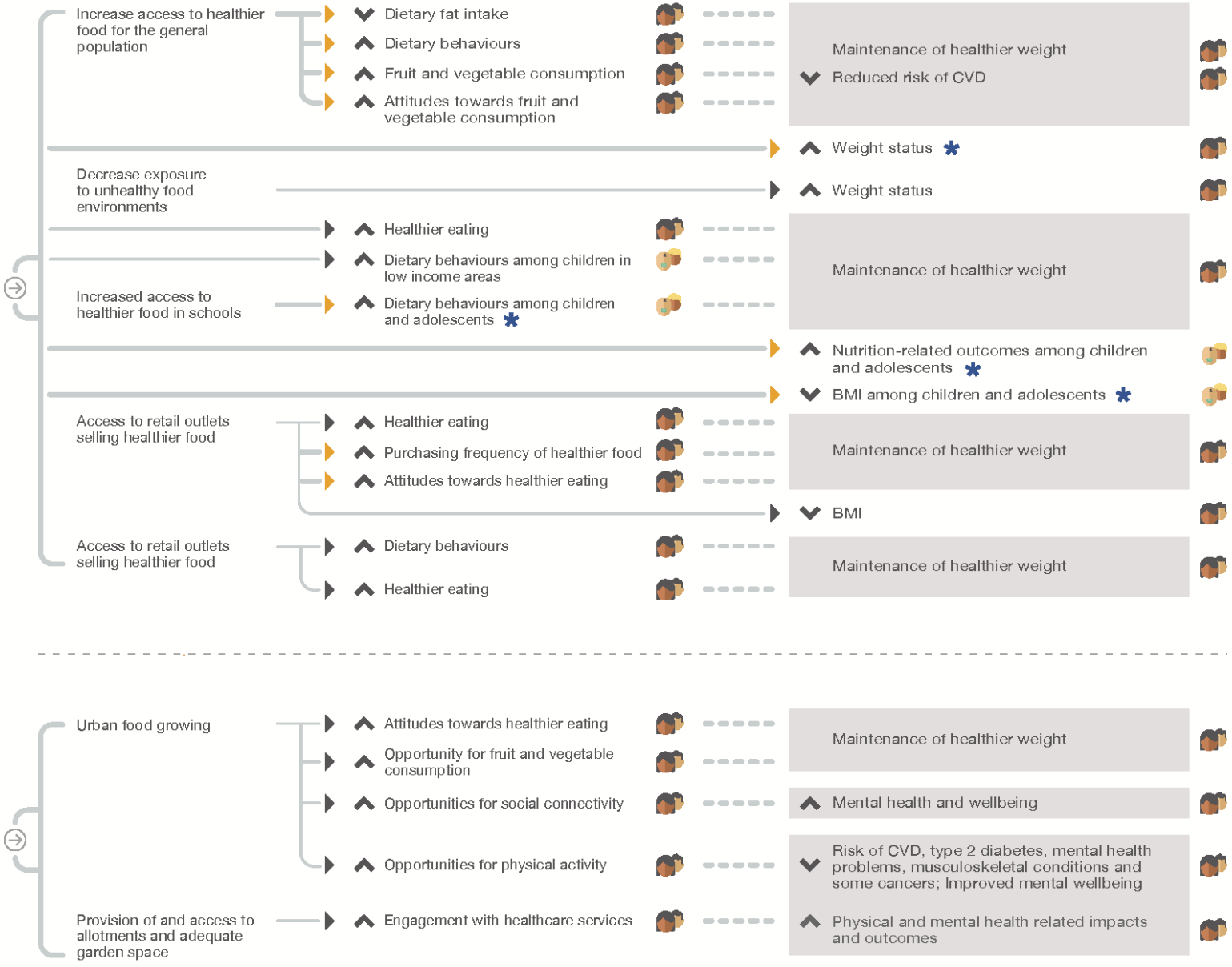
Planning Principles



Modifiable Features

Impact

Health Outcomes



Note: For further information on what constitutes a healthy balanced diet, please see the **Eat Well Guide**, available at: <https://www.gov.uk/government/publications/the-eatwell-guide>

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Food Environment: Case study 1 – Gardens for Life



PLANNING PRINCIPLE: Enhance community food infrastructure

BACKGROUND & SETTING:

The Women's Environmental Network (WEN) was commissioned by London Borough of Tower Hamlets's (LBTH) Public Health department to help set up 15 community gardens across the Borough. This 15 month project (April 2014 – July 2015) was designed to help improve residents' wellbeing by providing increased access to healthier food and creating community cohesion by working together, with support from WEN's community garden coordinators, to develop the growing spaces.

WHAT WAS THE INTERVENTION?

15 community gardens were successfully set up using two gardening coordinators who engaged 4,485 Tower Hamlets residents. 178 residents actively participated in gardening, largely growing food, and were supported by training sessions covering practical and theoretical topics of site planning, garden design, organic food growing, healthy eating and cooking, tailoring each workshop to the needs of the group.

POPULATION CHARACTERISTICS:

The London Borough of Tower Hamlets in East London is the third most deprived local authority district in England. The borough has a population of 272,890, which includes one of the highest ethnic minority populations in the country.

Unhealthy diets and low levels of physical activity are major causes of health issues in Tower Hamlets both in children and adults. 12.2% of children in Reception year are obese – the 9th highest rate in the country. By year 6 this increases to 25.1% which is the 5th highest rate in the country.

MAIN OUTPUTS AND OUTCOMES:

The Gardens for Life project showed an improvement in wellbeing for over half (59%) of participants for whom data were available (12.5%).

Gardens for Life provided new opportunities for people to meet their neighbours and build a sense of community around the garden itself. The project successfully promoted all of the 5 ways to Wellbeing ; including Connect, Be Active, Take Notice, Keep Learning and Give, through the acts of learning new skills, sharing their produce with friends and family and increasing their levels of physical activity.

The project provides access to local food and encourages healthy eating. Individual feedback highlighted a host of community benefits and how the gardens helped build social capital.

WHAT WERE THE KEY SUCCESS FACTORS?

Gardens for Life was funded by the local Public Health department and was delivered within 15 months with a budget of £120,000.

The project involved a variety of garden improvements ranging from single plots to communal gardens. This was a strength of the project as it has demonstrated that community gardens can be set up and operated in a wide variety of different settings. Partnership working was central to the success of this project. The project involved three Registered Social Landlords (RSLs), Tower Hamlets Public Health plus other council departments, including their Clean and Green and Planning teams. WEN also worked with non-housing partners, such as community centres, to achieve a range of different sites. To build sustainability into the project, sites were linked to the Tower Hamlets Food Growing Network, which WEN coordinates. The network provided support, advice, networking opportunities with other community gardens, access to the community seed library, learning workshops and exchange visits.

WHAT BARRIERS TO EFFECTIVE IMPLEMENTATION WERE FACED?

Data collection was problematic for this type of project for a variety of reasons including language, timing and turnover of participants. The majority of the participants did not speak or read English as a first language, and many were not literate in their mother tongue. This affected the response rate.

The project evaluation recommended more resources allocated to measurement and evaluation such as staff time to: build trust with participants, explain the forms in detail and ensure people understand what they are being asked, translate where appropriate, follow up with participants to ensure as many forms are returned as possible and keep collecting case studies and general evaluation feedback.

Challenges identified by the evaluation team included:

- outreach – this is essential but it is very time-consuming knocking on doors. Proper consultation takes more time, which is sometimes hard to fit in with project timelines. We produced flyers to post to all households and also held information events in the garden using seed sowing and children’s activities to attract people to the stall
- a lack of access to water – working with RSL bureaucracy to address this issue can take a long time
- the physical set-up of the gardens took more time and money than anticipated. The project team worked with corporate volunteering groups to set up some of the gardens
- diversity of groups - The project involved working with a wide range of different groups in Tower Hamlets. To ensure diversity it is important to target specific groups. WEN approached the Ocean Somali Community Association to work with Somali women and also the East London Chinese Community Centre

Future projects would benefit from the learning gained from the Gardens for Life project in a number of ways. Firstly, the project team would recommend planning projects of this type around the food growing season, and prioritising on-going support and long term sustainability of each garden. In real terms this could mean setting up fewer gardens but providing more on-going support to ensure that each was fully established by the end of the project. We would also recommend linking projects to wider networks for sustainability, as the Gardens for Life gardens were linked to the Tower Hamlets Food Growing Network. The lessons learned around the evaluation methods used would also be useful for similar projects.

Reference

Tower Hamlets Gardens for Life Evaluation Report, August 2015: <http://goo.gl/8P0Esr>

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Natural and sustainable environments

There is a very significant and strong body of evidence linking contact and exposure to the natural environment with improved health and wellbeing. For the purpose of this review, the natural and sustainable environment is comprised of neighbourhood ecosystems and the resulting co-benefits between the environment and health. Protecting the natural environment is essential to sustaining human civilization.

Principles for natural and sustainable environments

1. Reduce exposure to environmental hazards:

- recent evidence indicates that living in an area with clear air can lead to positive changes in people's health behaviours. Improved air quality is associated with increased physical activity among older adults (Annear et al., 2014)
- there is a wealth of consistent evidence demonstrating clear adverse effects of exposure to air pollutants on health outcomes across all population groups. For example, poor air quality is linked with an increased risk of developing chronic conditions (e.g., COPD and type II diabetes), neonatal complications and poor birth outcomes, cancer, worsened respiratory outcomes and childhood mortality, among others. Notably, there is consistent evidence for the adverse health effects associated with exposure to particulate matter (PM_{2.5} and PM₁₀) (Koranteng et al., 2007; Bonzizni et al., 2009; Song et al., 2014; Steib et al., 2012)
- exposure to excessive noise is associated with poorer mental health outcomes, particularly among older adults and children (Annear et al., 2014). It is also linked with higher anxiety levels among adults (Clark et al., 2007)
- the impact of flooding on health outcomes was outside the remit of the umbrella review. However, there is review level evidence to demonstrate that flooding can affect people's physical and mental health, with affected communities reporting higher symptoms of stress, mental illness and increased risk of chronic disease (Alderman et al., 2012)
- there is evidence from an evidence review of unknown quality that highlights the risk of carbon monoxide poisoning (Waite et al., 2014), and the increase the risk of mental health problems (Stanke et al., 2012) in flooding/disaster situations.



Reduce exposure to environmental hazards

2. Access to and engagement with the natural environment:

- access to, and engagement with, the natural environment is associated with numerous positive health outcomes, including improved physical and mental health, and reduced risk of cardiovascular disease, risk of mortality and other chronic conditions (Annear et al., 2014; Gascon et al., 2016; Calogiuri & Chroni, 2014; Lee & Maheswaran, 2010; Clark et al., 2007; Lacasana, Esplugues, & Ballester, 2005; Teng et al., 2014). There is consistent evidence that having access to recreational infrastructure, such as parks and playgrounds, is associated with reduced risk of obesity among adolescents and increase in physical activity (Davison & Lawson, 2006; Dunton et al., 2009; Calogiuri & Chroni, 2014). None of the reviews identified reported on the impact of access to, or engagement with the natural environment, on reducing health inequalities. However, evidence from empirical studies suggest that living in close proximity to green space, such as parks and other open spaces can improve health, regardless of social class (Mitchell & Popham, 2008)
- aesthetic park improvements can increase visitation and improve physical activity among children and older adults (McCormack, 2011; WHO Europe, 2007). Evidence also suggests that improving the appearance of parks can increase usage and increase physical activity among children and older adults (Hunter et al., 2015)
- evidence indicates that participation in physical activity in a natural setting is associated with more improved mental health outcomes than participation in physical activity in an indoor setting (Davison et al., 2006; Dunton et al., 2009)



Access to and engagement with the natural environment

3. Adaptation to climate change:

- there is low to moderate quality evidence that greening (planting of trees) has a cooling effect on the environment, with an urban park being approximately 1°C cooler than a non-green site (Bowler, 2010). There is empirical research to indicate that the implementation of green infrastructure may have the ability to reduce the effects of the urban heat island
- the impact of heat and cold extremes on health was outside the remit of this umbrella review. However the UK's Climate Change Risk Assessment (CCR, 2017) lists risks to health due to extreme temperatures specific for the UK, which are likely to increase in frequency due to climate change. Extremes of heat and cold are associated with potentially fatal illness, such as heat stroke or hypothermia, as well as increasing death from cardiovascular and respiratory diseases. Rising temperatures suggest there will be



Adaptation to climate change

- more heatwaves in the UK, but excess deaths from cold weather will remain challenging due to an increasingly aging population (Hajat et al. 2014)
- additional findings indicate that stagnant weather can reduce air quality and negatively affect health by trapping warm and cold air, leading to smog (CABE, 2009)



Natural & Sustainable Environments

Quality of Evidence:

- ▲ Improved
- ▼ Reduced
- ▶ High Quality
- Medium Quality
- Low Quality
- NR (Not reported):
Methodological quality of the original research is unclear and should be treated with caution.

Greyed Out Text

Association between a health impact & health outcome not obtained as part of the umbrella review.

Best Available Evidence:

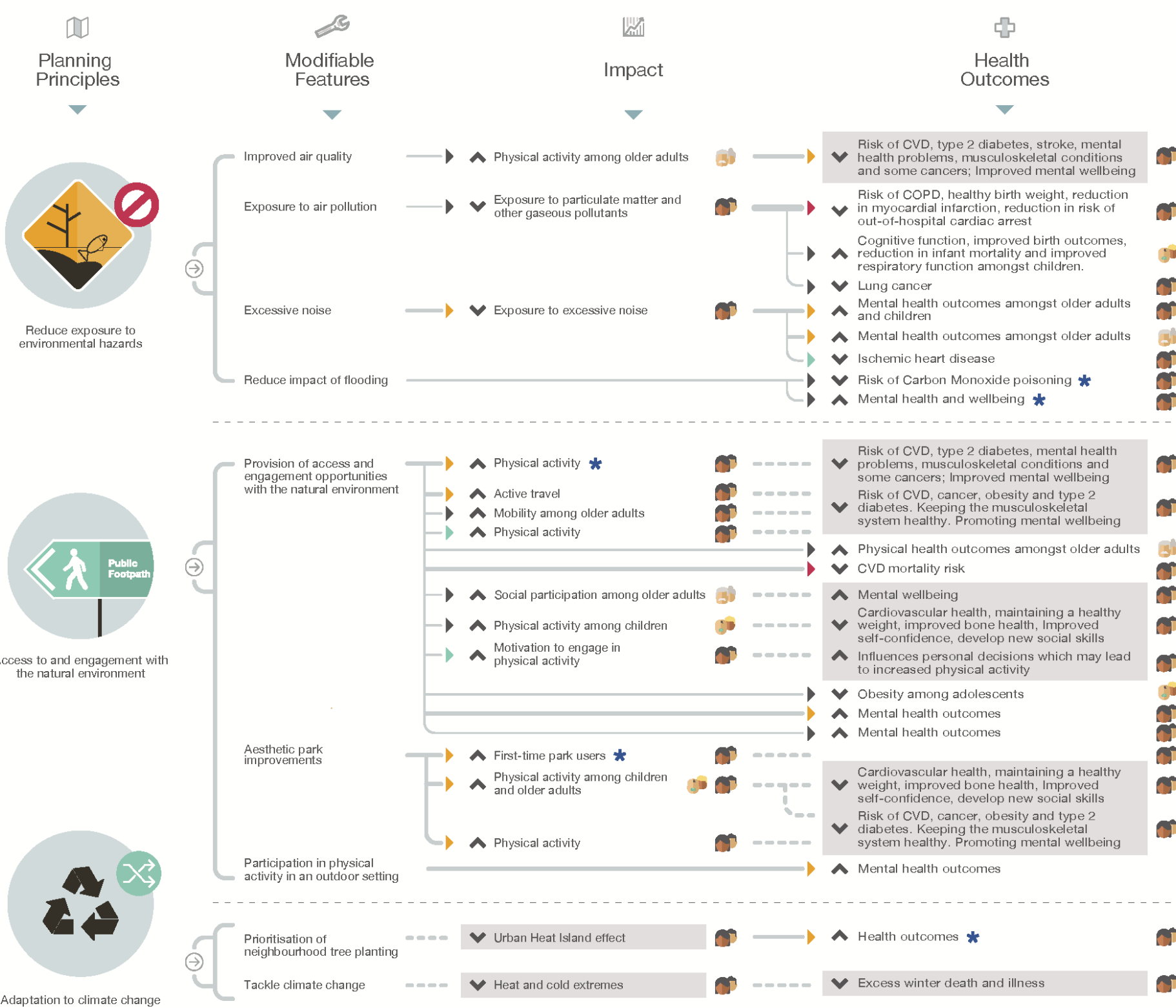
- * In some instances, more than one piece of review-level evidence reporting on the same health impacts and/or outcomes was identified as part of this umbrella review. In such instances this table highlights findings of the review(s) which reported evidence of the best methodological quality.

Population Groups:

- General Population
- Older Adults
- Children & Adolescents

Disclaimer:

This diagram has been produced as part of a wider evidence resource, commissioned by Public Health England and developed by the University of the West of England. Please see the document Spatial planning for health: an evidence resource for planning and designing healthier places for further information.



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Natural and Sustainable Environments: Case study 1 – Would you be happier living in a greener urban area?

PLANNING PRINCIPLE: Access to and Engagement with the Natural Environment

BACKGROUND & SETTING:

The research used data from the large, nationally representative, longitudinal British Household Panel Survey (>10,000 people). The survey contacted the same people once a year (up to 18 consecutive years) and asked them a range of questions each time including their current job, marital status, address, income and wellbeing.

STUDY DESIGN:

The analysis focused on those people who moved between different urban areas of England over the 18 (or fewer) years they were part of the study. What the researchers wanted to know was whether they were 'happier' (had greater satisfaction with life and less symptoms of anxiety and depression) in years when they lived in urban areas with more vs. less green space, after accounting for other changes in their lives such as changes in income, marital status etc. over the same time period.

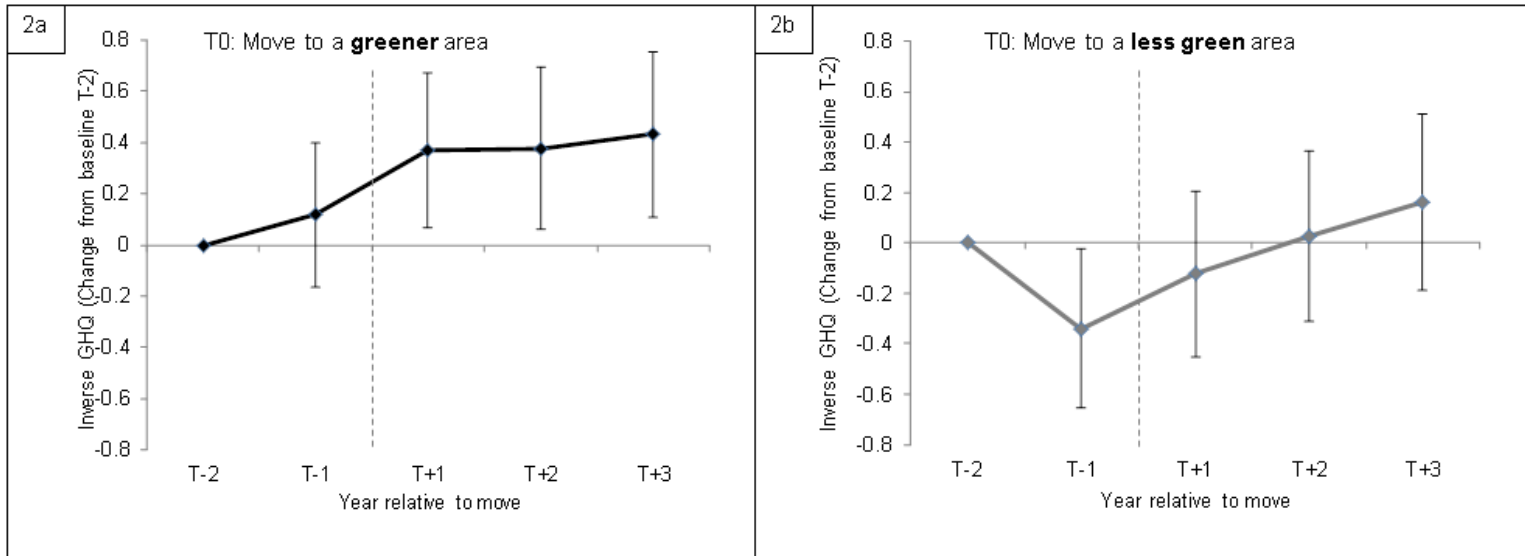
POPULATION CHARACTERISTICS:

Although the survey was representative, people who moved home during their time in the study were slightly younger than average. The researchers also focused only on those moving between urban areas to avoid complications associated with rural vs urban transitions.

MAIN FINDINGS:

Even after accounting for other changes in individuals' lives (such as income, employment and marital status), people reported higher life satisfaction and lower symptoms of anxiety and depression in those years when they lived in greener urban areas. For individuals moving from low to high green urban areas this increase was immediate and lasted for at least three years (the longest time we could explore post relocation). For those who moved from high to low green areas the pattern was less clear, maybe because the motives to move were more diverse (e.g. to get a better job).

Figure 2: Changes in (Inverse) GHQ scores compared to baseline (T-2) following relocations to (a) greener urban areas and (b) less green urban areas. (Error bars = 95% CIs)



Note: In Figure 2, T-1 and T+1 are annual data collection time points immediately prior to and succeeding the time of the move to a greener/less green area (T0). T-2 is the annual data collection time point preceding T-1, and T+2 and T+3 are the annual data collection time points succeeding T+1.

IMPLICATIONS FOR PUBLIC HEALTH AND PLANNING PROFESSIONALS:

Living in urban areas with greater amounts of greenspace may be good for the long-term mental health of urban populations.

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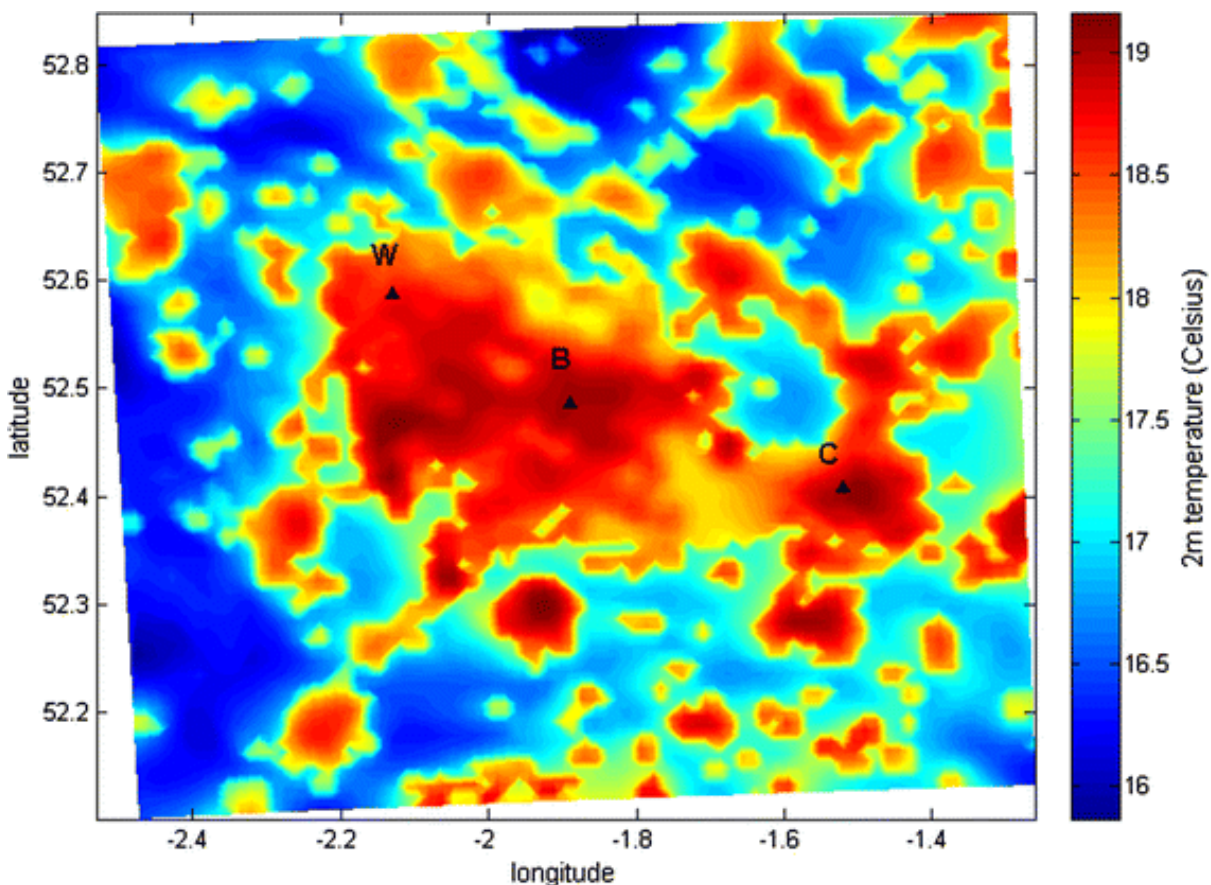
Natural and Sustainable Environments: Case study 2 – Mortality from Urban Heat Island Effect during West Midlands heatwave

PLANNING PRINCIPLE: Adaptation to Climate Change

BACKGROUND & SETTING:

The ‘Urban Heat Island’ (UHI) describes the phenomenon that cities are generally warmer than surrounding rural areas, due to a number of factors such as a lack of moisture and the use of man-made building materials in cities. The West Midlands is a highly urbanised region of the UK, and as such, has a substantial UHI (found to be up to 7oC warmer in city compared to countryside during the heatwave of August 2003; Heaviside et al. 2015). Since it is known that excess heat affects mortality risk in the UK (Hajat et al. 2014), it is likely that people in urban areas are particularly at risk from the effects of high temperature. The increased temperature due to the UHI is not always captured by sparse temperature monitoring stations, and urban effects are not always included in global climate models, which is the motivation for regional modelling of this type.

Figure 3: Modelled mean temperature at 2 metres height for all hours from 1st – 10th August 2003 for the West Midlands. W = Wolverhampton, B = Birmingham and C = Coventry locations.



STUDY DESIGN:

The researchers ran a regional climate model, gridded at a resolution of 1 km, covering most of the West Midlands region, to model air temperature at 2 m above ground level during the heatwave of August 2003. The model includes urban surfaces and buildings specific to the West Midlands area, so that the spatial distribution of temperature across the region can be visualised, and the UHI intensity can be quantified. By removing the urban surfaces from the regional model, and comparing the 2 different temperature maps, we were able to estimate the influence of urban surfaces on local temperature. We then applied a relationship between temperature and mortality to estimate the effects of the UHI on heat-related mortality, and estimated what the effects might be in future, as climate change causes an increase in temperature.

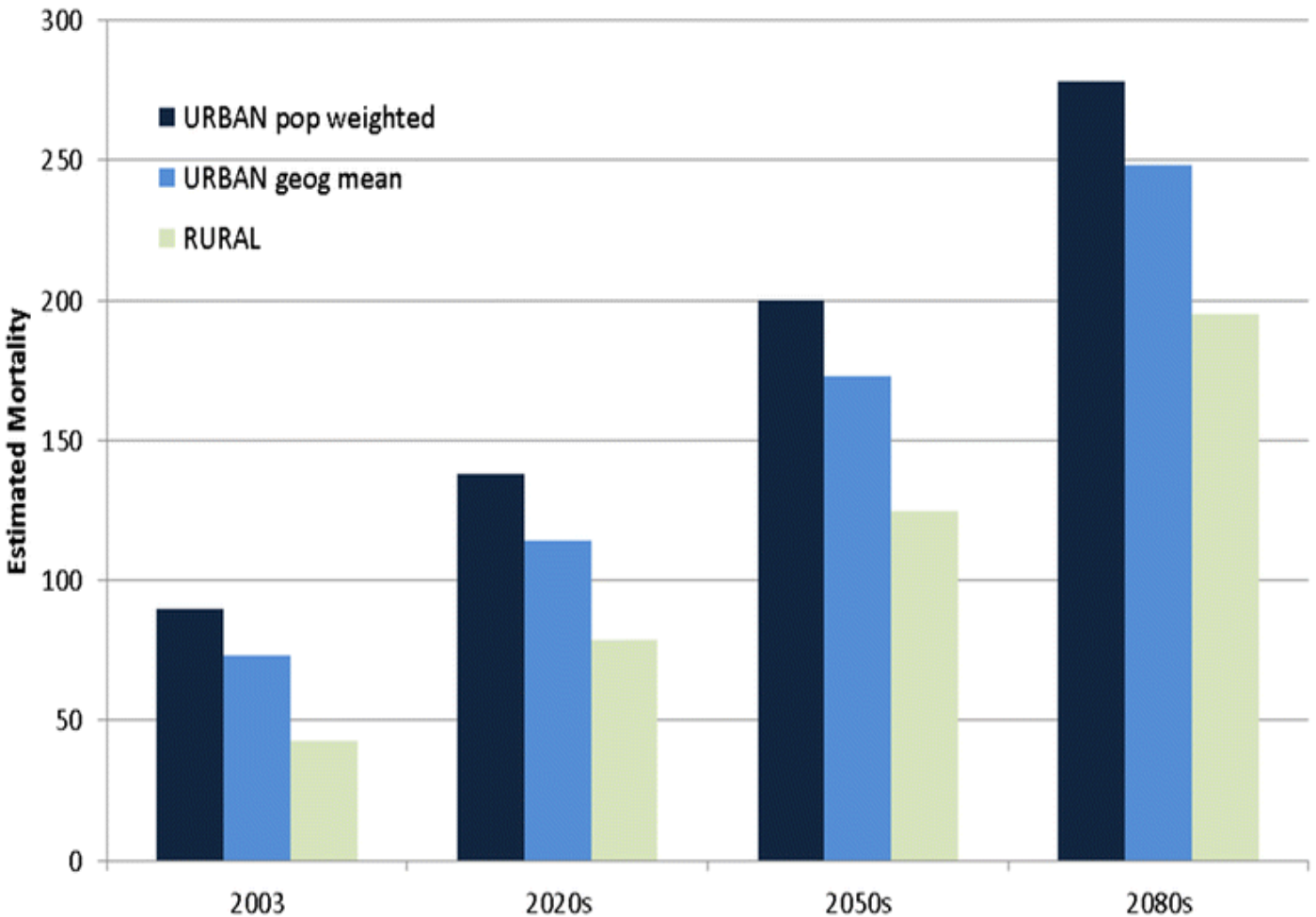
POPULATION CHARACTERISTICS:

The health impact assessment was applied across the whole modelled region, and included the whole population within the domain (around 5 million people). People most likely affected by heat effects during the heatwave of 2003 would have been those in the most built up areas, who were most exposed to the UHI effect. The elderly and those with existing illnesses would be most at risk from heat. Some housing types (such as attic apartments) also increase this risk.

MAIN FINDINGS:

Within the most built up areas of the West Midlands (e.g. Birmingham, Wolverhampton, Coventry) it was found that temperatures were up to 7°C higher than in the most rural areas during August 2003. Around half of the heat-related mortality (47 of the 90 deaths) which we estimated occurred in the West Midlands during the heatwave of 2003 could be attributed to the UHI. Due to climate change, a similar heatwave in the 2080s is projected to lead to 278 deaths, which is a threefold increase on the figure estimated during 2003.

Figure 4: Estimated mortality based on health impact assessment for heatwave of 2003 in West Midlands, plus projected impacts for future years (2020s, 2050s, 2080s). The different bars represent the estimates without population weighting (middle, light blue) and for a purely rural simulation (right hand, green).



IMPLICATIONS FOR PUBLIC HEALTH AND PLANNING PROFESSIONALS:

High resolution spatial modelling such as demonstrated here can help to highlight spatial vulnerability across built up areas. Health impact assessments which use coarse climate models for future temperature effects are likely to underestimate heat-related mortality. In the case presented here, without including urban effects, the health impact assessment would have only captured 50% of the mortality compared to when the UHI is included. Planners should consider the additional warming from the UHI effects, and potential effects on health, when planning future infrastructure. Measures to mitigate these health impacts - using greenspace, green roofs, blue space or high albedo surfaces - should be considered, and are currently being investigated using the same model.

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Transport

Transportation plays an important role in supporting daily activities. Active travel (cycling, walking and use of public transport) can increase physical activity levels and improve physical and mental wellbeing. Prioritisation of active travel can also reduce over reliance on motorised transport, contributing to improved air quality and a reduction in road injuries.

Principles for healthy transport

1. Provision of active travel infrastructure:

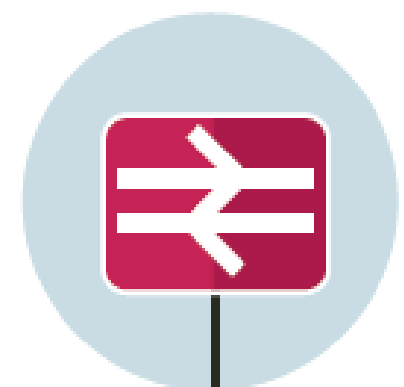
- there is a wealth of high quality evidence to show that investing in infrastructure to support walking can increase physical activity levels and improve mobility among children, adults and older adults (Carlin et al., 2015; D’Hease et al., 2015; Grasser et al., 2013; Larouche et al., 2014; Mueller et al., 2015; Wanner et al., 2012). There is moderate to high quality evidence that indicates that prioritising active travel, through investment in cycling infrastructure, can lead to numerous health gains. For example the implementation of new cycle lanes can lead to improved cardiovascular outcomes and improved weight status among children, adults and older adults (D’Hease et al., 2015; Larouche et al., 2014; Mueller et al., 2015; Wanner et al., 2012)



Provision of active travel infrastructure

2. Provision of public transport:

- evidence suggests that combining public transport with other forms of active travel, such as walking and cycling, can improve cardiovascular fitness (Xu et al., 2013). Provision of high quality public transport is associated with higher levels of active travel among children (Davison & Lawson, 2006)
- active travel in areas with low pollution levels is associated with increased physical activity among older adults. The perception of air pollution appears to constitute a barrier to participating in outdoor physical activity and active transport (Annear et al., 2014)



Provision of public transport

3. Prioritise active travel and road safety:

- attempts to prioritise pedestrians and cyclists through changes in physical infrastructure are associated with positive behavioural and health outcomes. For instance, the separation of cycling and pedestrian infrastructure from road traffic can encourage active travel (Fraser & Lock, 2011)
- traffic calming measures, including speed humps, speed tables, cushions and roundabouts, are associated with increased walking behaviour and a reduced risk of pedestrian injury (Rothman et al., 2013; Cairns et al. 2015). However, the impact of such measures on reducing health inequalities is not yet known. A recent report by the Royal Society for the Prevention of Accidents (ROSPA) suggests that traffic calming measures are effective when used in 20mph zones (ROSPA, 2015). This umbrella review found no review level evidence relating to the effectiveness of home zones that met eligibility criteria. However, there are reports in the grey literature that home zones, which can effectively reduce traffic speed to 10mph -15mph, reduce risk of road traffic collisions (Department for Transport, 2005)
- public realm improvements, such as street lighting, have been shown to increase physical activity participation among older adults and reduce the incidence of road traffic collisions (Beyer & Ker, 2009)



Prioritise active travel and road safety

4. Enable mobility for all ages and activities

- there is evidence that built environment strategies to promote physical activity can have a positive impact upon engagement in physical activity behaviours. For example, increasing access to playgrounds and recreational facilities is associated with increased walking among adolescents (Davison & Lawson, 2006; Rothman et al., 2003). Please also see “Neighbourhood Design” and “Natural and Sustainable Environments”
- evidence from high quality studies affirms a positive association between active travel to school or work and improved cardiovascular outcomes (Xu et al., 2013).
- the specific impacts of living in a rural setting on health were outside the remit of this umbrella review, however, a recent report by Active Living Research (2015) suggests that active travel is difficult to achieve in rural areas where residents live far away from local amenities and social services. This finding comes from a study that has not been quality assessed by the reviewers of this report. Please also see “Neighbourhood Design”



Enable mobility for all ages and activities

- the impact of improved mobility on the health outcomes among mentally and physically impaired people was outside the remit of this umbrella review. However Lezzoni et al., (2001) reported that addressing mobility issues among mentally and physically impaired individuals can improve quality of life

Transport

Quality of Evidence:

- ▲ Improved
- ▼ Reduced
- High Quality
- Medium Quality
- Low Quality
- NR (Not reported):

Methodological quality of the original research is unclear and should be treated with caution.

Greyed Out Text

Association between a health impact & health outcome not obtained as part of the umbrella review.

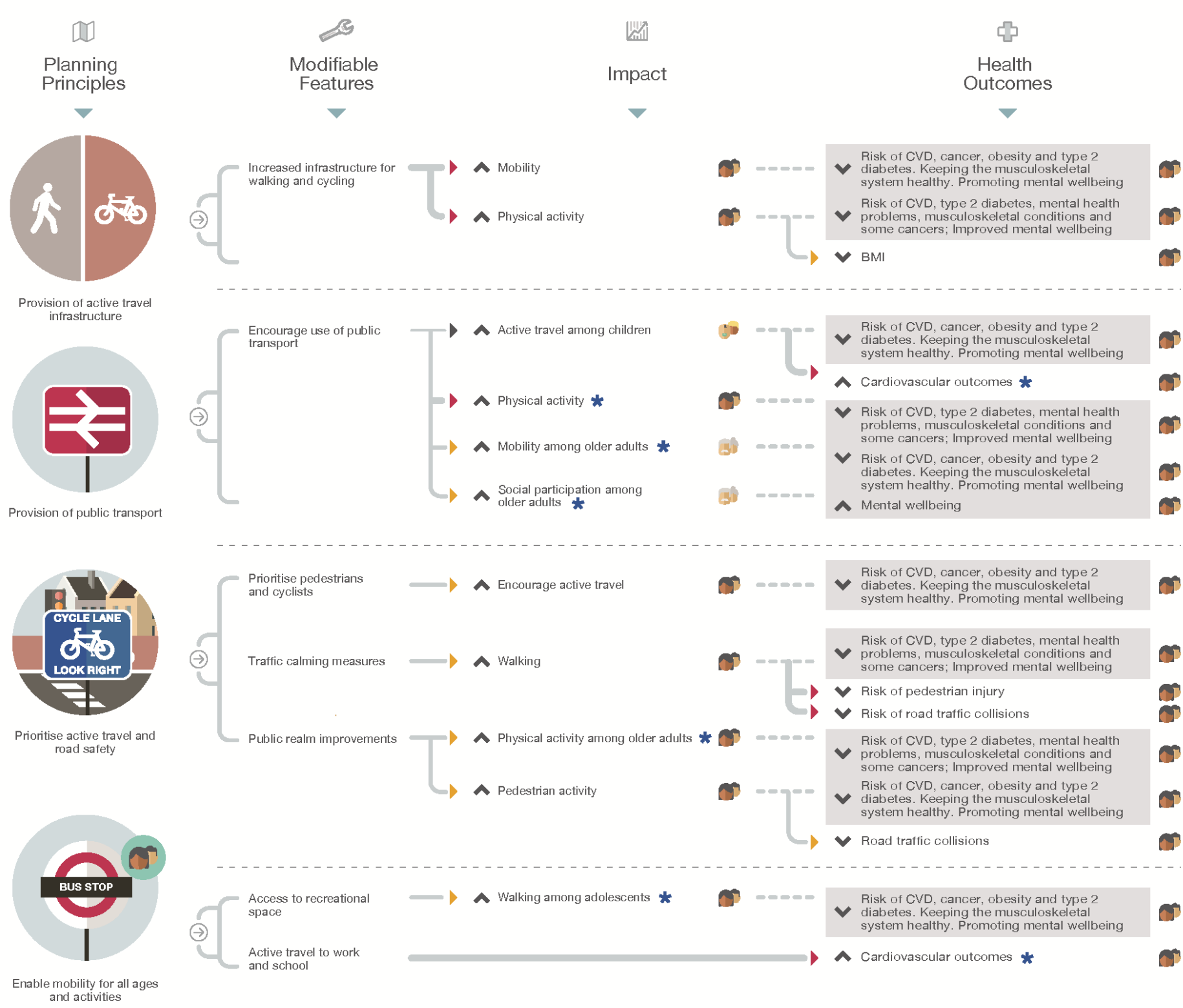
Best Available Evidence:

* In some instances, more than one piece of review-level evidence reporting on the same health impacts and/or outcomes was identified as part of this umbrella review. In such instances this table highlights findings of the review(s) which reported evidence of the best methodological quality.

Population Groups:

- General Population
- Older Adults
- Children & Adolescents

Disclaimer:
This diagram has been produced as part of a wider evidence resource, commissioned by Public Health England and developed by the University of the West of England. Please see the document Spatial planning for health: an evidence resource for planning and designing healthier places for further information.



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Transport: Case study 1 – Connect2



PLANNING PRINCIPLE: Improved connectivity of local walking and cycling routes

BACKGROUND & SETTING

Connect2 was a major new project that aimed to promote walking and cycling by improving local walking and cycling routes at 79 sites around the UK. The travel, physical activity and carbon impacts of the Connect2 programme were evaluated mainly through a cohort study of residents living within 5 km of three case study projects in Cardiff, Kenilworth and Southampton.

WHAT WAS THE INTERVENTION?

Each Connect2 site consisted of one flagship engineering project to overcome a physical barrier (a bridge over Cardiff Bay, a bridge over a dual carriageway in Kenilworth, and a riverside boardwalk in Southampton) coupled with improvements to signed, on- and off-road feeder routes, leading into that flagship project. Projects were tailored to individual sites, but all embodied a desire to create new routes for 'everyday, local journeys by foot or by bike' to destinations such as schools, shops, parks and countryside.

POPULATION CHARACTERISTICS

Although the study sample was older than the general population of the study areas, participants otherwise appeared fairly similar in their demographic, socioeconomic, and travel-related characteristics. Two of the case study sites were in cities, while the third linked a market town with the surrounding countryside.

MAIN OUTPUTS AND OUTCOMES

Living nearer the new routes did not predict changes in activity levels at one-year follow-up, but did predict increases in activity at two years, relative to those living farther away (15.3 additional minutes/week walking and cycling per km nearer; 12.5 additional minutes/week of total physical activity). The new routes may mainly have displaced walking or cycling trips in the short term but generated new trips in the longer term,

particularly among those unable to access more distant destinations by car. The findings support the potential for walking and cycling infrastructure to promote physical activity.

WHAT WERE THE KEY SUCCESS FACTORS?

To local people, the visibility of schemes seems to be an important mechanism for driving use. Also the scale and design of the schemes, and the contrast they present with existing infrastructure, may influence their use.

WHAT BARRIERS TO EFFECTIVE IMPLEMENTATION WERE FACED?

The Connect2 portfolio addressed a range of planning, design and engagement challenges. The nature of such infrastructure means that there are large numbers of diverse stakeholders. Foremost among these are local communities. A range of approaches was used to engage local people. Other stakeholders included a range of public and private service providers, organisations operating in the local area, and landowners. Barriers were as numerous and diverse as the schemes themselves. The principles of the approach used were to make a coherent case in the context of usage and impact and to engage a wide range of stakeholders in elements of planning and design. This wasn't always perfectly successful, but in a majority of cases, project steering groups were convened that supported the process of implementation. The research findings featured in this case study will help with engaging stakeholder groups concerned with similar interventions in the future.

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Transport: Case study 2 – Cambridgeshire Guided Busway



PLANNING PRINCIPLE: Creation of sustainable transport infrastructure

BACKGROUND & SETTING:

Improving transport infrastructure to support walking and cycling on the journey to and from work – active commuting – could help to promote physical activity and improve population health. The Commuting and Health in Cambridge study aimed to assess whether or not investment in new high-quality transport infrastructure was associated with an increase in active commuting; wider health impacts of changes in travel behaviour; determinants of the use and uptake of active commuting; and how changes in travel behaviour were distributed in the population and related to the wider social context. These aims were addressed using a quasi-experimental cohort study of commuters living within 30 km of Cambridge and working in the city, combined with both nested and supplementary in-depth quantitative and qualitative studies.

WHAT WAS THE INTERVENTION?

The Cambridgeshire Guided Busway, comprising a new bus network using 22 km of guideway (segregated bus track) accompanied by a traffic-free path for pedestrians and cyclists, opened in 2011.

POPULATION CHARACTERISTICS

Despite 85% of the sample having access to a car, active commuting was a highly prevalent behaviour in the study sample, reflecting the high local prevalence of cycling and the selection of largely healthy workers into the cohort.

MAIN OUTPUTS AND OUTCOMES

Commuting practices were complex and shaped by various changeable social and environmental factors. Walking and cycling were often incorporated into longer commuting journeys made predominantly by car or public transport. At three-year follow-up, living closer to the busway was associated with a greater likelihood of a large increase in the proportion of commuting trips involving any active travel, of a large decrease in the proportion of trips made entirely by car, and of an increase in weekly cycle commuting time. There was a mixed pattern of effects at the individual level, with the intervention providing a more supportive environment for active commuting for some and not for others. There was some evidence that the effect was most pronounced among those who reported no active commuting at baseline, and observational evidence suggesting a relationship between active commuting, greater overall physical activity, and improved wellbeing and weight status. These findings provide new empirical support and direction for reconfiguring transport systems to improve population health and reduce health inequalities.

WHAT WERE THE KEY SUCCESS FACTORS?

Although people were unlikely to use the new infrastructure unless it closely matched the journeys they needed to make, a range of other factors informed travel behaviour, and these were dependent on the value attributed to different aspects of the journey experience. These generally involved considerations of comfort, ambience or pleasantness and of feeling safe, which could trump considerations of reliability and speed. Although experiences of the busway were complex and ambiguous, they culminated in meaningful travel behaviour change for some users, through shifts in the balance between influential factors and planning, trialling and adopting new practices over time.

WHAT BARRIERS TO EFFECTIVE IMPLEMENTATION WERE FACED?

The project was contentious primarily because people didn't really grasp what was proposed and were therefore sceptical about its effectiveness. Although much effort went in to explaining the scheme and its benefits it took vision and strong political leadership to persevere with the scheme in the face of substantial opposition. Once people saw and understood the scheme for themselves the opposition faded away.

Establishing the basis for the business case for funding from the Department for Transport was also challenging, again because of the novel nature of the scheme. For example, the distances that people would walk or cycle to the stops was much debated. The business case did not include the benefits to people walking or cycling alongside the Busway.

Further similar schemes are now being promoted and are not facing the same issues, as the concept and benefits of both busways and high quality segregated cycleways are now generally recognised in the area.

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Discussion

Summary of findings

This umbrella review presents an overview of the evidence for the relationship between the built and natural environment and health. Evidence pertaining to five key aspects of the built and natural environment (neighbourhood design, housing, healthier food, natural and sustainable environment, transport) was collated, quality assessed and summarised to illustrate the linkages, strength of the evidence and recommendations for those working in the public health or planning professions.

Across all areas of the built and natural environment explored as part of this review, evidence was identified demonstrating an inextricable link between the built and natural environment and health.

Neighbourhood design

In the case of neighbourhood design, improving neighbourhood walkability (i.e., an area that is supportive of walking) and infrastructure designed to promote walking and cycling, was found to be associated with numerous positive health outcomes, including: increased physical activity levels and improved social engagement among older adults.

Furthermore, areas of mixed land use (i.e., neighbourhoods that include green spaces), diverse housing types and high quality public transport were found to be associated with increased physical activity levels, reduced risk of pedestrian injury and road traffic collisions, and increased social participation among older adults, among other positive health outcomes.

Housing

An examination of the evidence on the influence of housing on health revealed that good quality housing (e.g., energy efficiency, housing refurbishment, and removal of home hazards) and affordable housing was associated with a variety of positive health outcomes, including improved social outcomes among older adults, reduced injury among older adults and children and improved general physical and mental health.

Among vulnerable groups (e.g., substance users, homeless, disabled), provision of affordable housing was associated with improved quality of life, mental health and clinical health-related outcomes.

Food environment

Evidence for the impact of the food environment on health revealed that provision of healthier and affordable food could be effective in improving dietary attitudes and behaviours, and reducing dietary fat intake and BMI in public service settings (i.e., schools, community settings, council offices).

Research also indicated that multi-component interventions that take an integrated, whole school approach may be most effective in improving children's diet and food choices in schools. Urban food growing was also found to be associated with improved attitudes towards healthy eating, increased opportunities for social connectivity and increased opportunities for physical activity.

Natural and sustainable environment

In terms of the natural and sustainable environment, there was evidence that improvement to air quality, prioritisation of neighbourhood tree planting, and provision of open and green spaces, was associated with increased physical activity, increased environmental cooling, and improved general physical health outcomes (e.g., reduce CVD mortality risk).

In addition, provision of infrastructure to support walking and cycling and increased access to buildings and facilities was associated with increased physical activity and improved social engagement among older adults. This section of the review also highlights the consequences of flooding. The review found that flooding was associated with a number of health related issues including carbon monoxide poisoning and poor mental health outcomes.

Transport

In the case of transport, evidence was found to demonstrate that infrastructure for walking and cycling, installation of traffic calming measures, and public realm improvements (e.g., street lighting) was associated with increased mobility, physical activity levels, reduced BMI and reduced risk of injury, among other positive outcomes.

Furthermore, the provision of open and green space, high quality public transport and improved air quality was associated with numerous positive health outcomes, including: increased physical activity, improved cardiovascular outcomes, and improved social participation, among others.

However, despite the wealth of evidence identified and reviewed, the findings need to be interpreted with caution. The majority of review level evidence examined was reliant

on short-term, cross-sectional empirical studies. As such, in many cases it is impossible to identify the causal link between the aspect of the built environment and the health outcome(s). In the most part, this review has identified that numerous aspects of the built environment and health are related, but not necessarily causal.

However, the available evidence is suggestive that modification to certain aspects of the built and natural environment may impact positively upon specific health behaviours and health outcomes. Furthermore, the findings of this review reiterate the findings of a previous umbrella review (Bambra et al., 2010), that the impact of the built and natural environment on health inequalities remains inconclusive in some areas.

What is known on this subject

The natural and built environment plays a key role in shaping the social and economic determinants of health. Although the linkages between the environment and health have long been established, there is, in some cases, insufficient evidence to ascertain causality.

Nevertheless, the importance and influence of the built and natural on health and health outcomes is clear.

What this study adds

- this study systematically assessed evidence from recent systematic reviews on the linkage between the built and natural environment and health. The collation of evidence provides readers with an insight into the research that has been conducted in this field
- in certain cases, where appropriate and clearly identified, the information collected from the umbrella literature review was complemented by high quality evidence from other credible sources
- by adopting a systematic approach to evidence gathering, this study was able to clearly identify gaps in the evidence and make recommendations for further research
- the diagrams on each of the five aspects of the built environment examined as part of this review provide logical evidence-based messages to aid communication among planners and public health professionals

Implications for policy and practice

The environment in which people live has a profound impact on health and wellbeing. In addition to direct health benefits, enhancement of the built and natural environment can have an impact on people's attitudes, behaviours and perceptions of their environment. For instance, reducing air pollution can improve perceptions of safety and promote outdoor physical activity and social interaction.

Findings from this review strengthen the argument for an upstream shift to address key obstacles to healthy living and improve circumstances that produces unhealthy behaviour.

Communication between built environment and health professionals is essential. By incorporating health needs and impact into the conceptualisation, design and planning of infrastructural projects, policy makers, planners and built environment professionals are able to trigger the development of sustainable communities.

Conclusions

Strengths and limitations of the available evidence

The findings of this review provide an overview of the best available evidence for the relationship between the built environment and health. However, it is important to note that the decision to focus purely on review level evidence has its drawbacks. For example, despite an extensive search of the literature it soon became apparent that evidence for certain built environment areas/issues does not yet exist or has yet to be systematically reviewed. This is reflected and highlighted within the report and the accompanying diagrams.

Nevertheless, it is also important to note that, wherever possible, we have aimed to complement identified 'gaps' in the evidence with other types of evidence, mostly from empirical studies or qualitative studies that, as a panel, we felt came from reliable sources.

It is also worth highlighting that lack of evidence reviews and quantitative research on one specific topic does not mean that the built environment area/issue does not exist or is not important. In fact, one could argue that, due to the complexity of the issues that are at play within the built and natural environment, quantitative research may not be the most appropriate method of research in all cases.

In a complex system such as the built and natural environment, it is not always possible to undertake the experimental approaches (such as randomised controlled trials and natural experiments) that can in other circumstances offer the best way of assessing causality. Indeed, it has highlighted that there is a role for further research methodologies to be developed which can take more of a complex, whole systems approach to examining causality.

It is also worth bearing in mind the application and validity of the "precautionary principle" for public health, which states that, in cases of serious or irreversible threats to the health of humans or ecosystems, acknowledged scientific uncertainty should not be used as a reason to postpone preventive measures (WHO, 2004). The principle originated as a tool to bridge uncertain scientific information and a political responsibility to act to prevent damage to human health and to ecosystems.

Due to this complexity, failure to take precautionary (preventive) action can have severe social, economic and environmental costs particularly if methods of research for evaluating risk to human health are designed to indicate only direct associations between exposure and disease.

Strengths and limitations of this review

This review summarises a broad spectrum of research linking health and the built and natural environment. Careful attention was given to rate the quality of each included study. A key strength of this study is therefore the robustness of methodology and rigour of quality appraisal.

The quality of included studies was assessed on two separately quality matrices; the 7 item Methodological Quality Checklist (MQC) (Bambra et al., 2009) and the quality rating ascribed by the original authors of each review. Studies deemed to be of very low quality were excluded from the final analysis. Thus, health and built environment professionals are guided in their understanding of the influence of the built and natural environment on health outcomes, based on the best available, current and systematically retrieved, evidence.

This work focused on the findings from quantitative systematic review level evidence alone. We acknowledge that this does limit the findings to some extent as we have not included evidence from qualitative systematic reviews. However, this work is chiefly designed for public health professionals, and quantitative evidence is still considered by the public health profession to be the most appropriate approach for determining causality.

Future large scale reviews may benefit from the inclusion of qualitative review level evidence to explore the relationship between health and the built environment for a more in-depth understanding.

The findings of this review are also limited in their ability to draw firm conclusions about the many aspects of the impact of the built and natural environment on reducing health inequalities. This is due to the fact that despite the wealth of research exploring the relationships between the built environment and health, work focussed specifically on health inequalities is extremely limited.

Where evidence was identified as part of this review it is reported in the results section; however, in the most part the evidence is unclear and thus there is a strong case for examining health inequalities in more depth in future public health research (Bambra et al., 2010).

Finally, it is important to acknowledge that although the primary target audience of this review is public health professionals working in local authority settings in the UK, much of the existing good quality evidence comes from other high and middle income countries. This is potentially problematic as the planning principles followed in the UK are somewhat different to the principles adhered to elsewhere (e.g., US) (Chow et al.,

2009); this may mean that findings from other countries are not as applicable in a UK context. However, in response to this, we have highlighted UK-centric evidence in the results section where possible.

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