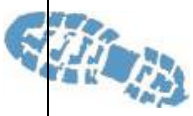
COLLABORATING FOR HEALTH

Review

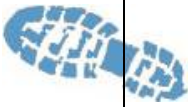
The benefits of regular walking for health, well-being and the environment

C3 Collaborating for Health*

September 2012



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Overview

The purpose of this review is to summarise the evidence of the benefits of walking for physical and mental health, as well as the features of the built environment necessary to facilitate and encourage this form of physical activity. Case studies demonstrating best practices in a variety of socio-demographic and geographical settings will be used to exemplify the 'real life' positive effects of walking.

Part I includes a summary and detailed tables of the findings of a literature review on the mental and physical benefits of walking, which form a body of evidence on the positive impact that walking can have on reducing the burden of non-communicable diseases (NCDs).

Part II includes a summary of the findings of a literature review on the evidence around the overall environment necessary to promote walking. This section includes summary information from studies related to active transport (walking and cycling), the built environment, and the environmental benefits of walking over carbon-emitting forms of transportation.

Part III presents a series of case studies to serve as exemplars for individuals and/or organisations that are considering incorporating interventions to promote walking as a form of physical activity in a variety of settings. In addition to case studies that have been externally evaluated, some examples are included that are not grounded in scientific evidence but use interesting approaches that could be used to start discussion among the many groups of people who have an influence over the walking environment.

Introduction

The world is currently facing an epidemic of rising rates of NCDs, caused in part by the rising trend in obesity rates, corresponding to declining rates of physical activity.[1]

Walking is one of the least expensive and most broadly accessible forms of physical activity.[2] It is rarely associated with physical injury and can easily be adopted by people of all ages, including those who have never participated in physical activity.[3] Studies have shown that walking has higher levels of adherence than other forms of physical activity, possibly because it is convenient and overcomes many of the commonly perceived barriers to physical activity: lack of time, lack of fitness or lack of skill.[4]

Walking is currently the most popular form of physical activity in the world, with studies from the United Kingdom and United States demonstrating that the prevalence of walking is two to three times higher than those of the next most frequently reported activities.[5] However, although walking is popular in these countries and elsewhere, walking rates have declined steadily over the last several decades[6] – for example, the proportion of children walking or cycling to school fell between 1969 and 2009 from 48 to 13 per cent in the United States,[7] and (among primary-school children) from 62 to 50 per cent between 1989 and 2004 in the United Kingdom.[8]

This report provides the evidence of health benefits of walking, providing the rationale for action and strategies for increasing walking rates among diverse populations, as this can help to lower risk factors for, and rates of, NCDs.

Part I: Evidence supporting the benefits of walking on physical and mental health

1. The impact of walking on physical health

As detailed in C3 Collaborating for Health's review of *The Benefits of Physical Activity on Health and Well-being*,[9] there exists extensive evidence supporting the benefits of physical activity on many parts of the body, which can result in reduced risk of non-communicable diseases (NCDs). Physical inactivity is estimated to cause around 5.3 million deaths each year,[10] and in many countries the majority of people do not reach the minimum level of physical activity recommended for good health – in England, for example, only around 42 per cent of men and 31 per cent of women reached the recommendations in 2008.[11] Walking in the United Kingdom fell by almost 20 per cent, from an average of 408 miles a year to just 314 miles, between 1976 and 2009.[12]

Walking is a particularly accessible form of physical activity: it is low-impact, appropriate for all age-groups, and is free. Not only is it a good way to get from A to B – brisk walking speed is about 3.5 miles (5km) per hour – but walking can also help people to avoid weight gain over the long term. Even slow walking burns around 114 calories per mile walked for someone weighing 200lb (91kg).[13]

> **Estimating calories burned: a rough estimate**
>
> To calculate the number of calories burned walking a mile at casual walking speed (2mph), multiply your weight in pounds by 0.49, and for brisk walking (3.5mph) multiply it by 0.57.

Studies are now emerging that differentiate the specific physical benefits of walking from the benefits of higher-intensity forms of exercise.

a) Effect of walking on all-cause mortality

Recent studies have shown an association between walking and a reduction in deaths from all causes, ranging from 19–30 per cent depending on the frequency and length of walking activities.[14] The most significant reduction in mortality was associated with walking 20km per week (beyond steps taken in normal day-to-day activities), while a reduction of 19 per cent was associated with 2.5 hours of brisk walking per week (around 12.5km, assuming walking at about 5km/hour).[15]

While the usual recommendation for physical activity for adults is 30 minutes at least five times a week,[16] the health benefits of brisk walking begin to be seen at levels well below this level. For example, a recent study of 400,000 people found that just 15 minutes a day of moderate exercise (which includes brisk walking) can have significant health benefits, adding up to three years to life expectancy. Every additional 15 minutes of daily exercise reduced all-cause death rates by a further 4 per cent.[17]

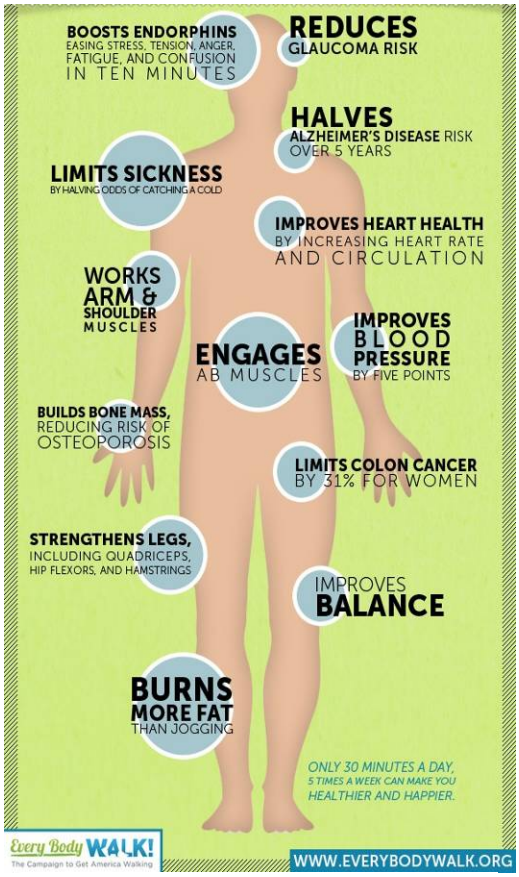

Figure 1: The anatomy of walking

b) Effect of walking on NCDs

Walking has been shown to have an important preventive effect on many of the major NCDs, including type 2 diabetes, cardiovascular disease (CVD – heart disease and stroke) and musculoskeletal conditions such as back pain.

i) Type 2 diabetes

Type 2 diabetes is the chronic condition on which the effects of walking (as opposed to general physical activity) have been most researched. Walking has been shown to:

- reduce significantly the risk of developing type 2 diabetes;
- adults with diabetes who walk at least a mile each day are less than half as likely as inactive adults with diabetes to die from all causes combined;
- increase fitness (heart and respiratory system) in adults with type 2 diabetes; and
- effectively control fasting and post-walk blood-sugar levels.

One death per year from all causes could be prevented for every 61 people with type 1 or type 2 diabetes who walk at least two hours per week.

Table 1a in Appendix I provides a snapshot of these relevant studies and their findings, and full references.

ii) Cardiovascular health

The impact of walking on the reduction of the risk factors for cardiovascular disease (CVD: heart disease and stroke) – including lowered blood pressure, improved blood cholesterol levels and reduced body mass index* – has been examined in several studies, including a meta-analysis and a systematic review.

Walking has been demonstrated to:

- result in reductions in CVD risk (especially for ischaemic stroke), as a result of duration, distance, energy expenditure and pace (i.e. the benefits are dose-responsive – the benefits increase as the amount of walking increases);
- lower coronary heart disease risk, with as little as one hour of walking per week (including those who are overweight, smokers or have high cholesterol)
- walking for 30 minutes a day on five days of the week can lead to a reduction in coronary heart disease risk of 19 per cent;
- lower blood pressure, although more research is needed to determine the specific walking intensity that results in the greatest blood-pressure improvements;
- increase maximum aerobic capacity (the capacity of an individual's body to transport and use oxygen during exercise) and aerobic endurance;
- decrease body weight, BMI, body fat percentage and waist circumference;
- increase HDL (‘good’) cholesterol; and
- increase muscle endurance.

In addition, there are potential cost savings to be made – one Australian study estimated that if all inactive adult Australians walked for an hour a day on at least five days of the week, the annual cost savings would be Aus $419.9 million.

Table 1b in Appendix I provides more information on these findings, and full references.

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* Body mass index is defined as a person's weight in kilograms divided by the square of his/her height in metres: kg/m^2

iii) Other NCDs

Physical activity has significant benefits in preventing **cancer**, notably breast cancer[18] (a risk reduction of approximately 20–40 per cent for those who do vigorous physical activity for 30–60 minutes on five days each week) and colon cancer (the most active people are at 30 per cent lower risk than the least fit).[19] However, to date there seems to have been little research on the specific benefits of walking on cancer prevention.

Physical activity can also be of great benefit to those living with and beyond cancer, with positive effects on fatigue levels, body strength, mental health (for example, anxiety levels and self-esteem) and quality of life.[20] In the United Kingdom, Macmillan Cancer Support's Move More campaign[21] is highlighting the benefits of exercise for cancer survivors:[22] a Macmillan survey of UK health professionals working with people with cancer found that around one in 10 of them still think it is more important to encourage cancer patients to 'rest up' rather than take appropriate physical activity, and over half (72 per cent of GPs) speak to none or just a few of their patients about the importance of physical activity.[23] Cancer survivors should be advised to build up their physical activity gradually, up to the level of the guidelines for the general population – and walking is ideally suited to this, as high-intensity exercise may exacerbate symptoms (such as fatigue and nausea.[24] Macmillan has now joined forces with The Ramblers in the United Kingdom, to run the national Walking for Health initiative, which is now also focusing on encouraging cancer survivors to walk more.[25]

Selected studies have also examined the impact of walking on other types of chronic disease, such as **chronic lung disease**, **arthritis** and **lower-back pain**. Walking has been demonstrated to:

- halve the risk of people with chronic lung disease being admitted as an emergency admission[26];
- increase aerobic capacity and capacity for functional exercise for people with arthritis;
- reduce pain for people with arthritis by between a quarter and a third; and
- have a low to moderate effect on the treatment of lower-back pain (further research is needed).

Table 1c in Appendix I summarises these papers, and provides full references.

2. The impact of walking on mental health

Although there is an emerging body of literature on the benefits of physical activity for mental health,[27] few published studies have documented the specific mental health outcomes from walking. Research findings currently indicate that walking can relieve symptoms of depression and anxiety, resulting in improvements in individual quality of life and reductions in the medical costs associated with treating these disorders,[28] and improve cognitive performance (performance in mental processes such as thinking, understanding and remembering).[29] There is a need for more research into the relationship between the social context of walking and its effect on mental health outcomes – for example, it can help to overcome social exclusion, which itself has health consequences.

Walking has been shown to:

- reduce physical symptoms of anxiety associated with minor stress;
- increase self-reported energy levels when older adults set their own pace;
- improve sleep quality;
- elevate affective response (e.g. pleasure), resulting in increased psychological well-being for individuals with type 2 diabetes;
- be associated with better cognitive performance at school;
- improve the cognitive functioning of older adults (compared to stretching and toning);
- improve cognitive performance and reduce cognitive decline among older people;
- increase the size of the hippocampus and prefrontal cortex, potentially beneficial for memory.

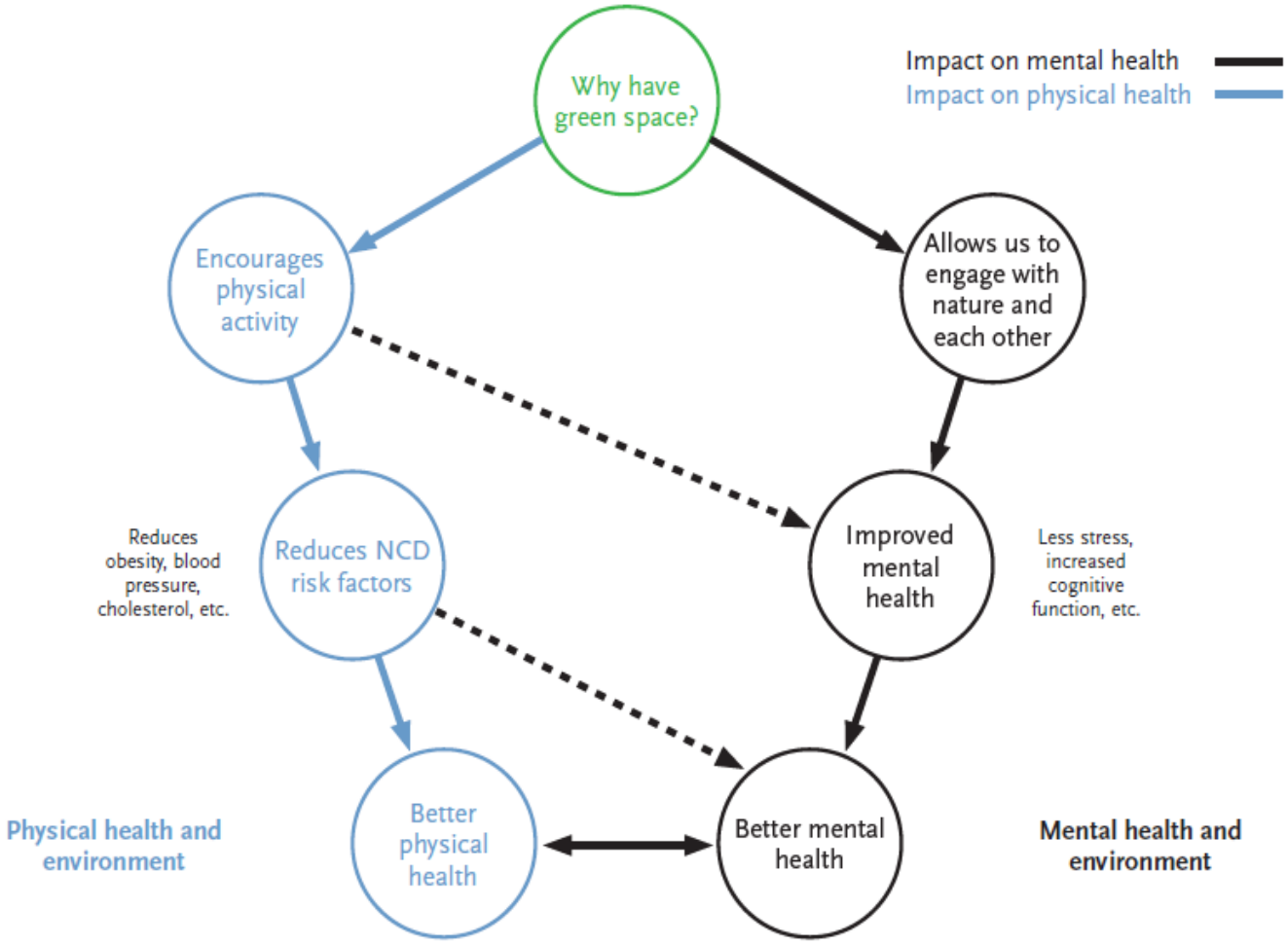
Table 2 in Appendix I provides more details on the studies examining the relationship between walking and mental health, and full references.

The greatest psychological benefits of walking have been found in social contexts with specific features of the outdoor environment (greenery and water), and walking has a greater affective and cognitive restorative affect for adults of poor mental health (compared to adults of good mental health) in rural (as opposed to urban) settings.[30]

UK mental-health charity MIND ran a small study of 'green exercise' (physical activity outdoors), questioning people involved in gardening, conservation and cycling as well as walking groups. 90 per cent of those surveyed said that they feel that green exercise benefits their physical health – but an even higher proportion, 94 per cent, felt that it improves their mental health.[31]

This link of mental health with exercising in green space is also shown in figure 2.

**Figure 2: Walking in green space –
benefits for physical and mental health**



3. Walking guidelines

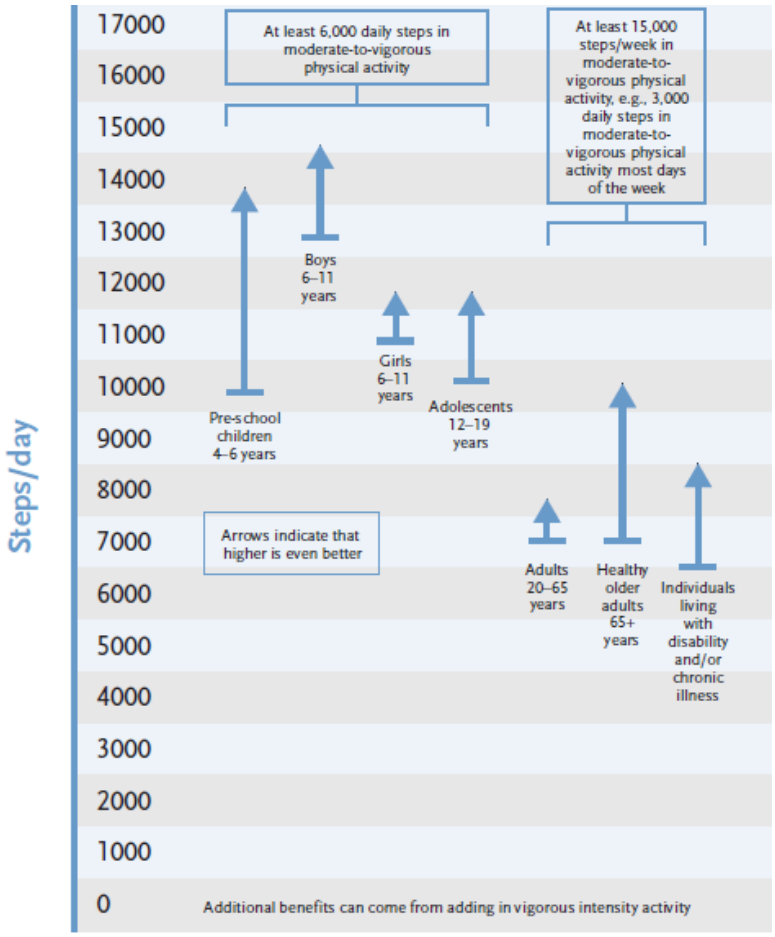
Physical activity guidelines are usually stated in terms of intensity, duration and frequency – for example, a common guideline is that moderate-intensity physical activity should be performed for a minimum of 30 minutes (not necessarily in a single bout of 30 minutes – it can be taken in shorter sessions) on five days per week.[32] With the increasing popularity of pedometers as means of measuring physical activity in terms of steps per day, it is important to understand how these guidelines translate into number of steps. (See Table 3 in Appendix I for a summary of pedometer-based walking interventions.)

Moderate-intensity physical activity

For good health, physical activity should be of 'moderate intensity'. For walking, this is at least 100 steps per minute, equivalent to approximately 3,000 steps per half hour[33] – and the CDC suggests an easy rule of thumb for gauging levels of physical activity, the talk test: 'if you're doing moderate-intensity activity you can talk, but not sing, during the activity. If you're doing vigorous-intensity activity, you will not be able to say more than a few words without pausing for a breath.'*

In 2011, three review studies examining the recommended number of daily steps for adults, children and special populations, in order to determine 'how many steps per day are enough?'[34] The researchers also identified the minimum number of moderate to vigorous steps recommended for male and females at a variety of age thresholds. These findings are summarised in figure 3.

Figure 3: Recommended number of steps per day by age group



* http://www.cdc.gov/physicalactivity/everyone/measuring/index.html

- Adults usually walk between 4,000 and 18,000 steps per day. Traditional rural communities, such as the Amish, are at the upper end of this scale, while sedentary, obese adults would be at the lower end of the scale.[35] The majority of pedometer-based interventions result in an increase of 2,000–2,500 steps per day.[36] Currently, American adults average 6,500 steps per day, across all populations.[37]
- Office workers who currently average approximately 7,000 steps per day can benefit from pedometer-based interventions, with one study evidencing an increase of more than 3,000 steps per day after less than one month of participating in the intervention[38]
- Older adults and special populations (including individuals suffering from chronic conditions and disabilities), currently average between 2,000–9,000 steps/day, and 1,200–8,800 steps/day respectively.[39] Pedometer-based interventions have demonstrated on average an increase of 775 and 2,215 steps per day among older adults and special populations, respectively.[40]
- Children between the ages of six and 12 typically average between 10,000 and 16,000 steps per day, while adolescents only average approximately 8,000–9,000 steps per day.[41]

  Children from North America take fewer steps than children from other regions of the world. For example, American boys and girls take 9,500 and 7,900 steps per day respectively, while Amish young people who tend to abstain from modern technology average over 15,000 steps per day.[42]

How active are you?

Researchers have also established pedometer-determined physical-activity thresholds for adults categorised by their activity level[43]:

< 2,500 steps/day (sedentary – basal activity)

2,500–4,999 steps/day (limited activity)

5,000–7,499 steps/day (low active)

7,500–9,999 steps/day (somewhat active)

10,000–12,499 steps/day (active)

≥12,500 steps/day (highly active)

The advice on walking depends on the age of the individual. A person walking at 3mph uses around 30 per cent of their maximum energy consumption when they are 25, but this decreases by 10 per cent a decade, so someone aged 75 walking at the same speed uses up 60 per cent of his or her maximum energy.[44]

As noted in section 1, above, the health benefits of physical activity begin to be seen at levels well below that of 30 minutes/day or 10,000 steps a day, with 15 minutes a day of brisk walking adding up to three years to life expectancy. [45]

In addition, people who begin to do more physical activity tend to get a taste for it, and increase their quota.[46] As walking is a particularly accessible way of starting physical activity, this suggests it could be a good 'way in' to increasing physical activity, with attendant health benefits. As Mike Loosemore, consultant in sport and exercise medicine at the Institute of Sport, Exercise and Health, University College London, has commented, 'any increase in exercise improves your health' – and this can act as 'a gateway to doing more'.

Part II: The walking environment

1. Overcoming barriers to walking

i) The range of barriers

Although it is the easiest and most accessible form of physical activity, there may still be barriers (real or perceived) to walking. These can include a perceived lack of time[47] (although in fact people may not realise how long it takes to walk short distances), lack of safe and attractive places to walk, and adverse weather (either too hot or too cold). The physical barriers may be significantly increased for people who are socially excluded, such as elderly people, people with disabilities or parents with small children – for example, steps, narrow pavements and lack of places to sit down.[48] Enablers of walking include improvements to the built environment (footpaths, seating), highlighting the social aspects of walking (through walking groups) and tools such as smartphone route planners (which reduce concerns over getting lost).

A survey of people in London in 2011 specifically asked what factors would encourage them to walk more. Responses included new and improved walks for pleasure (74 per cent), knowing that walking was as quick as the bus for short distances (73 per cent), and if there were more facilities in the local area (61 per cent).[49]

Figure 4 (see next page) sets out the range of physical and perceptual barriers and enablers to walking in more detail.

ii) Initiatives to overcome barriers

A range of initiatives have proved successful in motivating individuals to increase their walking duration, frequency and intensity, helping to overcome the barriers to walking. This can be through improving access to active travel opportunities and improving the built environment (see below), as well as specific, targeted interventions (often including pedometer use).

Recent reviews have found that, in order to be effective, interventions to promote walking should be[50]:

- tailored to people's needs;
- targeted either at sedentary individuals or individuals already motivated to change;
- individually tailored: mass-media campaigns may increase knowledge and awareness, but are unlikely to result in behaviour change;
- brief: telephone prompts had equal efficacy to more in depth telephone counselling;
- prescriptions to walk 5–7 (instead of 3–5) days per week at a moderate (instead of vigorous) pace;
- group oriented: the social aspect can increase adherence to a walking programme.

An example: Walkit.com

The 'urban walking route planner' WalkIt.com (available online and as a smartphone app) facilitates walking in over 40 UK cities by plotting the best route (whether the fastest or the least polluted), calculating the time it will take to walk (at slow, medium or fast pace), calories burned, steps taken, and the carbon dioxide emissions offset by walking rather than driving.

Successful walking campaigns are often run by volunteers. For example, the Stockholm Diabetes Prevention Programme advertised in local media to recruit volunteers to be leaders of walking groups, for 8–11-week sessions. Many leaders volunteered for multiple campaigns. This method of newspaper recruitment resulted in attracting diverse participants, one-third of whom had no previous exercise experience,[51] indicating that volunteer networking can be an effective way of reaching previously underserved populations.

Social media can also help to encourage walking – for example, the US-based See Mommy Run is a dedicated social network to establish walking and running groups by facilitating communication between like-minded people in the local community, and media such as Map My Walk allow users to share routes.

See Table 5a for links to a variety of global and national walking campaigns and information (including challenges, workplace-based initiatives, and school programmes), and Table 5b for online tools to encourage walking (both tables are in Appendix II).

iii) Messaging to overcome barriers

Clear messaging on the benefits of walking – going beyond health – may also help to motivate people to walk more. For example, a survey of Londoners in 2008[52] assessed the level of knowledge about the benefits of walking (health, financial, etc.), and suggested that the most powerful messages for future marketing of walking were likely to include messages around pollution (affecting family members as well as individuals surveyed) and time, as well as health:

- 'in heavy traffic jams, air quality can be poorer inside the car than outside;
- children walking to school helps improve air quality around schools;
- Walking one mile in 20 minutes burns the same number of calories as running one mile in 10 minutes'.

Promoting walking: the *West Wing*, walking and health

Every Body Walk! a US-based educational campaign to encourage walking – has produced a short public-health advertisement (May 2012) bringing together many of the cast of the *West Wing* to promote the health benefits of walking using – of course – a 'walk and talk' meeting.[53]

Figure 4: Some barriers to and enablers of walking

Barriers	
Physical barriers	• Lack of walking paths / pavements • Poor quality walking surfaces • High-speed traffic • Air pollution / traffic fumes • Lack of attractive places to walk (e.g. green space) • Too many steps • Few places to sit • Weather
Personal / perceptual barriers	• Unfit / health problems • Too tired • Lack of time • Lack of family support • Unsafe: fear of injury, crime (especially after dark) and getting lost • Boring • Some cultures may see exercise as inappropriate for women/girls
Enablers	
Physical enablers	• Improve the number and quality of walking paths – requires funding for municipal improvements, and may be helped by pressure from local groups • Engineering improvements – roads that are wide, with safe places to cross, traffic calming measures, and ramps rather than steps • Improvements to facilities, such as seating in parks • If the weather is a barrier, buy appropriate clothing and watch the weather forecast, and walk during the middle of the day when it is cold, and in the early mornings/late evenings in hot climates
Personal / perceptual enablers	• Start small – even walking for a few minutes is better than nothing, and it is a great way to build up fitness levels • Walk locally: you will get to know your neighbourhood gradually. Use your smartphone map to help to overcome the fear of getting lost • Taking more exercise, such as walking, may help improve sleep patterns and give you more, rather than less, energy • Walking may be quicker than you think for short trips (try a tool such as www.walkit.com to work out how long it will take) – or add short walks to your schedule, such as parking further away from the building, or getting off the bus a stop early • Walking with other people makes the activity social, and helps overcome feeling unsafe or afraid of crime – or just bored • Social media can help to identify people locally who may be interested in setting up walking groups • Dog-walking can also be a strong motivator

Sources[54]

2. Active transport

As societies have modernised, increased availability of motor vehicles has resulted in a decrease of walking as a primary means of transportation. This trend has also corresponded with rising global obesity levels, as increased energy expenditure is required for walking and cycling compared to vehicle usage. Bell et al. conducted a longitudinal study in China that emphasises this causal link.[55] In the 1980s, very few people in China owned a motor vehicle, and between 1989 and 1997, 14 per cent of Chinese households acquired a motor vehicle – researchers found that, after adjusting for diet, Chinese men who acquired a motor vehicle were twice as likely to become obese, and experienced an average 1.8 kg greater weight gain than their non-vehicle-owning peers.[56]

And cars are often used even for very short journeys. In the United States, cars are used for 55 per cent of trips that are approximately 0.5km in length, 85 per cent of trips that are 1.0km in length, and >90 per cent of longer trips.[57] On average, Europeans walked almost three times more than Americans (382km versus 140 km per person per year) and bicycled more (188km versus 40 km per person per year) in 2000.[58] Nations with the highest levels of active transport generally have the lowest rates of obesity.[59]

In the United States, active transport options are more prevalent in older cities, with mixed land use, excellent public transportation systems, and sidewalks.[60] An Atlanta-based study found that each additional kilometre walked per day was associated with a 4.8 per cent reduction in an individual's probability of becoming obese, whereas each hour spent driving was associated with a 6 per cent increase in an individual's probability of becoming obese.[61]

In addition to reducing obesity, studies have shown that active transport is associated with:

- reduction in risk of cardiovascular disease
- reduction of around 11 per cent – with the strongest correlation among women[62];
- reductions in the risk of obesity
- risk reduction of up to 50 per cent[63];
- lower levels of triglycerides (the fat that can cause hardening and narrowing of the arteries)[64];
- improved HDL ('good') and reduced LDL ('bad') cholesterol[65];
- reductions in BMI[66];
- reductions in blood pressure; and
- reductions in blood-sugar levels.[67]

Table 3 in Appendix II details many of the benefits of active transport.

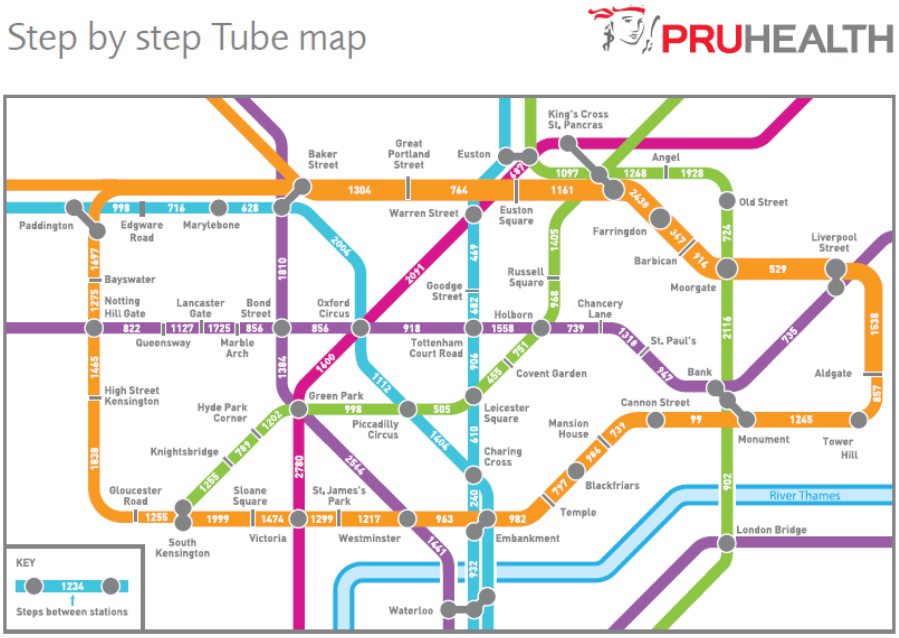
A UK study of public transport users found that two-thirds were active enough through their daily transportation routines to meet government physical activity recommendations.[68] The majority of individuals in this study spent between 20 and 60 minutes per day participating in active transport. Younger, less affluent people without access to a vehicle demonstrated the highest levels of active transport.[69] Walking as a form of active transportation has demonstrated greater long-term sustainability than cycling, especially among obese women.[70]

Although walking rates in industrialised countries are on the wane, school-based active transport programmes are gaining popularity. Case study 2 is an evidence-based UK example of a successful walk-to-school campaign, and case study 6 is about the 'walking school bus' movement.

The policies and infrastructure changes needed to facilitate active transport are discussed in the next section. Table 4 in Appendix II summarises the key studies related to the health benefits of walking as a form of active transport.

An example: Walking tube map

This 'tube' map shows central London's underground stations – but with the approximate number of steps needed to walk between each one. This is particularly helpful as the diagrammatic representation of the tube map often does not reflect the actual distance between stations above ground, which may (as in the case of Leicester Square and Covent Garden, for example) be very close together.



3. The built environment

There is a significant amount of scientific literature examining the aspects of the built environment that create favourable conditions for walking. A list of these studies is included in Table 6 in Appendix II. It is beyond the scope of this paper to provide a detailed literature review of these studies, and this would be an excellent topic for future analysis.

The factors of the built environment that have a favourable impact on pedestrian activity include[71]:

- street lighting and pavements;
- availability of public transport;
- street connectivity;
- high housing density and mixed land use;
- car-free zones;
- pedestrian crossings and traffic calming in residential areas;
- reductions in motor vehicle speed; and
- limited or more expensive parking.

People who live in areas with high 'walkability' are more likely to engage in active transport and access to neighbourhood amenities such as shops and parks will also stimulate active travel: individuals who live in neighbourhoods with high walkability participate in approximately 30 minutes more active transport each week.[72] There are tools for assessing local environments for factors contributing to healthy (or unhealthy) lifestyles (including physical activity opportunities), such as the Community Health Environment Scan Survey (CHESS).[73]

A study of the Atlanta area demonstrated that each quartile increase in land-use mix was associated with a 12.2 per cent reduction in the likelihood of obesity, independent of gender and ethnicity.[74] In addition, individuals living in mixed-land use neighbourhoods have higher levels of social capital, as they are more likely to know their neighbours, be politically and socially engaged, and more trusting than people living in vehicle-oriented suburbs.[75]

Studies have also shown an inverse correlation between traffic speed/volume, and levels of walking/cycling.[76] The promotion of walking and neighbourhood walkability has the potential to benefit not only the health of pedestrians, but also the health of the broader natural environment.

Unfortunately there are very few peer reviewed studies looking at the environmental benefits of walking. A study in King County, Washington, found that a 5 per cent increase in walkability was associated with a 32.1 per cent increase in active travel and a 5.5 per cent in motor-vehicle emission of air pollutants.[77]

There is a need for government policies that prioritise pedestrian safety and the development of communities with high walkability as one of the components in the fight against rising rates of NCDs. Making the economic case for such policies (the health impacts of which will be felt over a long period of time) can help to strengthen the case.

An example: Walk Score

Walk Score (http://www.walkscore.com/) is an online tool with the strapline 'Drive less. Live more'. It aims to help in ascertaining the walkability of an area, highlighting land use (e.g. local shops and restaurants), green space, schools and commuting time – including an estimate of the cost of taking the car from home to work.

The economics of walking

There is also some evidence that in the United States – where suburbs have often been accessible only by car – 'walkable' neighbourhoods are increasingly popular (for example, among retiring baby-boomers), and increasingly expensive. A 2012 report from the Brookings Institute[78] shows that in Washington DC (and after controlling for household income), an increase in 'walkability' of 20 points on its scale (out of a range of 94 points) translates into an $8.88 value premium in office rents and $81.54/square foot premium in residential housing values. The report also suggests 'walkability' as a mechanism to increase a place's triple bottom line: profit (economics), people (equity) and planet (environment) – but notes that there are not yet clear, accepted metrics to measure the benefits.

However, a tool that can help to assess the economic benefits of new pedestrian and cycling developments has been developed by the World Health Organisation: the Health Economic Assessment Tool (HEAT) for walking and cycling,[79] which can provide an estimate of the economic benefits accruing as a result specifically of lower death rates among more active populations. It has been designed to be used by transport planners, traffic engineers and special interest groups working on walking and cycling, as well as being of interest to health promotion experts and health economists. It evaluates the reduced mortality from past and/or current levels of walking and cycling, and the economic consequences of a potential future change in levels of walking and cycling. It is to be used to assess habitual behaviour (e.g. regular commuting) at population level among adults – it is not appropriate to use it to look at individual behaviour.[80]

Part III: Walking and the environment: a win–win

Increasing levels of walking, in place of taking the car or other forms of motorised transport, can have benefits for the health of the environment as well as of individuals. Reduced car use decreases air pollution levels, which can have significant benefits for health, reduces traffic congestion and accidents, and contributes to reduced traffic noise (through lower traffic volume), which is one of the most pervasive forms of noise pollution.

The environmental benefits are also important, as lower car use leads to lower carbon emissions, particulate levels (pollution) in the air. Transport is a major emitter of these pollutants, responsible for an estimated 45 per cent of the ozone precursors and 38 per cent of the particulate matter emitted in Europe.[82] Pollution can be particularly harmful to the health of children and older adults, and a strong relationship has been shown between levels of airborne particles, sulphur dioxide and other fossil-fuel emissions, and risk of early death from heart disease, and respiratory illnesses such as allergies, asthma and lung cancer.[83]

Good messaging and information on the impact of walking on the environment may also encourage walking. 43 per cent of 1,000 respondents to a survey in 2011 in London, for example, cited knowing more about the impact of walking on their carbon footprint as being a factor that could motive them to walk more.[84] Estimates on carbon emissions can be roughly calculated using online tools – for example, the website WalkIt.com (see p. 11 above) includes CO_2 emissions avoided by walking: around 0.2kg of CO_2 is avoided for each mile walked rather than driven in the car.

Particularly where cities are rapidly expanding (the population of the world's cities is currently growing by a million people a week, largely in developing countries), prioritising green space can have environmental and health benefits – creating the 'lungs' of the city, as well as providing areas for people to walk and exercise, with attendant physical and mental health benefits.

The specific environmental benefits of walking do not appear to have been studied in peer-reviewed publications – a subject for interesting future research.

Cars and carbon dioxide emissions

An average car emits around 287g of carbon dioxide per mile. This is greater for short journeys, as cars use more fuel when the engine is cold: a journey of 1 mile emits around 574g of carbon dioxide,[81] and perhaps more, when factors such as passengers, luggage, poor maintenance, underinflated tyres or use of air-conditioning are factored in, all of which decrease fuel efficiency.

Frieburg

Illustrating the issue: urban India

In India, cities were initially built for walking and cycling as the main modes of transport, but the urban environment – driven by the rapidly increasing size of the cities – now prioritises motorised forms of transport, rather than pedestrian facilities. Currently, many people living in urban areas cannot afford to buy their own motor vehicle, but this is rapidly changing. Vehicle registrations in India increased from 1.8 million in 1971 to 62.7 million in 2003 and almost 100 million by 2007[85]: this may continue to grow at a rate of as much as 8–12 per cent per year, with consequent rises in pollution, congestion, and traffic accidents. The transport sector is the fourth-largest sector for CO_2 emissions,[86] and emissions from road transport are expected to increase two- to three-fold between 2008 and 2025.[87]

A recent *Lancet* article found that increasing active travel and decreasing car use would have greater health benefits in Delhi than in London, with the benefit coming primarily from reductions in heart disease. Taking this approach would also have a greater effect on health than would simply increasing the number of lower-emission cars. It concluded that 'Although uncertainties remain, climate change mitigation in transport should benefit public health substantially.'[88]

But pedestrian facilities are not a policy priority: Indian cities are often seeking projects that are highly capital intensive, which walking is not – so organisations such as the Clean Air Initiative for Asian Cities (CAI-Asia) Center are trying to link walking to public transport, in the hope that investment will spill over into walkability, which is an important basis for a 'liveable' city.

Jaipur

Part IV: Case studies

1. Introduction

These case studies have been selected to illustrate the various types of macro- and micro-scale walking activities, interventions and programmes currently under way, and to spark ideas that can be further explored in local communities. This sample was chosen to reflect geographic, socio-demographic and cultural diversity, as well as a combination of different types of walking activities (e.g. leisure time activities and active transport). The final case studies look beyond the individual to the environmental changes such as adaptation of local built environments to improve pedestrian safety, which will improve walking accessibility.

One size does not fit all – any initiative must be adapted in order to suit the circumstances in which it is being established and the population at which it is aimed.

There currently exist many walking initiatives around the world, although there is a need for greater research as to the short- and long-term outcomes of these projects. While the health benefits of the initiatives in the case studies have been included where known (and the majority have evaluated at least some of the mental or physical health benefits), please note that many are not subject to rigorous scientific study. Lack of evaluation – while, of course, in no way diminishing the effects of the initiative on those taking part – may make the value of the project less obvious to others, and make it less likely to be replicated elsewhere. To be a best-practice case study, any new initiatives should consider evaluating participation rates and mental/physical health impacts.

The case studies that pertain to the built environment do not possess evaluations pertaining to their health benefits, but instead are examples of the range of options available to government and policy makers who wish to prioritise the long-term health of their citizens and communities through promoting walkability.

2. Case studies: walking programmes

Case study 1: The Global Corporate Challenge

The Global Corporate Challenge[89] is an annual, 12-week walking challenge for employees, established in Australia in 2004 and now reaching 55 countries: 130,000 participants from 1,000 organisations took part in 2011. This year, starting on 24 May 2012, over 180,000 participants are expected to participate. The cost of entering the GCC is £49 per head in the United Kingdom.

Workplaces enter teams of seven people, each of whom are issued with a starter pack (including two pedometers), with the aim of walking at least 10,000 steps each day – and in 2011, the average daily step count was 12,725 (about 5 miles).[90] The hope is not only that physical activity levels will increase for the period of the GCC, but that, because of the length of time for which the GCC runs, will mean that walking becomes a habit, i.e. the participants will continue to do greater amounts of physical activity following the end of the GCC.

Each participant adds their daily step count into a website, which both tracks the step progress of the individual and also calculates the distance travelled by the team as a whole, plotting a course 'around the world' showing the team's progress on a map. The website also contains nutritional and health information, and information on the carbon emissions that have been avoided by walking rather than taking the car.

In 2011, following the GCC, a study of 752 participants found that before the GCC only 18 per cent of employees were walking 10,000 steps per day, while after GCC 58 per cent of employees were walking an average of 10,000 steps per day.[91] A 2008 longitudinal study has also demonstrated that the programme creates sustainable behaviour change, as positive results were maintained eight months after programme participation.[92]

The positive effects of the GCC, coupled with concerns over high rates of childhood obesity, prompted the establishment of the Global Children's Challenge in 2011.[93] In its first year alone, 120,000 children participated from around the world. In 2012, for each participant taking part in the adult GCC, a child from the community will be enrolled at no cost to the school, family, or government.

Health benefits

Over the last four years, the GCC has engaged in research projects and scientific studies in partnership with Lancaster University, Monash University and the Foundation for Chronic Disease Prevention in the Workplace (FDCP) to analyse the evidence base surrounding the GCC's effect on employee health and wellbeing.

The physical and mental health benefits of the GCC have been assessed as follows[94]:

- 90 per cent said that the GCC improved their overall health and wellbeing;
- 24 per cent and 29 per cent of employees in a 2011 survey lowered their systolic and diastolic blood pressure respectively;
- 51 per cent reported reduced stress and improved quality of sleep at night;
- 71 per cent reported an increase in energy levels;
- where weight loss was reported, it averaged 4.5 kg (9.9 lbs);
- 54 per cent of those surveyed with high blood pressure were categorised as low risk by the end of the GCC;
- there was an 11 per cent increase in daily consumption of fruits and vegetables
- the 2011 survey found a 5.2 cm average waist reduction among those who had experienced a reduction in waist measurement;
- the same study also saw an average body fat reduction of 10 per cent among those who experienced a reduction in body fat.

The benefits of the GCC for the workplace include:

- 75 per cent reported improved office morale;
- 57 per cent reported better teamwork;
- 52 per cent reported increased productivity in their day-to-day tasks;
- 54 per cent claimed they had higher job satisfaction;
- 40 per cent fewer sick days were taken by GCC participants compared to non-GCC participants; and
- 52 per cent felt stronger work engagement.

Case study 2: UK – Walk once a Week

Walk once a Week (WoW) is the largest national walk-to-school programme in the United Kingdom.[95] Since it was started by Living Streets Charity in 2005, WoW has encouraged more than 300,000 children to walk to school regularly with, for example, 'Park and Stride' car drop-off zones a mile from schools, from where children can walk the rest of the way. The programme is under way in nearly 2,000 schools in England, and schools in Scotland and Wales are also starting to participate. Children who walk to school at least once a week can earn a different badge every month, with the badges designed by children in one of the largest UK annual art competitions. Teachers also promote the walking programme through the use of classroom wall charts, team passports and certificates.

In 2009 Wavehill Consulting was contracted by Living Streets to undertake an independent evaluation of the WoW programme,[96] incorporating stakeholder interviews as well as a survey of primary-school children and their parents.

The evaluation findings are summarised below:

- school walking rates have risen as high as 96 per cent;
- reduced traffic and parking congestion;
- school identities are redefined as 'pro-walking' – for example, school assemblies on walking safety and benefits;
- improvement in children's moods and attention spans;
- schools taking part have 9 per cent higher walking rates than the national average;
- 23 per cent of children surveyed walk with one of their parents to school (demonstrating that WoW spreads the benefits of walking within families); and
- the benefits of WoW far exceed the costs, with a ratio of 0.32 (costs £900,000, compared with benefits of £2.8 million).[97] This calculation is derived from a complex model that includes the cost of a car or bus journey if the children had not walked, the percentage of children who participate in WoW from each school, the carbon trading value of CO_2 saved by walking, the assumption that most children who walk to school will also walk home, and the costs of the WoW badges, postcards and materials.

Case study 3: Australia – Heart Foundation Walking

Heart Foundation Walking (HFW) is Australia's largest network of free community walking groups, and is aimed at implementing safe, accessible, and sustainable free walking groups across the country through community partnerships.[98] It was launched in 2007, and was based on the Heart Foundation's Just Walk It programme that had run since 1995. Over 37,000 Australians, from all states, have participated in the Heart Foundation's walking groups. HFW aims to making walking easy and enjoyable, especially for people who were previously inactive.

HFW groups are led by local volunteer walk organisers and are participated in by a wide range of people – parents with strollers, people with special needs and seniors – and take place in venues including local communities, shopping centres and workplaces.

As of 15 March 2011 more than 14,000 Australians from 249 local government regions were participating in an HFW group. Participant information and demographics is recorded in a centralised database. In addition, each month participants record their number of walks and total minutes of physical activity, with walkers rewarded when they reach milestones, such as their 25th walk. Online registration and tools such as Google maps are used to delineate walking routes.

HFW has been successful at attracting diverse population groups, including those least likely to be physically active such as:

- seniors (43 per cent of those taking part are over age 65);
- people who are overweight (36 per cent) or obese (23 per cent);
- people on lower incomes (36 per cent have household income below A$25,000);
- people who live alone (25 per cent);
- people with English as a second language (5 per cent); and
- Aboriginals (3 per cent).

HFW has demonstrated high group and individual retention rates of above 80 per cent after two years, and above 70 per cent after three years.

Health benefits

Evaluation data has demonstrated that 85 per cent of walkers perceive HFW as important for their social and mental wellbeing and 94 per cent of walkers perceive HFW as important for their physical wellbeing.

Additional evaluation is needed to study a cohort of HFW members and compare their baseline biometric indicators with one-year follow-ups to identify the specific health benefits of the HFW programme.

Case study 4: Hillcrest Heights, MD, USA – Iverson Mall Walkers

Since 1989, a group of senior citizens – 450 strong – has been meeting three times per week to walk laps inside Iverson shopping mall in Hillcrest Heights, Maryland.[99] The group also participates in several annual Washington DC-area charity walks each year, as well as aerobics and line dancing within the mall. Although the health benefits of this specific project have not been evaluated, walking has many benefits to senior citizens, such as:

- It alleviates many of the outdoor walking barriers/dangers for seniors such as bad weather, lack of sidewalks and traffic crossings, lack of public toilets, and fear of criminal activity;
- malls are often centrally located and easily accessible by public transport; and
- bright lighting and even floor surfaces reduces the potential for falls.

A pilot study by the University of Calgary[100] of an eight-week mall-walking programme found:

- high attendance rate for a self-motivated programme, with the majority (64.1 per cent) attending more than three times per week;
- average age of 66;
- second most popular reported walking site for people 45 and older;
- 36.4 per cent increase in leisure-time activity levels;
- 18 per cent increase in mall walking steps over the eight-week period;
- increased hip flexibility by 11 per cent; and
- a significant decrease in participant BMI from an average of 29.1 at the beginning of the programme to 28.5 at the end of the eight weeks

Mall walking provides a community-based alternative to outdoor walking, which is easily accessible to the general population.

Additional research is also needed on the mental-health benefits of the social relationships established during mall walking.

Case study 5: Oxfordshire, UK – Nordic Walking

Oxfordshire County Council, in conjunction with GoActive, has established a strong network of Nordic Walkers in the county. The programme began with 17 Nordic Walking instructors (and has since trained a further 32 volunteer leaders, to ensure the sustainability of the project), and has reached over 1,000 people. The programme was aimed at the over-50s – and was so successful that, for the first time, GoActive had a waiting list for its initiative. There is now a demand among younger adults and families to take part, so the initiative is being expanded.

There are also moves to work with GPs and practice nurses to 'prescribe' Nordic Walking, as walking with a trained practice nurse can be much less intimidating than for example, suggesting that patients attend exercise classes at a local leisure centre, and the aim is to increase physical activity levels.

Health benefits

Although the Oxfordshire initiative is not being specifically evaluated (other than for participation levels), Nordic Walking has a number of demonstrated health benefits, which include[101]:

- mental-health benefits of higher levels of confidence and enjoyment both of physical activity and of being outdoors;
- reduced levels of depression[102];
- lower blood pressure and resting pulse rate for elderly women[103];
- improved posture[104];
- improves mobility for people suffering from chronic conditions such as Parkinson's disease[105];
- reductions in waist, upper arm and hip circumference[106];
- more energy; and
- improved sleep patterns.[107]

When the correct technique is used, Nordic Walking uses up to about 20 per cent more energy (kcal) than regular walking, and uses many more muscles (up to 90 per cent of the major skeletal muscles), and it also relieves pressure on the joints of the lower body.

Case study 6: New Zealand – Walking school bus

Since 1999, the region of Auckland, in New Zealand, has been spearheading the 'walking school bus' initiative, in which groups of children walk to and from school together; 'children love taking part because they find it fun!'[108] Just like a real bus, it leaves at a set time (usually around 8:30), with the children joining at stops situated close to their homes – they are supervised by local adult volunteers (usually parents), who act as the bus 'driver'. The routes are about 1.5km (or a 30-minute walk) in length.

There are now over 300 walking school bus routes in the Auckland region – over 1,800 volunteers support it, and it is used by around 5,000 schoolchildren every day. The local transport authority has also become a partner in the project, producing a guide for people establishing a walking school bus.[109]

The project has a variety of benefits in addition to the health benefits of greater physical activity: children learn about road safety and increase their independence; parents have a chance to meet and speak, building a stronger community; and traffic congestion and air pollution from the school run are decreased in the local community.

Health benefits

The health benefits of walking school buses are beginning to be evaluated and do seem to indicate a small increase in the amount of physical activity taken by children.[110] In addition to contributing to the recommended hour a day of physical activity for children, small studies have indicated that, among older children (particularly boys), walking to school may also be associated with higher levels of physical activity during the rest of the day (e.g. after school).[111] In addition, there is evidence that children who are physically fit[112] and commute to school[113] have better cognitive performance than those who do not. A study of the walking school bus has questioned whether they are cost effective in reducing child obesity[114] – this did not, however, include the benefits of reducing pollution, and the authors note that cost-effectiveness could be improved by more comprehensive implementation within existing infrastructure arrangements, and that more research and evaluation should be undertaken on such programmes, given the importance of active transport in increasing children's physical activity levels.

Case study 7: Hong Kong – QualiWalk

In Hong Kong, a campaign entitled 'Healthy Exercise for All' includes a walking initiative, QualiWalk[115] (other strands of the campaign include 'Exercise in the workplace' and 'Dance for health'. It is aimed at all agegroups, and encourages the building of walking into everyday life. The campaign is run by the Leisure and Cultural Services Department, with input from the Department of Health and the Physical Fitness Association of Hong Kong. It includes QualiWalk training classes, and a range of online materials to encourage walking (in both Chinese and English). Participants are encouraged to have their fitness levels checked by the instructors in the class – and there is also information and charts available both at the class and online to make it easier for people to work out their own fitness levels, and to work out when their heartrate is within the target heart rate zone for 'moderate' exercise.

The website also suggests a number of safe walking trails, and makes suggestions for increasing regular walking, such as getting off public transport a couple of stops early and walking the rest of the way, or taking part in walking activities with friends: simple steps, but things that can make a difference.

Health benefits

Although the impact of Qualiwalk does not appear to have been evaluated, those taking part are encouraged to consider their health – both in terms of the mental and physical benefits of walking (such as easing stress), and also to ensure that they do not push themselves too far too fast.

3. Case studies: the built environment

Case study 8: Latin America – Ciclovías

The ciclovías – which translates as 'bike paths' – are initiatives to transform busy streets, on one day of the week, by banning all forms of motorised transport, leaving them open for walkers, runners and cyclists.[116] Not only does this promote alternative forms of transport, it transforms the urban environment and strengthens citizen ownership and responsibility. The first ciclovía was in Bogotá – each Sunday, for seven hours, over 70 miles of roads are closed to motor traffic, and up to 1.5 million people use the streets. In addition, free yoga and other exercise classes (known as the Recreovia) are held in local parks – over 70 per cent of ciclovías include physical-activity classes.[117] The costs of ciclovías are low – the Bogota ciclovía, for example, is estimated to cost about US$6 per person per year.[118]

The successes in Bogotá have encouraged a network looking to adopt similar models in other cities – the Bike Trails Network of the Americas – and ciclovías are also now held in cities in countries including Peru, Mexico, New Zealand and the United States.

Health benefits

A review of 38 ciclovías found that they have real potential for positive public-health outcomes, summarising the evidence to date – which is limited, but encouraging.[119] For example, one study found an estimated 41 per cent of ciclovía participants in Bogota took part for more than three hours (including about a third walking or running, and about half the participants cycling).[120] A study of health-related quality of life measures found that adults participating in at least one day of the ciclovía each month scored higher than those who did not participate (even after adjusting for sociodemographic and other factors),[121] and one study showed that levels of particulate matter along a section of Bogota's ciclovía street was 13 times higher on a weekday than on Sunday (the day of the ciclovía).[122]

The health benefits of the ciclovías have recently been evaluated – with the cost–benefit ratio for health benefit from physical activity estimated at 3.23–4.26 for Bogotá, 1.83 for Medellín (also in Colombia), 1.02–1.23 for Guadalajara (Mexico) and 2.32 for San Francisco.[123]

Case study 9: United States – The Atlanta Beltline

The Atlanta Beltline is a multi-million dollar project currently under way to develop a 22-mile loop of transit, trails and pedestrian friendly development using existing historical railroads that encircle the city of Atlanta, Georgia.[124] The Beltline connects 45 of the city's neighbourhoods, and over 100,000 people live within half a mile of the Beltline, which has a radius of between two and four miles from the city centre. The project creates 2,100 acres of new parks and 33 miles of new multi-use trails.[125] In addition the project will develop commercial and residential areas and improve road infrastructure (including pavements) and transit infrastructure (including a light-rail line). This initiative will occupy 6,500 acres, approximately 7 per cent of Atlanta's total area, and will affect the daily lives of those who live, work, play and go to school near it. The project is funded by tax allocation bonds that will be repaid from the rising property values in the district resulting from the Beltline development.

The Beltline project exemplifies the interrelationship between the built environment and health. A Health Impact Assessment[126] was conducted from 2005 to 2007 to assess the Beltline's impact on physical and environmental-health determinants. A HIA is an effective tool for incorporating evidence-based health recommendations into planning of city infrastructure and transportation networks, especially when the goal is to maximise pedestrian access, safety and use. It addresses issues such as social equity, physical activity, safety and the environment. The HIA was cited in the awarding of additional funds for $7 million for brownfield clean-up and greenspace development.[127]

The HIA noted, among other things, that:

- the Beltline will provide park access (defined as living within 0.5 miles of a park) to 11,000 people;
- approximately 88,000 people (41 per cent of the population) will have access to the trail system;
- the Beltline can be used to facilitate active transport of students to schools through the Safe Routes to Schools programme. Currently, 19 schools are located within 0.5 miles of the Beltline transit and trails, and a combination of infrastructure improvements, safety education and enforcement will create an environment that favours walking to school;
- safe and convenient walking (such as sidewalks) will be facilitated between communities and public transport stops;
- facilities such as sports courts and walking circuits in parks will be set up, ensuring that they meet the particular needs of children, seniors and individuals with disabilities; and
- educational campaigns on parks and trails will be put in place to promote physical activity.

Case study 10: India and Denmark – Urban walkability

'Walkability' in cities is an important determinant in building physical activity into everyday life, allowing people to choose to walk rather than to take motorised transport. Different challenges that are faced in developed and developing countries – with vastly different levels of pollution, traffic congestion, infrastructure (such as pedestrian footpaths suitable for all, including the elderly and disabled) and road safety.

Mumbai

As has already been noted in Part III, above, walkability in Indian cities is often very low – even where a city may appear on paper to be 'walkable' (e.g. mixed land use) it may, in fact, have dangerous streets that preclude safe walking, with pedestrians directly competing with motor vehicles for road space. A recent survey in six Indian cities, including Chennai, found that 60 per cent see pedestrian facilities as 'bad' or 'very bad', and 62 per cent would shift their current walking trips to motorised transport unless the walking environment improves. Improvements can be made – but currently it is often only in the wealthiest areas where the streets are suitable for walking,[128] and one scheme, Mumbai's 23km of 'skywalks', has not been universally welcomed, being both expensive (a projected cost of US$300 million) and leading to businesses at ground level losing business.[129]

However, there are a number of more practical policy steps that are being encouraged by organisations such as the Clean Air Initiative for Asian Cities (CAI-Asia) Center, which could begin to help to integrate walking into city design – these include conducting pedestrian benchmark surveys, developing street-design guidelines, promoting applied research on walkability, and establishing Urban Metropolitan Transport Authorities (although these tend to be recommendatory bodies, rather than implementing agencies).

In contrast, the capital city of Denmark, Copenhagen, has spent the last 50 years taking a series of gradual steps, beginning with the closure of the main street, Strøget, to motor vehicles, to shift the city from a car-oriented to a pedestrian-oriented space.[130] By 1996, Copenhagen had six times the amount of car-free space than it had in 1962 when pedestrian initiatives began.

The steps include:

- attempting to reduce parking spaces by 2–3 per cent annually;
- the creation of pedestrian-only streets, allowing the transformation of car parks on these streets into public spaces;
- encouraging children to walk or cycle to school;
- paths for walking and cycling have been created and extended – now, over a third of people commute to work by bike;
- in addition, the majority of the buildings are low in height, and densely packed. This allows the wind to pass over them, and gives the city centre a mild, airy climate – more conducive to walking than the rest of Copenhagen.

Copenhagen

Appendix I: Selected literature on the health benefits of walking

Tables 1a–1c provide select examples of key research studies and/or reports that support the impact of walking on the prevention and control of major NCDs, notably type 2 diabetes and cardiovascular disease. Table 2 provides information on the mental-health benefits of walking.

Table 1a: Benefits of walking for type 2 diabetes

Specific benefit	Paper
Walking can lower blood glucose levels after the walk (demonstrated reduction 2.2 mmol/l). No effect after a period of rest	Fritz, T. and U. Rosenqvist, 'Walking for exercise? Immediate effect on blood glucose levels in type 2 diabetes', *Scandinavian Journal of Primary Health Care* (2001) 19(1): 31–3: http://informahealthcare.com/doi/abs/10.1080/pri.19.1.31.33
Walking reduced mortality among a broad spectrum of adults with type 1 and type 2 diabetes. One death per year may be prevented for every 61 people who walk at least two hours per week	Gregg, E.W., R.B. Gerzoff, C.J. Caspersen, D.F. Williamson, V. Narayan, 'Relationship of walking to mortality among US adults with diabetes', *Arch Intern Med*. (2003) 163: 1440–7: http://archinte.ama-assn.org/cgi/content/abstract/163/12/1440
Moderate physical activity, such as walking, can reduce risk of developing type 2 diabetes (men were not included in this study)	Hu, F.B. et al., 'Walking compared with vigorous physical activity and risk of type 2 diabetes in women', *JAMA* (1999) 282(15): 1433–9: http://jama.ama-assn.org/content/282/15/1433.short
Heart-rate-prescribed walking can improve cardiorespiratory fitness, but did not have an impact on blood-sugar control in patients with type 2 diabetes	Morton, R.D., D.J. West, J.W. Stephens, C. Bain and R.M. Bracken, 'Heart rate prescribed walking training improves cardiorespiratory fitness but not glycemic control in people with type 2 diabetes', *Journal of Sports Sciences* (2010) 28(1): http://www.tandfonline.com/doi/abs/10.1080/02640410903365685
Encouraging dog walking or another interest that motivates a commitment to physical activity can result in health benefits, especially for people who lack motivation for other forms of physical activity, who want slowly increase their physical activity levels slowly, and who want to maintain physical activity levels	Peel, E., 'Type 2 diabetes and dog walking: patients' longitudinal perspectives about implementing and sustaining physical activity', *Br J Gen Pract* (2010) 60(577): 570–7: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2913737/
Group brisk walking was equally effective as individualised fitness programmes for blood-sugar control and reduction of cardiovascular risk profile	Praet, S.F.E., 'Brisk walking compared with an individualized medical fitness programme for patients with type 2 diabetes: a randomized controlled trial', *Diabetologia* (2008) 51(5): 736–46: http://www.springerlink.com/content/41wj6t344777421h/
Adults with diabetes who walk at least one mile per day are less than half as likely as sedentary adults with diabetes to die from all causes combined	Smith, T.C., D.L. Wingard, B. Smith, D. Kritz-Silverstein, E. Barrett-Connor, 'Walking decreased risk of cardiovascular disease mortality in older adults with diabetes', *Journal of Clinical Epidemiology* (2007) 60(3): 309–17: http://www.jclinepi.com/article/S0895-4356(06)00256-3/abstract

Structured education programme in conjunction with pedometer use resulted in reductions of two-hour post walking and fasting glucose of -1.31 mmol/l and -.32 mmol/l respectively. No improvement in glucose control for the education programme alone	Yates, T., M. Davies, T. Gorely, F. Bull and K. Khunti, 'Effectiveness of a pragmatic education program designed to promote walking activity in individuals with impaired glucose tolerance: a randomized controlled trial', *Diabetes Care* (2009) 32(8): 1404–10: http://care.diabetesjournals.org/content/32/8/1404.short

Table 1b: Cardiovascular benefits of walking

Specific benefit	**Paper**
Dose-dependent reductions in CVD risk with higher walking duration, distance, energy expenditure and pace. Associations appeared to be stronger for ischaemic stroke than other CVD outcomes such as coronary heart disease or haemorrhagic stroke	Boone-Heinonen, J., K.R. Evenson, D.R. Taber and P. Gordon-Larsen, 'Walking for prevention of cardiovascular disease in men and women: a systematic review of observational studies' *Obes Rev* (2009) 10: 204–17: http://www.ncbi.nlm.nih.gov/pubmed/19207874
Light to moderate physical activity, as low as one hour of walking per week lowers coronary heart disease risk for women (including those who were overweight, smoked or had high cholesterol) (men were not included in this study)	Lee, I.M., K.M. Rexrode, N.R. Cook, J.E. Manson and J.E. Buring, 'Physical activity and coronary heart disease in women: Is "no pain, no gain" passe´? *JAMA* (2001) 285(11): 1447–54: http://www.ncbi.nlm.nih.gov/pubmed/11255420 Note: this study was conducted on a cohort of women only
Walking is beneficial for lowering blood pressure. More research is needed to determine the specific walking intensity that results in the greatest fall in blood pressure	Lee, L., M.C. Watson, C.A. Mulvaney, C. Tsai and S. Lo, 'The effect of walking intervention on blood pressure control: a systematic review', *International Journal of Nursing Studies* (2010) 47: 1545–61. http://www.ncbi.nlm.nih.gov/pubmed/20863494
Walking increased maximum aerobic capacity, and decreased body weight, BMI, body fat percentage and resting diastolic blood pressure in previously sedentary adults	Murphy, M.H., A.M. Nevill, E.M. Murtagh and R.L. Holder, 'The effect of walking on fitness, fatness and resting blood pressure: a meta-analysis of randomized controlled trials', *Prev Med* (2007) 44(5): 377–85: http://www.ncbi.nlm.nih.gov/pubmed/17275896
Walking 30 minutes/day, 5 days/week = 19% reduction in coronary heart disease risk Reduction in systolic and diastolic BP	Murtagh, E.M., M.H. Murphy and J. Boone-Heinonen, 'Walking – the first steps to cardiovascular disease prevention', *Curr Opin Cardio.* (2010) 25(5): 490–6: http://www.ncbi.nlm.nih.gov/pubmed/20625280
Increased HDL ('good' cholesterol) Average weight loss of 1.4kg and waist circumference reduction of 2.2cm Increased aerobic and trunk muscle endurance Exemplified walking as a high-adherence form of physical activity	Parkkari, J., A. Natri, P. Kannus, A. Mänttäri, R. Laukkanen, H. Haapasalo, et al., 'A controlled trial of the health benefits of regular walking on a golf course', *American Journal of Medicine* (2000) 109: 102–8. http://www.amjmed.com/article/S0002-9343(00)00455-1/abstract

Potential annual cost savings of $419.9 million if all the inactive adult Australians engaged in 1 hour of normal walking a day for 5–7 days a week	Zheng, H., F. Ehrlich and J. Amin, 'Economic evaluation of the direct health care cost savings resulting from the use of walking interventions to prevent coronary heart disease in Australia', *Int J Health Care Finance Econ* (2010) 10: 187–201. http://www.ncbi.nlm.nih.gov/pubmed/19882347

Table 1c: Other chronic disease benefits of walking

Specific benefit	Paper
People with chronic obstructive pulmonary disease who undertake more walking halve their risk of being admitted as an emergency admission	Garcia-Aymerich, J. et al., 'Risk factors of readmission to hospital for a COPD exacerbation: a prospective study', *Thorax* (2003) 58(2): 100–5: http://www.ncbi.nlm.nih.gov/pubmed/12554887
Review of four RCTs – walking resulted in 19% improvement in aerobic capacity, 18% improvement in functional exercise capacity, reductions in arthritis pain (24–32%)	Westby, M.D., 'A health professional's guide to exercise prescription for people with arthritis: areview of aerobic fitness activities', *Arthritis Care & Research* (2001) 45: 501–11: http://onlinelibrary.wiley.com/doi/10.1002/1529-0131%28200112%2945:6%3C501::AID-ART375%3E3.0.CO;2-Y/abstract
Low to moderate evidence that walking is an effective treatment for lower back pain. Need for more research	Hendrick, P., A.M. Te Wake, A.S. Tikkisetty, L. Wulff, C. Yap and S. Milosavljevic, 'The effectiveness of walking as an intervention for low back pain: a systematic review', *Eur Spine J* (2010) 19: 1613–20: http://www.ncbi.nlm.nih.gov/pubmed/20414688

Table 2: Mental health benefits of walking

Specific benefit	Paper
Authors conducted a review of mental-health benefits of physical activity (the authors found only limited evidence from walking-specific studies)	Atkinson, M. and L. Weigand, *A Review of Literature: The Mental Health Benefits of Walking and Bicycling* (2008): http://www.ibpi.usp.pdx.edu/media/Mental%20Health%20Benefits%20White%20Paper.pdf
Leisure physical activity (which can include walking) can reduce the physical symptoms and anxiety associated with minor stress	Carmack, C.L., E. Boudreaux, et al., 'Aerobic fitness and leisure physical activity as moderators of the stress-illness relation', *Annals of Behavioral Medicine* (1999) 21(3): 251–7: http://www.springerlink.com/content/488406687w963150/
Short walks, where active middle-aged and older adults set their own pace, increase self-reported energy levels	Ekkekakis, P., S.H. Backhouse, C. Gray and E. Lind, 'Walking is popular among adults but is it pleasant? A framework for clarifying the link between walking and affect as illustrated in two studies', *Psychology of Sport Exercise* (2008) 9(3): 246–64: http://www.sciencedirect.com.proxy.lib.sfu.ca/science/article/pii/S1469029207000337

A study of 120 previously sedentary older adults found that after a year of moderate-intensity walking their hippocampus had grown by 2 per cent (an area of the brain important for memory)	Erickson, K., et al., reported at the Alzheimer's Association International Conference 2012. Full reference to follow on publication.
Improved sleep for group with normal glucose tolerance after four months of Nordic Walking	Fritz, T., et al., 'Effects of Nordic Walking on health-related quality of life in overweight individuals with type 2 diabetes mellitus, impaired or normal glucose tolerance', *Diabet Med.* (2011) 28(11): 1362–72 http://www.ncbi.nlm.nih.gov/pubmed/21658122
Psychological benefits of a brisk walk are dependent upon social context and features of the outdoor environment (greenery and water)	Johansson M., and T. Hartig, 'Psychological benefits of walking: moderation by company and outdoor environment', *Applied Psychology: Health and Well-being* (2011) 3(3): 261–80: http://onlinelibrary.wiley.com/doi/10.1111/j.1758-0854.2011.01051.x/abstract[131]
Brisk walking was able to elevate affective response, resulting in increased psychological well-being for individuals with type 2 diabetes	Kopp, M., et al., 'Acute effects of brisk walking on affect and psychological well-being in individuals with type 2 diabetes', *Diabetes Research and Clinical Practice* (2012) 95(1): 25–9: http://www.diabetesresearchclinicalpractice.com/article/S0168-8227(11)00519-5/abstract
Walking can improve mental function of adults aged 60–75 when compared to stretching and toning	Kramer, A.F., S. Hahn, et al., 'Ageing, fitness and neurocognitive function', *Nature* (1999) 400: 418–19: http://www.biu.ac.il/tvunit/papers/Kramer-Vakil_1999_(39).pdf
Walking in rural (vs urban) settings has a greater cognitive restorative affect for adults of poor mental health, compared to adults of good mental health	Roe, J. and P. Aspinall, 'The restorative benefits of walking in urban and rural settings in adults with good and poor mental health', *Health and Place* (2011) 17(1): 103–13: http://www.sciencedirect.com/science/article/pii/S1353829210001322
Walking or cycling to school is associated with better cognitive performance	Martínez-Gómez, D., et al., 'Active commuting to school and cognitive performance in adolescents: the AVENA Study', *Arch Pediatr Adolesc Med.*(2011) 165(4):300–5: http://archpedi.ama-assn.org/cgi/content/short/archpediatrics.2010.244
High levels of regular, long-term physical activity were associated with better cognitive performance and less cognitive decline among older women (men were not included in this study)	Weuve, J., J.H. Kang, et al. 'Physical activity, including walking, and cognitive function in older women', *Journal of the American Medical Association* (2004) 292(12): 1454–61: http://www.ncbi.nlm.nih.gov/pubmed/15383516

Appendix II: The walking environment

Table 3 provides evidence on the benefits of using pedometers to encourage walking. Table 4 gives information on the impact of active travel on health. Table 5a is a list of some walking initiatives from around the world and in a range of settings; table 5b is a short summary of some online tools to encourage and facilitate walking. Table 6 lists some studies of the built environment and its impact on walking.

Table 3: Walking and pedometers

Specific benefits	Paper
Review found that overall pedometer use increases physical activity 26.9% over baseline, decreases BMI and decreases blood pressure. These changes were associated with having a set step goal	Bravata, D.M. et al. (2007). 'Using pedometers to increase physical activity and improve health: a systematic review', *JAMA* (2007) 298: 2296–304: http://jama.ama-assn.org/content/298/19/2296.short
Use of pedometers has a moderate positive effect on the increase of physical activity Average increase of 2,000 steps per day Greatest effect among women with the goal of 10,000 steps per day	Kang, M., S.J. Marshall, T.V. Barreira and J.O. Lee, 'Effect of pedometer-based physical activity interventions: a meta-analysis', *Res Q Exerc Sport* (2009) 80: 648–55: http://mtweb.mtsu.edu/mkang/Effect%20of%20pedometer-based%20physical%20activity%20interventions%20A%20meta-analysis.pdf
Moderate walking = at least 100 steps/minute People should walk a minimum of 3,000 steps in 30 minutes on 5 days each week Three sets of 1,000 steps in 10 minutes each day can also be used to meet the above goal	Marshall, S., S. Levy, C. Tudor-Locke, C., et al., 'Translating physical activity recommendations into a pedometer-based step goal 3,000 steps in 30 minutes', *American Journal of Preventive Medicine* (2009) 36: 410–15: http://www.ajpmonline.org/article/S0749-3797(09)00087-7/abstract
By end of 12-week period, pedometer group of overweight and obese women had increased their number of steps per day by 36% compared to the intervention group Pedometer group also demonstrated a significant decrease in systolic blood pressure	Pal, S., C. Cheng, G. Egger, et al., 'Using pedometers to increase physical activity in overweight and obese women: a pilot study', *BMC Public Health* (2009) 9: 309: http://www.ncbi.nlm.nih.gov/pubmed/19703317
Longer pedometer-based interventions results in the greatest weight loss. On average participants lost 0.05kg/week	Richardson, C.R., T.L. Newton, J.J. Abraham, A. Sen, M. Jimbo and A.M. Swartz, 'A meta-analysis of pedometer-based walking interventions and weight loss', *Ann Fam Med* (2008) 6: 69–77: http://www.annfammed.org/content/6/1/69.abstract
Pilot project of lending pedometers out at five public Canadian libraries resulted in increased walking, increase motivation to walk and goal-setting. Preliminary evidence that lending pedometers through libraries is an effective low-cost approach to increasing community walking rates	Ryder, H., K. Faloon, L. Levesque and D. McDonald, 'Partnering with libraries to promote walking among community-dwelling adults: a Kingston Gets Active pilot pedometer-lending project', *Health Promotion Practice* (2009) 10: 588: http://hpp.sagepub.com/content/10/4/588.short

Table 4: Active transport

Specific benefit	Paper
Active transport is inversely related to obesity rates. Europeans walk on average three times as much distance in a year as Americans.	Bassett, D.R., J. Pucher, R. Buehler, D.L. Thompson and S.E. Crouter, 'Walking, cycling, and obesity rates in Europe, North American, and Australia', *Journal of Physical Activity and Health* (2008) 5: 795–814. http://policy.rutgers.edu/faculty/pucher/jpah08.pdf
Review identifies 14 studies from the United States, Australia and the United Kingdom focusing on active transport of children to school. Most quasi-experimental and demonstrated a small effect on active transportation. More rigorous studies are needed.	Chillon, P., K. Evenson, A. Vaughn and D.S. Ward, 'A systematic review of interventions for promoting active transport to school', *International Journal of Behavioral Nutrition and Physical Activity* (2010) 8(10): http://www.ijbnpa.org/content/8/1/10
Land use mix, time spent in cars, and time spent walking have a strong association with obesity	Frank, L.D., M.A. Andresen and T.L. Schmid, 'Obesity relationships with community design, physical activity, and time spent in cars', *Am J Prev Med* (2004) 27: 87–96: http://www.ncbi.nlm.nih.gov/pubmed/15261894
Active commuting (including walking and cycling) was associated with an 11% reduction in cardiovascular risk factors, with a stronger correlation among women	Hamer, M. and Y. Chida, 'Active commuting and cardiovascular risk: a meta-analytic review', *Preventive Medicine* (2008) 46(1): 9–13: http://www.ncbi.nlm.nih.gov/pubmed/17475317
Evidence demonstrating that long term walking levels (not cycling levels) remained stable after an initial increase, suggesting that walking for transportation may be an effective long-term strategy for increased physical in abdominally obese women	Hemmingsson, E., J. Uddén, M. Neovius, et al., 'Increased physical activity in abdominally obese women through support for changed commuting habits: a randomized clinical trial', *International Journal of Obesity* (2009) 33: 645–52: http://www.ncbi.nlm.nih.gov/pubmed/19417772
Study of 5% of the population of Montreal found that 837,000 motorised kilometres (for trips less than 1.6 km) could be converted into almost 1,156 million steps every day.	Morency, C., M. Demers and L. Lapierre, 'How many steps do you have in reserve? Thoughts and measures about a healthier way to travel', *Transp Res Rec*. (2007) 2002: 1–6: http://www.mendeley.com/research/steps-reserve-thoughts-measures-about-healthier-way-travel/
Contributes to body of evidence demonstrating the health benefits of active travel, as it results in a higher percentage of adults who achieve recommended levels of physical activity, lower percentage of adults with obesity, and a lower percentage of adults with diabetes	Pucher, J., T. Buehler, D.R. Bassett and A.L. Dannenberg, 'Walking and cycling to health: a comparative analysis of city, state, and international data', *American Journal of Public Health* (2010) 100(10): 1986–92: http://www.ncbi.nlm.nih.gov/pubmed/20724675

Table 5a: Selected walking campaigns from around the world			
Initiative	**Country**	**Type of campaign**	**Website**
i) Country-specific initiatives			
Canada Walks!	Canada	Walkable communities / active transport	www.canadawalks.ca/
Canadian Volkssport Federation	Canada	Groups	http://walks.ca/CVF/Home.html
Every Body Walk!	USA	Resources and stories	www.everybodywalk.org/
Healthy Families BC, Walking Challenge	Canada	Challenge	http://healthyfamiliesbcwalkingchallenge.ca
Living Streets	UK	Active transport	http://www.livingstreets.org.uk/
Paths for All	Scotland	Access / active transport	http://www.pathsforall.org.uk/
Project SMILES	Spain, UK (Ireland and Sweden)	Active transport	http://www.smilesproject.eu/
Ramblers	UK	Access / groups	http://www.ramblers.org.uk/
See Mommy Run	USA	Social network	http://www.seemommyrun.com/about
Walk for Lunch	USA	Groups	http://walkforlunch.com/
Walk Safely to School Day	Australia	Schools	www.walk.com.au
Walking for Health	UK	Groups	http://www.walkingforhealth.org.uk/
Walking Site	USA and Canada	Resources	www.thewalkingsite.com
Walking Spree	USA	Workplace	www.walkingspree.com
Where 2 Walk	UK	Routes	where2walk.co.uk

ii) International initiatives			
Global Corporate Challenge and the Global Children's Challenge	Global	Workplace / challenge	www.gettheworldmoving.org
Global Children's Challenge	Global	Schools / challenge	www.gccjunior.org/
IML Walking Association	Global	Events	http://www.imlwalking.org
Pedestrian Quality Needs (study)	20 countries across Europe and the Middle East	Access / active travel	www.walkeurope.org
Walk 21	Global	Conferences	http://www.walk21.com
Walking School Bus	USA, New Zealand etc.	Schools	www.walkingschoolbus.org/index.html
Walking with Attitude	Australia, UK, etc.	Workplace / challenge	http://www.walkingwithattitude.com/index

Table 5b: Online walking tools

Tool	Description	Website
MapMyWalk	Website that allows mapping (and sharing) of walking routes, using Google maps. It tracks distance and elevation.	http://www.mapmywalk.com/
WalkIt	This 'urban walking route planner' plots the best routes for walking in over 40 UK cities, giving a choice of the fastest or the least polluted route, calculating the time it will take to walk (at slow, medium or fast pace), the calories burned, steps taken, and the CO_2 emissions offset by walking rather than driving (see also p. 11).	www.walkit.com
Walkscore	Walk Score gives a 'walkability' score for an area, highlighting land use (e.g. local shops and restaurants), green space, schools and commuting time (see also p. 16).	http://www.walkscore.com/

Table 6: Walking and the built environment

Ball, K., A. Timperio, J. Salmon, et al., 'Personal, social and environmental determinants of educational inequalities in walking: a multilevel study', *J Epidemiol Community Health* (2007) 61: 108–14: http://www.ncbi.nlm.nih.gov/pubmed/17234868

Cho, G., D.A. Rodriguez and A.J. Khattak, 'The role of the built environment in explaining relationships between perceived and actual pedestrian and bicyclist safety', *Accid Anal Prev* (2009) 41(4): 692–702: http://www.ncbi.nlm.nih.gov/pubmed/19540957

Christian, H.E. et al., 'How important is the land use mix measure in understanding walking behaviour? Results from the RESIDE study', *International Journal of Behavioral Nutrition and Physical Activity* (2011) 8(55): http://www.ijbnpa.org/content/8/1/55

Coogan, P.F., L.F. White, T.J. Adler, et al., 'Prospective study of urban form and physical activity in the Black Women's Health Study', *Am J Epidemiol* (2009) 170: 1105–17: http://www.ncbi.nlm.nih.gov/pubmed/19808635

Deehr, R. and A. Shumann, 'Active Seattle: Achieving walkability in diverse neighborhoods', *American Journal of Preventive Medicine* (2009) 37: S403–11. http://www.ncbi.nlm.nih.gov/pubmed/19944941

Ewing, R., T. Schmid, R. Killingsworth, et al., 'Relationship between urban sprawl and physical activity, obesity, and morbidity', *Am J Health Promot* (2003) 18: 47–57: http://www.ncbi.nlm.nih.gov/pubmed/13677962

Frank, L.D., T.L. Schmid, J.F. Sallis, et al. (2005). 'Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ', *Am J Prev Med* (2005) 28: 117–25: http://www.ncbi.nlm.nih.gov/pubmed/15694519

Giles-Corti, B., M.H. Broomhall, M. Knuiman, et al., 'Increasing walking: how important is distance to, attractiveness, and size of public open space?', *Am J Prev Med* (2005) 28: 169–76: http://www.ncbi.nlm.nih.gov/pubmed/15694525

Hoehner, C.M., L.K. Brennan Ramirez, M.B. Elliott, S.L. Handy and R.C. Brownson, 'Perceived and objective environmental measures and physical activity among urban adults', *Am J Prev Med* (2005) 28: 105–16: http://www.ncbi.nlm.nih.gov/pubmed/15694518

Jacobsen, P.L., F. Racioppi and H. Rutter, 'Who owns the roads? How motorized traffic discourages walking and bicycling', *Inj Prev* (2009) 15: 369–73: http://injuryprevention.bmj.com/content/15/6/369.full.html#related-urls

Kaczynski, A.T. and K.A. Henderson, 'Environmental correlates of physical activity: a review of evidence about parks and recreation', *Leisure Sciences* (2007) 29: 315–54: http://www.ingentaconnect.com/content/routledg/ulsc/2007/00000029/00000004/art00001

Krieger, J., J. Rabkin, D. Sharify and L. Song, 'High point walking for health: creating built and social environments that support walking in a public housing community', *Am J Public Health* (2009) 99(3): S593–9: http://www.ncbi.nlm.nih.gov/pubmed/19890163

Lachapelle, U. and L. Frank, 'Transit and health: mode of transport, employer-sponsored public transit pass programs and physical activity', *Journal of Public Health Policy* (2009) S73–S94: http://www.ncbi.nlm.nih.gov/pubmed/19190584

Leyden, K.M., 'Social capital and the built-environment: the importance of walkable neighbourhoods', *Am J Public Health* (2003) 93: 1546–51: http://www.ncbi.nlm.nih.gov/pubmed/12948978

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Appendix III: Levels of evidence and evidence gaps

Despite the extensive body of research linking physical activity and health benefits, there is relatively little scientific evidence on specific types of activities (see Box 1), including walking. There are far fewer Level 1 and Level 2 studies (which are costly and time consuming), compared to Level 3 studies. However, this does not cast doubt on the veracity of the overwhelming evidence on the benefits of physical activity, which is why major national and international authorities responsible for health and well-being have unanimously endorsed the benefits of physical activity in reducing risk factors associated with NCDs.

Box 1: Levels of scientific evidence	
Level 1	Randomised control trials without important limitations
Level 2	Randomised control trials with important limitations Observational studies (non-randomised clinical trials or cohort studies) with overwhelming evidence
Level 3	Other observational studies (prospective cohort studies, case-control studies, case series)
Level 4	Inadequate or no data in population of interest Anecdotal evidence or clinical experience

Source:[132]

There are a number of interesting gaps in the research, for example how the suggested 10,000 steps a day links in to the general recommendation of 30 minutes a day of moderate physical activity.

There are also potential areas for research such as the environmental benefits of walking, and the economic benefits that could be obtained by prioritising walking as a form of physical activity and active transport.

Endnotes

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