Physical activity and the environment update

Effectiveness and Cost-Effectiveness Evidence Review 3: Park, Neighbourhood and Multicomponent Interventions

FINAL

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1. Introduction

A review of NICE guideline PH8 on physical activity and the environment identified that some sections of the guideline needed updating as new evidence was available (see review decision). The update also has a particular focus on those who are less able to be physically active (see scope).

The update focuses on interventions in the following environments:

- Built environment including roads, pavements, the external areas of buildings and open 'grey' space, such as urban squares and pedestrianised areas.
- Natural environment, including 'green' and 'blue' spaces. Green spaces include: urban parks, open green areas, woods and forests, coastland and countryside, and paths and routes connecting them. Blue spaces include: the sea, lakes, rivers and canals.

A series of evidence reviews was undertaken to support the guideline development. This third evidence review focuses on the effectiveness and cost effectiveness of park, neighbourhood and multicomponent interventions.

2. Methods

This review was conducted according to the methods guidance set out in 'Developing NICE guidelines: the manual' (October 2014).

2.1. Review questions

1 Which interventions in the built or natural environment are effective and cost-effective at increasing physical activity among the general population?
  1.1 Which transport interventions are effective and cost effective?
  1.2 Which interventions related to the design and accessibility of public open spaces in the built and natural environment are effective and cost effective?
2 Does the effectiveness and cost effectiveness of these interventions vary for different population groups (particularly those less able to be physically active)?
3 Are there any adverse or unintended effects?
  3.1 How do these vary for different population groups (particularly those less able to be physically active)?
  3.2 How can they be minimised?

4 Who needs to be involved to ensure interventions are effective and cost effective for everyone?

5 What factors ensure that interventions are acceptable to all groups?

Any available evidence relating to the cost effectiveness of interventions was also included in this review. The full economic analysis is presented separately.

2.2. Searching, screening, quality assessment and data extraction

Screening

Two systematic searches of relevant databases were conducted (one largely covering transport interventions and the other open spaces) from 22 to 24 June 2016. Two separate searches were carried out because although the two areas shared some outcomes, others were specific to either transport interventions or open spaces. A search of websites was conducted from 1 to 5 August 2016 to identify relevant evidence for this review (see Appendix 3).

PH8 searches were conducted in 2006, and included all relevant publications up to that point. For this update guideline, sources were searched from 2006 to June 2016. The decision was made not to revisit evidence included in PH8 because public health is a fast-moving area and the context in which recommendations are being implemented has changed significantly since 2006. This was for several reasons;

- The Surveillance report and update decision for PH8 stated that no evidence had been identified suggesting that any of the existing recommendations should be reversed, but that new evidence suggested that recommendations could be updated and strengthened.

- The search strategies for PH8 did not exclude interventions targeted at people with limited mobility. It is therefore expected that any interventions targeted at people with limited mobility prior to 2006 would have been captured by PH8.

Review Protocol

The protocol outlines the methods for the review, including the search protocols and methods for data screening, quality assessment and synthesis (see Appendix 3). To note:

- During title/abstract screening, two exclusion codes were used - 'weed out' and 'non-comparative studies'. Non comparative studies included cross-sectional surveys and correlation studies.

- Qualitative studies were only included if they were UK-based AND linked to an intervention of interest as outlined in the review protocols. If few effectiveness or intervention-linked qualitative studies were included the committee agreed to consider UK-based qualitative studies that were not linked to an intervention of interest

- Systematic reviews of interventions of interest were not included but the reference lists of 18 relevant systematic reviews were checked. Twenty three studies were identified via this method and were screened at title and abstract. Full papers were ordered for 7 studies. Of these, 4 were included as evidence for this guideline.

- Modelling studies (that were not economic modelling studies) were excluded.

- Cost benefit studies which only included (or included majority) 'prospective' or 'hypothetical' costs were also excluded. Any studies of this type were forwarded to the modelling team at the Economic and Methods Unit (EMU) for information.

- As agreed at PHAC 0 the following were considered out of scope: interventions involving school playgrounds and interventions involving "fitness zones" in parks. . Interventions involving school playgrounds were excluded as they were noted as being accessible usually only by pupils at the school and during school hours, as opposed to being accessible by the public in general. Fitness zones were excluded as they were considered to be equipment that people may choose to use to change their behaviour at an individual level, rather than an environmental intervention.

Screening

All references from the two database searches were screened on title and abstract by a single reviewer against the criteria set out in the protocol. A random sample of 10% of titles and abstracts was screened independently by a second reviewer, with differences resolved by discussion. Agreement at this stage was 95% for the transport database and 94% for the

open space database. Full-text screening was carried out by a single reviewer and a second reviewer independently screened 10% of all full-text papers. Agreement at this stage was 100% for the transport database papers. Agreement at this stage was 83% for the open space papers – the 2 mismatched papers were resolved. Reasons for exclusion at full paper stage were recorded (see below and Appendix 3).

In addition to the database search, a search of websites identified 259 documents or sites containing potentially relevant information. Each of these documents or sites were considered by one reviewer and potential includes checked by a second.

Data Extraction

Each included study was data extracted by one reviewer, with all data checked in detail by a second reviewer. Any differences were resolved by discussion between the reviewers.

Where data are reported effect sizes, means, standard deviations and 95% confidence intervals have been included. In all instances the most complete data available have been presented in the review findings and evidence statements. For Evidence Statements, please see below.

Quality Assessment

Included studies were rated individually to indicate their quality, based on assessment using a checklist. Each included study was assessed by one reviewer and checked by another. Any differences in quality rating were resolved by discussion. The tool used to assess the quality of studies and summaries of the QA results of all included studies are documented in Appendix 3. The quality ratings used were:

++ No risk of Bias: All or most of the checklist criteria have been fulfilled, and where they have not been fulfilled the conclusions are very unlikely to alter.
+ Low Risk of Bias: Some of the checklist criteria have been fulfilled, and where they have not been fulfilled, or are not adequately described, the conclusions are unlikely to alter.
– High risk of Bias: Few or no checklist criteria have been fulfilled and the conclusions are likely or very likely to alter.

Presentation of Evidence

Each included study is summarised in narrative format. This contains information on research design, setting, quality assessment and results as relevant to each review.

In addition:

- GRADE (Grading of Recommendations Assessment, Development and Evaluation) was used to synthesise and present the outcomes from quantitative studies, of which there were 20 for this Review. These are presented as Evidence Statements

- Qualitative evidence was considered disparate and sparse for this review, with only three studies including qualitative data, one of which was a mixed methods study. Studies are therefore summarised by presentation of their key themes. These are presented in Evidence Statements.

- Cost effectiveness data, presented in a very limited amount by two effectiveness studies, are summarised by key findings, presented as Evidence Statements.

GRADE

GRADE was used to appraise and present the quality of the outcomes reported in included studies – see Appendix 4 for full GRADE tables for Review 1 by outcome. This approach considers the risk of bias, consistency, directness, and precision of the studies reporting on a particular outcome. Critical outcomes for GRADE were the primary outcomes listed in the scope. Important outcomes were the secondary outcomes listed in the scope. (For more details about GRADE, see Appendix H of the NICE Methods Manual (2014) and the GRADE working group website). The quality ratings used to assess the evidence base were: high, moderate, low and very low. Appraisal of the evidence using GRADE methodology starts from 'Low' for evidence derived from observational studies.

Evidence Statements for Review 3 are presented below. For studies of effectiveness, quality of evidence was appraised using GRADE. Evidence statements for qualitative and economic studies were constructed using quality appraisal tools and in line with the NICE manual.

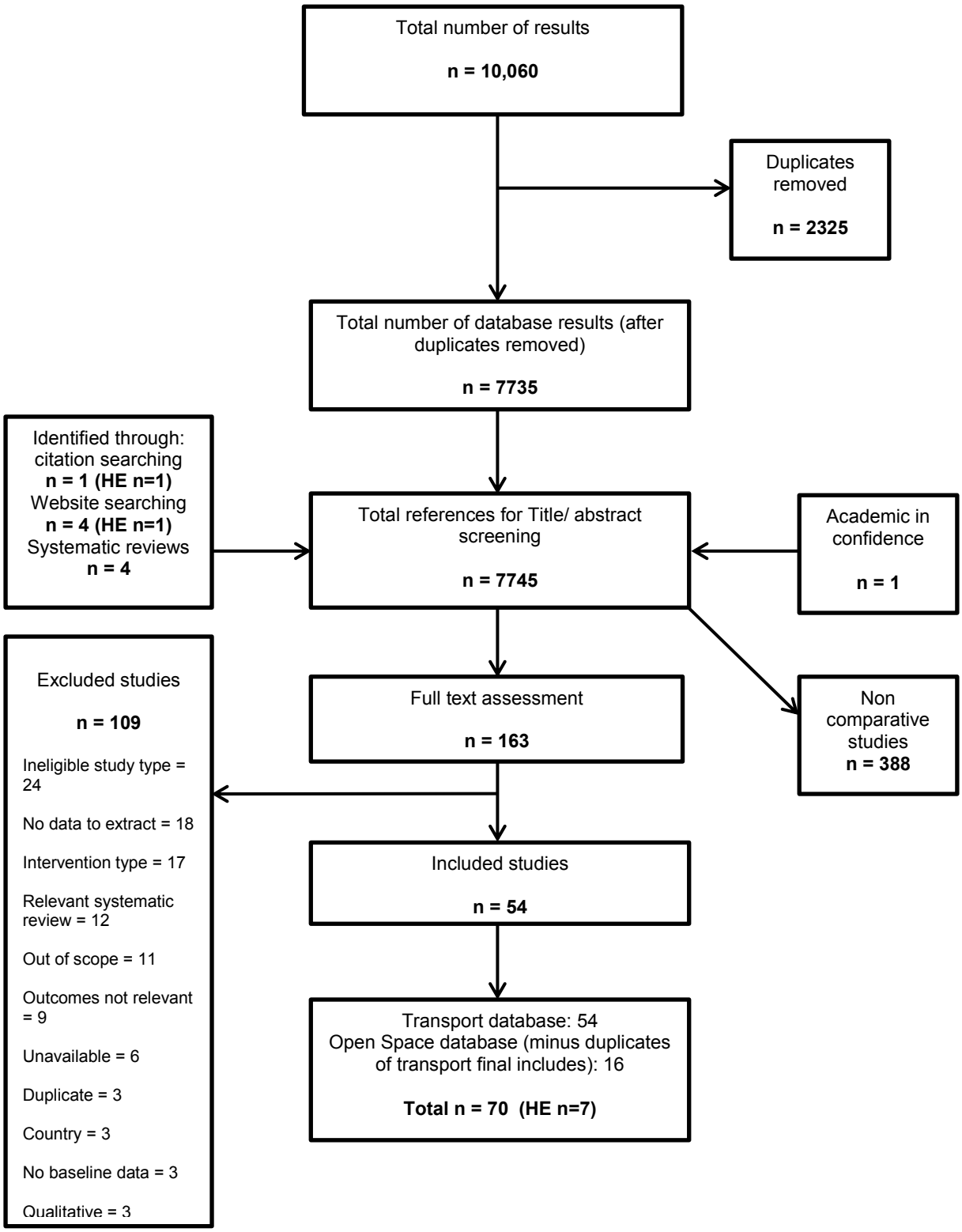
3. Results

3.1. Flow of literature through the review

A total of 70 studies met the inclusion criteria for the evidence reviews to support the guideline on physical activity and the environment.

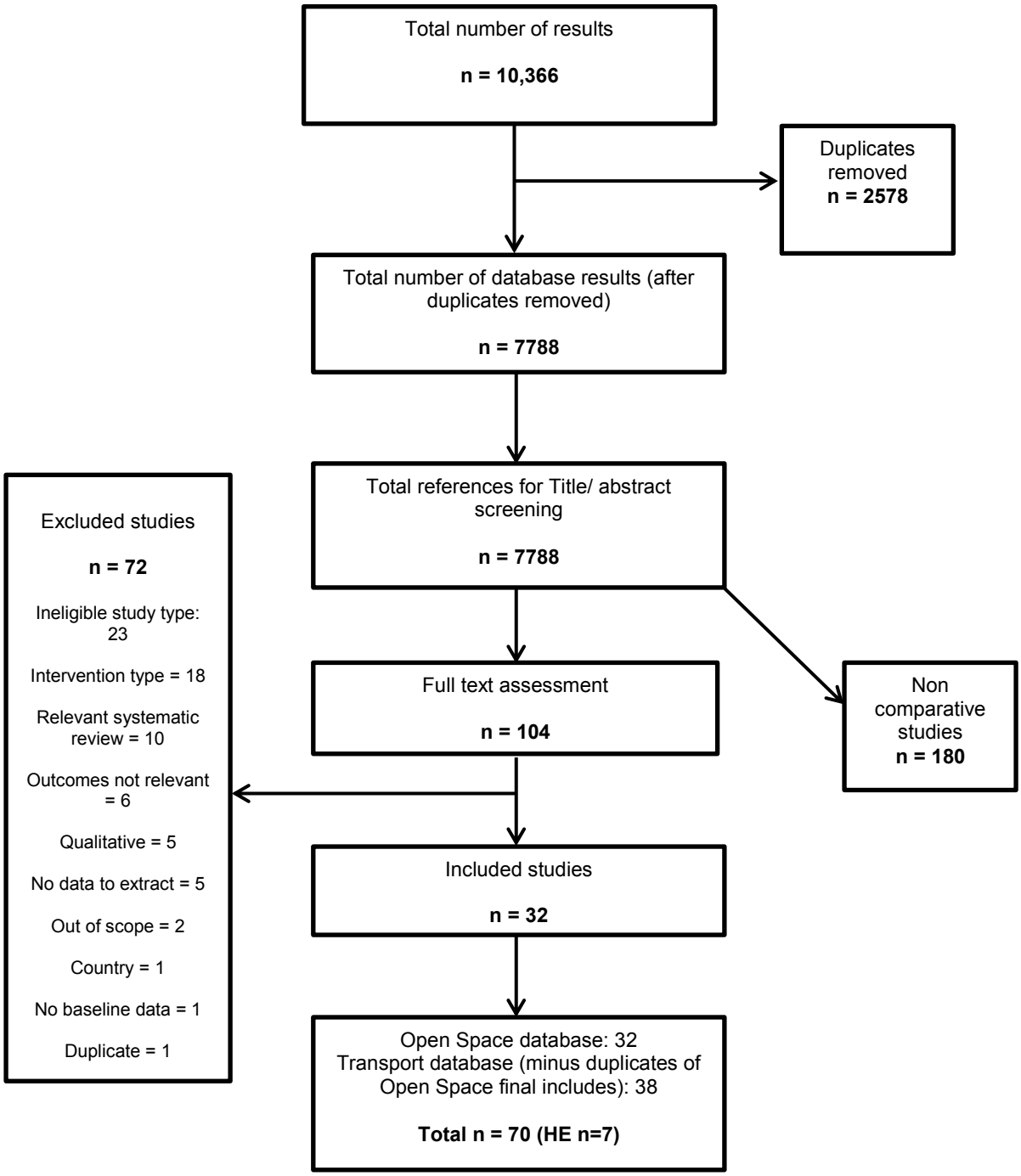
Of these 70, 60 studies were identified from two searches of databases for transport and open space interventions. An additional 1 paper was provided to NICE on an 'academic in confidence' basis. 1 was identified through citation searching and 4 from studies included in systematic reviews. From the website search, 4 new studies were identified that met the review inclusion criteria (one on public transport, one on parks, one multi-component, one on cycling infrastructure). Figures 1 and 2 below show the flow of literature through the review. [To note that there are 16 final includes which are duplicated across the two databases, hence the total number of studies from the two flow charts is more than 70].

Figure 1. Flow of literature through the review: transport database (2006-present)



HE = Health Economics. These papers either have the primary aim of conducting an economic analysis, or contain a portion of economic analysis

200 *Figure 2. Flow of literature through the review: open space database (2006-present)*



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3.2. Characteristics of the included studies

The table below outlines the main themes of the 70 papers that met the inclusion criteria for the evidence reviews.

Theme	Number of papers
Review 1	
Public Transport	18
Review 2	
Ciclovia	3
Trail: trails and paths	14
Trail: Cycle Infrastructure	4
Trail: On-street cycle lanes	4
Safe Routes to School	5
Review 3	
Neighbourhood	6
Parks	12
Multi-component	4
TOTAL	70

Characteristics of all 70 included transport and open space studies are given in Appendix 1.

Papers included in this review are: 6 neighbourhood interventions; 12 park based interventions; and 4 multicomponent interventions. Full details of the 22 studies included in this review are given in the evidence tables in Appendix 2. The table below shows the characteristics of the studies included in this review.

Characteristics of studies included in Review 3 – park, neighbourhood and multicomponent interventions

Study Author, Date	Study Type (author's description)	Population group	Intervention details	Theme
Bohn-Goldbaum 2013	Controlled before and after study (quasi-experimental design)	Children aged 2 - 12 years. Australia, Sydney.	Park improvements. Upgrading paths, improving lighting, increased greenery and park furniture	Parks
Chomitz et al 2012	Uncontrolled retrospective mixed-methods before and after study (retrospective mixed-methods design)	Middle- and high school students and adults. USA, Massachusetts.	Active Living by Design: improving pedestrian safety; opening and renovating parks, providing bike racks, extending walking path etc.	Multicomponent

Study Author, Date	Study Type (author's description)	Population group	Intervention details	Theme
Christian et al 2013	Controlled before and after study (natural experiment)	Over 18 only. With English proficiency. Australia, Perth.	Residential Environments Project (RESIDE). Designed neighbourhood.	Neighbourhood
Cohen et al 2009	Controlled before and after study	Observation: whole population. Survey: 18 or over only. USA, California.	Improvements to five parks including new gymnasiums, landscape designs, improvements to picnic areas etc. Community involvement	Parks
Cohen et al 2014	Controlled study (Quasi-experimental post-only comparison)	Whole population of park users. USA, Los Angeles.	3 new "pocket park" spaces created from vacant lots etc.	Parks
Cohen et al 2015	Mixed method controlled before and after study	Observation: whole population of park users. Survey: 18 and over only. USA, San Francisco.	Park improvements including new play equipment, improvements to the landscape designs and ground surfaces etc. Community involvement	Parks
Coulson et al 2011	Qualitative focus group study (Case study observational design)	All residents (adults and children). UK, Bristol.	Extension of cycle network into neighbourhood (partial completion); traffic calming and pavement free surfaces	Neighbourhood
Droomers et al 2016	Controlled before and after study (quasi-experimental study)	Adult residents. Netherlands, multiple.	Green interventions in 24 neighbourhoods: including new or refurbished public parks, improvement to the playground landscape designs etc.	Multicomponent
Dunton et al 2012	Controlled before and after study (quasi	Children 9-13 years old taking part in Healthy	Smart growth (SG) neighbourhood . New neighbourhood with walking	Neighbourhood

Study Author, Date	Study Type (author's description)	Population group	Intervention details	Theme
	experimental study)	PLACES trial. USA, California.	distance shops and schools	
Gidlow et al 2010	Uncontrolled before and after study (single site pre-post test study design)	Survey: 16 years or older. Focus groups: Adults and youth. Direct observation: all ages. UK, Stoke on Trent.	Park improvements	Parks
King et al 2015	Uncontrolled before and after study (Prospective, non-randomized study design)	Child and adult park users. USA, Denver.	Park renovation (playground equipment, sports fields, benches, gathering area)	Parks
Knuiman et al 2014	Uncontrolled longitudinal study (natural experiment)	Whole population (adults only). Australia, Perth.	Natural experiment - neighbourhood changes over time	Neighbourhood
Norwood et al 2014	Controlled before and after study	18 and over only. UK, Scotland.	Scottish government Smarter Choices Smarter Places programme (SCSP). Upgrades to walking and cycling network.	Multicomponent
O'Brien and Morris 2009	Uncontrolled before and after study	Whole population - activities specifically target low socio-economic groups, disabled persons, BME groups, women, girls and young people. UK – multiple.	Various woodland related. Children's play area, bike hire facilities, walking and cycling trails, concessions scheme etc.	Multicomponent
Patton-Lopez et al 2015	Uncontrolled before and after study (Community-based participatory approach)	Children, adolescents and adults using park. Focus on youth. USA, Oregon.	Park improvements: tree houses, slides, natural climbing features, play equipment. Community involvement	Parks

Study Author, Date	Study Type (author's description)	Population group	Intervention details	Theme
Quigg et al 2012	Controlled before and after study (natural experiment)	Children aged 5 - 10 years. New Zealand, Dunedin.	Upgrading of 2 playgrounds. Improved safety, waste facilities, new play equipment	Parks
Roemmich et al 2014	Uncontrolled before and after study	0-12 years old and 19+ years old. USA, North Dakota.	Removal of seating in parks to increase activity in adults	Parks
Slater et al 2016	Controlled before and after study (quasi-experimental, prospective, longitudinal study design)	Whole population of park users. USA, Chicago.	Park improvements including replacing old playground equipment and surfacing	Parks
Tester and Baker 2009	Controlled before and after study	Whole population of park users. USA, San Francisco.	ReConnect: park improvements	Parks
Trayers et al 2006	Qualitative focus group study	Residents, primary school pupils, further education, planners. UK, Bristol.	Home zone development and an extension of the National Cycle Network	Neighbourhood
Veitch et al 2012	Controlled before and after study (natural experiment)	Children (2-18) and adult park users. Victoria, Australia.	Park refurbishment (fenced dog area, playground, walking track, BBQ area, improvement to the landscape designs, traffic-free measures)	Parks
Ward Thompson et al 2014	Controlled before and after study (Longitudinal cohort study)	65+ years only. Living in intervention or control streets. UK, multiple.	DIY Streets increasing safety and attractiveness through adding planters, changing parking provision, and reducing traffic volume and speed	Neighbourhood

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3.3. Study findings

Twenty-two studies that addressed neighbourhood, park, or multi-component interventions are considered here. For GRADE profiles see Appendix 4 and for Evidence Statements please see below.

Studies were grouped by the type of intervention:

- Park (12 studies)
- Neighbourhood (6 studies)
- Multicomponent (4 studies)

Parks

12 studies reported on the effectiveness of interventions in parks: 8 controlled before and after studies, 2 conducted in Australia [both -][1,2], 5 conducted in the USA [all -][3,4,5,6,7] and 1 from New Zealand [-][8]; 3 uncontrolled before and after studies, all from the USA [2- and 1+][9,10,11] and 1 mixed methods study from the UK[12] with a qualitative [-] and quantitative (before and after study) [-] component.

All of the interventions were based on either upgrading park facilities, the construction of new parks, or changing the micro-environment in the parks to encourage physical activity.

Upgrading Park Facilities

A controlled before and after study in Sydney, Australia by **Bohn-Goldbaum et al** (2013 [-]) set out to determine how a playground renovation in a deprived area impacted on usage and physical activity of children. Specific changes in the park renovation included upgrading paths and adding new greenery, lighting, and facilities (e.g., park furniture). More green space was created by opening the adjacent sports field to public use, increasing the accessible park size from 2.2 to 4.6 hectares. The control park was similar to the intervention park, but underwent no changes. Observational data using the System for Observing Play and Recreation in Communities (SOPARC) and intercept interviews (n = 140) were collected simultaneously on park use and park-based activity among playground visitors at pre- and post-renovation at an intervention and a comparison park during three 2-hour periods each day over two weeks.

No detectable difference in use between intervention and control parks was observed at follow-up. In the intervention park, attendance increased among boys, but decreased among girls although this (non-significant) decline was less marked than in the comparison park. Following renovation, there was no detectable difference between parks in the number of children engaged in moderate to vigorous physical activity (MVPA) [interaction between park and time: p = 0.73]. At the intervention park, there was a significant decline in girls engaging in MVPA at follow-up (p = 0.04).

Cohen et al (2009 [-]) conducted a controlled before and after study in California in the USA. The study was conducted in ten urban parks (5 intervention and 5 control) and residents living within a 2-mile radius were included in surveys. The five intervention parks had been scheduled for major improvements, and each intervention park was matched with a similar park that was not planned to receive upgrades by the city. Three parks constructed completely new gymnasiums. The fourth park had its old gymnasium refurbished and underwent some field improvements in watering and improvement to the landscape designs of the park. The fifth had improvements to picnic areas, upgrades to a walking path, and enhancements to a playground area so that it had rubber surfacing around the climbing apparatus and stationary horses. The researchers objectively measured park use and collected self-reports of park use by residents before and after park improvements. The System for Observing Play and Recreation in Communities (SOPARC) was used to count park users and measure their activity levels and conducting household interviews and intercept surveys with park users. Results were presented for all 10 parks combined: no results were presented for intervention parks specifically. The 10 parks were located in predominantly Latino and African-American and low-income neighbourhoods. Parks contained an average of 12 physical activity areas.

Overall park use and physical activity declined in both intervention and control parks over the period of the study, with 39% of the decline directly attributable to fewer scheduled organized activities. However, perceptions of park safety (personal security) increased significantly more in the intervention parks than in the comparison parks.

Cohen et al (2015 [-]) also published a controlled before and after study that involved the systematic assessment of six parks (4 intervention, 2 control) in San Francisco, USA. Control parks were similar in size, socio-economic and demographic composition of local neighbourhoods (defined as a ½ mile radius around the park). No information was given on proximity of control and intervention parks. At follow up, of the intervention parks, two were

renovated and two partially renovated. Park use before and after the park renovations was measured using SOPARC. Additionally, they interviewed approximately 75 adult park users and 75 residents from randomly selected households within ½ mile of the parks.

The results show that there was a 250% increase in energy expended at and 230% increase in park use in the intervention parks which had completed renovations compared to the baseline ($p<0.001$). There was a statistically significant decrease in park use (48%) and MET hours expended (53%) in the control parks with no renovations compared to baseline ($p<0.001$). In parks with completed renovations, attendance by children and adults increased significantly, teens decreased significantly, and seniors saw no significant change. No significant increases were seen in parks with no renovations.

Additionally, the survey of residents living within ½ a mile of the intervention and control parks showed that park renovations were associated with a significantly increased perception of park safety (personal security) between baseline and follow-up ($p<0.001$). The study also showed that those that did consider the park safe were significantly more likely to visit the park ($p<0.001$). Completed park renovations, were not positively associated with the self-reported number of exercise sessions ($p>0.05$), but the self-reported frequency of park visits was positively associated with the number of exercise sessions ($p< 0.001$). The team also calculated cost-effectiveness of the total renovation of the two completed parks, which ranged substantially from $0.27/MET-hour at the larger renovated park to $2.66/MET-hour for the smaller park.

Gidlow et al (2010 [-]) used an uncontrolled before and after study with a qualitative element to evaluate an 18-month project to promote and improve neighbourhood green space in a deprived urban community in Stoke-on-Trent, UK. A four-part pre-post evaluation involved collection of qualitative and quantitative data: postal survey, informal and formal consultation with local adults and youth (focus groups and interviews), direct observation of park use, and an audit of green space quality. Baseline data and continued consultation were used to inform intervention activities to increase local residents' use of a 4.6 hectare neighbourhood park.

Postal surveys (n = 89 at baseline, 120 at follow-up) showed that there was no significant difference in the percentage of people who considered design, ease of getting around, maintenance, and children's / parents' facilities at the park to be good between baseline and follow-up. There was no significant difference between baseline and follow-up for the number of days people reported engaging in at least 30 minutes of moderate physical

activity and consequently there were no significant differences between baseline and follow-up in the proportion of respondents meeting the PA recommendations. There was a small but significant correlation between frequency of visits (n = 688 overall) and meeting the physical activity recommendations (r=0.349, p=0.012).

Qualitative focus groups (n = 35 people at baseline, 10 at follow-up) at baseline saw green spaces as important for psychological benefits and social interaction. Some also noted physical benefits. At baseline, results reported some indication of improvements to anti-social behaviour at follow-up, but it is unclear whether this is related to the intervention. The potential for increased safety (personal security) through more lighting is mentioned several times.

Patton-Lopez et al (2014 [-]) conducted an uncontrolled before and after study to investigate the effect of adding play equipment including a tree house, slides, climbing frames and natural climbing features to an existing park in a deprived neighbourhood in Oregon, USA on rates of activity among children and adolescents between baseline and 18-month follow-up. 527 observations using a tool adapted from the SOPARC tool were made over baseline and follow-up combined (separate figures not provided).

Results show that there was no significant difference between baseline and follow-up in percentages of children (aged 3-11) and adolescents observed at the park who were undertaking moderate physical activity (MPA) or vigorous physical activity (VPA).

Quigg et al (2011 [-]) conducted a controlled before and after study to investigate the effect of upgrading two community parks in New Zealand (one with more extensive changes including surfacing, waste facilities, play equipment and seating; and the other with changes to play equipment only) on total daily physical activity (TDPA) of children aged 5-10 years old. This intervention group was compared with a control park (unclear whether in a different neighbourhood or the same), where no park upgrades had been carried out. TDPA was measured objectively at baseline and 1-year follow-up, through participants wearing an accelerometer for 8 days. Completion was rewarded with a family swim voucher.

184 children were observed at baseline (no split given), and 156 at follow-up (77 intervention, 79 control). No raw data was presented, and the only results relating TDPA to parks were from a multivariate model, which reportedly found no evidence that participants in the intervention community had a statistically significant difference in their mean TDPA, compared to those living in the control community at follow-up. The results showed that

exposure to a playground was not a significant predictor of TDPA for intervention (p = 0.417) or control groups (p = 0.456).

Slater et al (2016 [-]) conducted a controlled before and after study to investigate the impact of playground renovations and resurfacing alongside community engagement measures in 47 parks in Chicago, USA, on park usage, park based sedentary behaviour and park based MVPA between baseline and 1 year follow-up. This intervention group was compared to those observed in 30 matched control parks which had undergone no renovations or community engagement measures, and were otherwise similar to intervention parks. Parks were matched on size, proximity, neighbourhood socioeconomic status, and race/ethnicity. SOPARC tool was used in direct observations for 2 days at baseline and 3 days at follow-up.

Results found that the change in park usage between baseline and follow-up was significantly higher in the intervention group than the control group (p = <0.05), and that crime count and park maintenance were both significant predictors of park use (p = <0.05), whereas the park having programmes was not. MVPA also increased significantly in the intervention group compared with the control group (p = <0.05), with crime count as the only significant predictor. However, the results show that intervention parks had significantly more people engaging in sedentary behaviour, whereas control parks saw a significant decrease in observed sedentary behaviour over time (p<0.05). Reasons for this are unclear.

Tester and Baker (2009 [-]) used a controlled before and after study design to evaluate the impact of renovations including upgrading playfields, increasing lighting, and adding picnic benches to 2 parks in San Francisco USA on park use and physical activity between baseline and 1-year follow-up, compared with a similar control park in another neighbourhood with no interventions. Observations were collected using SOPARC, and splitting observed individuals into sex (male, female) and age (children, teens, adults, seniors) groups, before categorising physical activity (sedentary, moderate and vigorous).

Results show that there were significant increases in overall numbers of visitors in the two intervention parks (p = 0.00) but no significant increase in the control park (p = 0.36). In intervention parks significant increases were seen in numbers of children, adults and seniors, while visits by teens decreased (p = <0.05).

Intervention parks both saw significant increases in numbers of people observed in MPA and VPA, but also in sedentary behaviour, while control park levels were generally unchanged. Intervention group changes are due to an overall increase in numbers visiting the parks: in

the two intervention parks combined, there were 1681 physically active visitors in the follow-up week, compared to a total of 360 at baseline. There is no statistical comparison between intervention and control groups.

Veitch et al (2012 [-]) carried out a controlled before and after study to investigate the link between refurbishment of one park in a disadvantaged area in Australia – including a fenced area for dogs, an all-abilities playground, a walking track, a BBQ area, and improvement to the landscape design– on park use and physical activity between baseline and 1-year follow-up (8 months after park completion). A similar park in the same neighbourhood was used as a control, risking contamination. A modified version of SOPARC was used, and trained observers recorded gender, age, and activity.

At 1-year follow-up, there was a significantly larger increase in observed number of users of the intervention park (increase from 235 to 985 users) compared with the control group (increase from 83 to 51 users) ($p = <0.0005$). In the intervention park, numbers of people observed walking and number of people being vigorously active increased significantly more than in the control park (walking: intervention 155 to 369; control 75 to 51; $p = <0.0005$. Vigorous activity: intervention 38 to 257; control 5 to 0; $p = 0.008$).

Numbers of people observed standing and lying/sitting also increased in intervention groups (36 to 298; 6 to 61 respectively). This may be a function of the overall increase in park users rather than a shift in proportion, and control levels drop to 0 for both measures (3 to 0; 0 to 0 respectively). Significance of interaction between park and time not reported.

New Parks

Cohen et al (2014 [-]) published a controlled before and after study looking at the effects of 'pocket parks' on physical activity[1] in Los Angeles, USA. Three pocket parks in areas of high deprivation were compared to existing neighbourhood parks that served similar socio-demographic populations. Observational data were collected 4 times a day for a week at baseline (before parks were constructed) and at follow up (2 years later). Data were coded for gender, age group (child, teen, adult, senior), race/ethnicity (Latino, black, white, other),

[1] Pocket parks are often quite small (less than one acre) compared to neighbourhood or community parks, and they generally serve the immediate population living within one-quarter to one-half mile. Pocket parks also usually have limited facilities, offer few or no programs, lack indoor facilities, and are not staffed. To increase safety (personal security) and reduce crime the entire area is typically fenced and can be locked outside the hours of operation.

and activity level (sedentary, walking, vigorous) of each observed park user. They also surveyed 392 household members within one-half mile of the 3 pocket parks before and 432 after park construction, as well as 71 pocket park users and compared them to 992 neighbourhood park users and 342 residents living within ½ mile of other neighbourhood parks.

The authors report that the new pocket parks had significantly more users than comparison park playgrounds. The comparison park playground areas had approximately 70% fewer users than the pocket parks on a daily basis (95% confidence interval 49%, 83%). The local population density also had a significant relationship with park use. An additional local population of 10,000 people is associated with 43% more users.

The authors used their results to conduct a cost-effectiveness analysis. The cost per metabolic equivalent of task (MET) expended was lowest in one of the intervention parks with the largest number of users at $0.43/MET. At the other two parks cost per MET was $0.72/MET and $2.63/MET. Overall cost effectiveness was $0.73/MET gained. The difference in cost-effectiveness is based upon the number of park users and their physical activity levels in each of the pocket parks.

King et al (2015 [+]) conducted an uncontrolled before and after study to evaluate the effect of constructing a new park including a playing field, playground, and community gardens in place of undeveloped green space in Denver, USA on energy expenditure in the surrounding areas and park use at 2-year follow-up compared with baseline (no control). Direct observations using the SOPARC tool were made over summer months at both time points, and included time slots throughout the day. 4,525 people were observed at follow-up.

Results appear to show an overall increase in energy expended, and a movement from energy expended in areas surrounding the park (a decrease of 38% from baseline to follow-up) to energy expended within park boundaries (authors state the increase is “three-fold” but actual figures not given; $p = 0.002$). There is a decrease in sedentary activity (significance not reported) and moderate physical activity ($p = 0.007$), and a significant increase in vigorous activity expended ($p = 0.04$) during observations. Results show a significant increase in visits to the park by teens ($p = 0.007$) and smaller but still significant decreases in adults and children ($p = 0.064$ and 0.001 respectively).

Changing the micro-environment

Roemmich et al (2014 [-]) carried out an uncontrolled before and after study in North Dakota, USA to evaluate the impact of removing seating from a playground, and then one month later replacing the seating in its original place on the physical activity of adult and child park users at baseline, while the seating is removed, and after it is replaced (Part 1). The authors repeat the same study in the same park one year later (Part 2; 2013). SOPARC tools used for both Part 1 and Part 2.

Authors report that MET intensities were greater for both adults and children when seating was not available than either before it was moved, or when it was replaced ($p<0.02$). However, the review team is unclear about the validity of this conclusion, as neither METs over time in adults nor METs over time in children appear to change significantly. However, the odds of adults standing rather than sitting was between 4.7 and 9.4 higher, and the odds of adults engaging in moderate to vigorous physical activity (MVPA) between 4.1 and 22.7 times higher when seating was removed compared to when it was present. These findings are replicated in part 2 of the study, with the exception of odds of adults standing rather than sitting (Odds Ratio 0.9, 95% CI 0.3, 3.0) which was not significant ($p = 0.9$). The reasons for this are unclear.

Key limitations to the parks studies

Key limitations to the park studies include the following: small sample sizes so low generalisability, selective outcome reporting (Bohn-Goldbaum et al 2013); lengthy follow-up periods meaning that factors beyond the scope of the study may contribute to outcomes (Cohen et al 2009); limited usefulness of results due to combination of intervention and control groups in the analysis (Cohen et al 2014); limiting of results to one season reducing generalisability, possible contamination between intervention and control parks when within the same neighbourhood (Cohen et al 2015); high loss to follow-up, no checking of qualitative data by a second researcher (Gidlow et al 2010); unclear aims and data analysis, difference in season used for baseline and follow-up data collection (Patton-Lopez et al 2014); lack of control park to provide assurance that background trends are not impacting on outcome measures, no study power reported (King et al 2015); small sample size resulting in wide confidence intervals and therefore low certainty [observed in many studies in this group], no reporting of actual outcome figures (proportions, associations, or p-values only) (Quigg et al 2011); multiple modelled analyses obscuring results, unclear reasons for methodology (Roemmich et al 2014); inability to attribute outcomes to environmental interventions when community involvement interventions run alongside, length of data collection periods differing between baseline and follow-up (Slater et al 2016); lack of

511 blinding of observers leading to potential assessor bias [observed in many studies in this
512 group], short observation times (Tester and Baker 2009); intervention and control parks
513 differing in size, inability to tell whether existing users were changing behaviour, or whether
514 new users were being displaced (Veitch et al 2012).
515

Applicability: The evidence is only partially applicable, as out of the 12 studies, eight were conducted in the USA, two in Australia, one in New Zealand, and only one in the UK.

[1] Bohn Goldbaum et al 2013 [-]
[2] Veitch et al 2012 [-]
[3] Cohen et al 2009 [-]
[4] Cohen et al 2014 [-]
[5] Cohen et al 2015 [-]
[6] Slater et al 2016 [-]
[7] Tester and Baker 2009 [-]
[8] Quigg et al 2011 [-]
[9] King et al 2015 [+]
[10] Patton-Lopez et al 2014 [-]
[11] Roemmich et al 2014 [-]
[12] Gidlow et al 2010 [-]

516

517 **Neighbourhood**

518
519 Six studies reported on the effectiveness of neighbourhood interventions; 3 controlled before
520 and after studies, one conducted in Australia [+][1], one in the USA[+][3] and one in the UK[-][6]; 1
521 uncontrolled before and after study, conducted in Australia [+][4]; and two qualitative studies,
522 both conducted in the UK [+][2,5.]
523
524 In a controlled before and after study, **Christian et al** (2013 [+]) *(linked to Knuiman et al*
525 *2014)* examined whether people moving into a housing development (in Perth, Australia),
526 designed according to Liveable Neighbourhoods Guidelines (LNGs) engaged in more
527 walking after the move, than those who moved to neighbourhoods not meeting LNGs[2].

[2] LNGs incorporate 4 design elements: 1) community design (mixed use planning, mixed lot sizes), 2) movement network (interconnected street networks, public transport access etc.), 3) public parklands (balance between small and large parks), 4) lot layouts (to maximise surveillance of streets / parks, increase density around activity hubs).

Participants included those with English language proficiency, age 18 years or older, with an intention to relocate (to one of 73 particular, pre-defined newly built neighbourhoods) by December 2005. Participants were surveyed at baseline, as well as 1 and 3 years after baseline; 1,047 completed all three surveys. The comparator was 44 neighbourhoods classified as conventional (not complying with LNGs) but matched to intervention ones in terms of stage of development, block value, and proximity to ocean.

No significant difference, as determined through the Neighbourhood Physical Activity Questionnaire (NPAQ), was found between intervention and control group in terms of mean minutes of walking at baseline or subsequent follow ups. This is true of recreational walking, transport walking, and all walking totalled.

Geographic information systems showed that intervention neighbourhoods had significantly more street connectivity, residential density, and land use mix than controls (1-and 3-year follow up all P<.001). However, no significant changes, as determined through the Neighbourhood Environment and Walking Scale questionnaire (NEWS), were found between intervention and control groups in terms of perceptions of street connectivity, traffic safety, presence of traffic slowing devices, and crime safety.

Knuiman et al (2014 [+]) *(linked to Christian et al 2013)* examined neighbourhood walkability and destination accessibility in relation to active travel by walking within a neighbourhood (in Perth, Australia) over 7 years in an uncontrolled longitudinal study. Participants included adults with English language proficiency, and with an intention to relocate (to one of 73 particular, pre-defined newly built neighbourhoods) by December 2005. Surveys were completed by 1,813 at baseline, 1,467 at 1 year follow up, 1,230 at 3 years and 565 at 7 years. The Neighbourhood Physical Activity Questionnaire found that after relocation, neighbourhood active travel by walking and mean trips made per week decreased initially and recovered by 7-year follow-up.

Data from Geographic information systems (objective data) and data from Neighbourhood Environment and Walking Scale questionnaire (perception data) found:

- Objective but not perceived connectivity is associated with active travel by walking.
- Neither perceived nor objective residential density mix is associated with active travel by walking.
- Perceived and objective land-use mix is associated with active travel by walking.

- Perceived and objective access to bus stops and railway stations are associated with active travel by walking.
- Perceived number of types of destinations is more strongly associated with active travel by walking than objective measures of destinations present.

[See evidence tables for details].

In a controlled before and after study, **Dunton et al** (2012 [+]) evaluated the impact of a recent move to one particular Smart Growth neighbourhood (see table for further details) on children's physical activity context (where they physically exercise) compared with children living in any of six low-to-medium density suburban control neighbourhoods in California, USA. There were 46 children, aged 9 – 13, in the intervention group and 48 in the control. There were no significant differences in baseline characteristics between the groups. For both groups, four days of data were collected through text message surveys sent to participants' phones. Participants completed surveys on their phones at the time, and data was sent back to researchers. Accelerometers were worn by all children from Friday morning to Monday evening to validate activity survey questions.

Although minutes of daily moderate to vigorous physical activity (MVPA) increased in both the intervention group between baseline and follow up (from 32.75 min/day to 42.78 min/day) and the control group (from 34.23 min/day to 38.40 min/day), the difference between groups was not significant (P=0.51). The proportion of physical activity bouts reported in outdoor locations with no traffic increased among intervention children between baseline (55%) and follow-up (66%), and decreased in the control group from 78% to 49% (p = 0.036).

A qualitative study by **Trayers et al (2006)** [+] *(Linked to Coulson 2011)* explored the perspectives of four groups of stakeholders about proposed neighbourhood improvements in a deprived inner city neighbourhood (in Bristol, UK) and their perceived health and physical activity benefits, and whether perceptions align. Proposed improvements included a home zone development and extension of the National Cycle Network. Participants (10 residents from neighbourhood; 10 students and tutors from a local further education college; 9 pupils from a primary school; 3 local authority planners overseeing the developments) were recruited to focus groups, focusing on the potential health benefits of environmental change: i.e. increased physical activity.

Participants expressed concerns about the plans increasing the potential for anti-social behaviour as well as dangers associated with proposed cycle/walkway being isolated.

Others were of the opinion that the plans would improve road safety. Physical activity was considered by most participants to be the least important theme, particularly compared with safety. Residents understood that some people might use the new cycle/walkway instead of driving, but referred to these people as "them" rather than "us". One college student appeared enthusiastic about the path as alternate travel, but tempered with concerns about safety (personal security). The authors concluded that a mismatch between planners' and residents' perspective exists in relation to benefits of new Home Zone and cycle/walk way.

Coulson et al (2011 [+]) *(Linked to Trayers 2006)* used a qualitative methodology to investigate the experiences of residents of a deprived inner city neighbourhood in Bristol, UK, before, during, and after construction of a home zone development and a cycle-walkway to improve the neighbourhood, with particular focus on quality of life and physical activity. The home zone or "living street" aimed to improve environmental aesthetics, give greater priority to non-motorised road-users and slow traffic, largely by breaking up motorists' sight-lines and introducing shared space, such as pavement-free surfaces. The cycle-walkway was the conversion of a disused railway bed into a National Cycle Network extension. Adult residents of the neighbourhood were invited to 5 focus groups, the first of which was before the implementation of the interventions had begun; 36 residents participated.

Adult participants generally saw their levels of physical activity as unchanged since implementation of the home zone and cycle paths. However, participants perceived increased activity in children. The cycle walkway was reportedly used to get children to nursery and to walk dogs; a perceived limitation of the route was that it did not fully connect through to the station or city centre. Concerns remained about safety (personal security), both regarding the home zone and cycle walkway (see table for further details).

Ward-Thompson et al (2014) [-] assessed the effect of a UK street improvement programme called "Liveable Neighbourhoods" (see table for further details) on older adults' physical activity and quality of life through cross-sectional, longitudinal cohort and activity surveys. Participants were aged 65 or older and living in either the intervention sites or matched comparison sites (where no intervention took place and matched in terms of housing type, street layout and socioeconomic status as measured by the relevant Index of Multiple Deprivation for the local census area. For the repeat cross-sectional survey, there were 56 people in the intervention group at baseline and 29 at 2 year follow up; and 40 in the control group at baseline and 32 at follow up. Differences between intervention and comparison groups are not reported. Of these participants a subset (who completed both

baseline and follow-up surveys) were analysed as a longitudinal cohort, with 20 in the intervention group and 16 in the comparison.

The cross-sectional survey results indicated that self-reported frequency of summer outdoor activities declined in the intervention group (p = 0.02) at 2 year follow-up; no significant differences for the comparison group. However, in the intervention group, perceptions that "most of the streets and paths in my neighbourhood are safe to walk after dark" increased significantly (p=0.04). The comparison group saw no significant change over time.

The longitudinal cohort survey found that self-reported levels of outdoor activity in summer did not increase significantly in either intervention or comparison groups (p value not reported). Responses to the statement 'it is easy for me to walk on my street' showed an increase in the intervention group, a change that was significant compared with the comparison group (p=0.03).

Key limitations to the neighbourhood studies

The major limitations to neighbourhood studies included: baseline measures not being appropriate comparisons due to participants living in different neighbourhoods at this point; delay in implementation of results meaning that outcomes do not fully measure the interventions (Christian et al 2013); self-selection of participants in qualitative studies; 'burn out' of participants during process due to over-surveying affecting quality or quantity of responses, sample not representing the population demographically (Coulson et al 2011); grouping of multiple control areas meaning detail is lost in the analysis, difficulty in completing the data collection method when taking part in physical activity potentially underestimating effects (Dunton et al 2012); high rates of drop out implying attrition bias, no information on what participants are told about the study, artificial baseline data is not useful comparison (Knuiman et al 2014); small sample size, low generalisability, no demographic information given (Trayers et al 2006); high drop-out in intervention group, intervention not finished during study, missing outcome data (Ward-Thompson et al 2014).

Applicability: The evidence is partially applicable to the UK as 3 of the studies were conducted in the UK, two were conducted in Australia and 1 in the USA.

1. Christian et al (2013) [+]
2. Coulson et al (2011) [+]
3. Dunton et al (2012) [+]

4. Knuiman et al (2014) [+]
5. Trayers et al (2006) [+]
6. Ward-Thompson et al (2014) [-]

Multicomponent interventions

Four studies reported on interventions which had multiple parts, and which have therefore been categorised as "multicomponent". Of these four, three were controlled before and after studies, one from the Netherlands [+][1] one from the UK [-][2], and one from the USA [-][3]. The remaining study was an uncontrolled before and after study conducted in the UK [-][4].

A controlled before and after study conducted by **Droomers et al** (2016 [+]) investigated the impact of neighbourhood-level interventions linked to green space on physical activity (PA) and perceived good health of residents, compared with several control groups. Intervention neighbourhoods were a subset of those adopting the "District Approach" (see evidence table), specifically those addressing green space through creating new parks, redeveloping existing parks, creating allotments, fish ponds, community gardens and so on, and had 1,018 participants. Control groups were: a narrow control made up of neighbourhoods very similar to intervention group; a broad control group with more neighbourhoods; a national control; and a control using neighbourhoods adopting the District Approach but not through improving green space. Data was collected through the national Dutch Health Interview Survey (HIS).

Only regression coefficients are reported – no raw data. Results at 3.5 year follow-up showed that there was no significant difference between the change in the proportion of people taking ≥1 leisure walk/week over time in the intervention group and the first three control groups. However, the District Approach control group had a significantly more positive change than the intervention group (-0.36 [95% CI-0.67, -0.05]). There was no significant difference between the change in proportion of people taking ≥1 leisure cycle/week or undertaking ≥1 session of leisure sports/week between the intervention group and any control group. Authors conclude that the trend change in the prevalence of being physically active at least once a week, as well as good perceived general health, did not differ between the deprived neighbourhoods that implemented interventions involving green space, and the control areas.

Norwood et al (2014 [-]) conducted a controlled before and after study to assess the effect of the Smarter Choices, Smarter Places (SCSP) programme, which involved interventions to introduce new bus services and shelters, ticketing improvements, improvements to paths, and promotional activity to increase walking, cycling and public transport use, on physical activity (PA) in adults. The intervention group consists of seven locations in Scotland, and the control group was made up of three areas in Scotland which were similar to the intervention areas. Questionnaires collected self-reported data, 12,411 participants responded at baseline, and 9.542 at follow-up for intervention and control groups combined.

Regression analysis controlled for age, ownership of a car, employment status, health status, age, ethnicity, and education level. The results suggested that, although the proportion of participants who were active at all decreased in both intervention and control groups between baseline and follow-up (intervention -0.7%-point, control 9.2%-point), the likelihood of PA participation is significantly higher in the intervention areas relative to the control areas ($p < 0.01$, regression coefficient is 0.39). Similarly, although proportion of participants meeting MPA guidelines decreased in both intervention and control groups between baseline and follow-up (intervention -3.4%-point, control 14.9%-point), those who were physically active were significantly more likely to meet physical activity guidelines in the intervention areas relative to the control areas (regression coefficient 0.13; $p = <0.05$).

A controlled before and after study conducted by **Chomitz et al** (2012) [-] evaluated the effect of the Active Living By Design (ALBD) project in Massachusetts USA, which involved recruiting bike and pedestrian coordinators to advocate for physical activity; improving walking environments like streets and parks, and extending a walking path connecting the intervention town to a larger city, on physical activity of middle school (aged 11-13), high school (aged 14-18) and adult residents. 3,562 people participated at baseline (all intervention group as no control data collected), and 5,792 at follow-up (intervention and control combined).

Results showed that intervention group adults and high school students had significantly greater odds of meeting MPA or VPA guidelines at follow-up compared with baseline (Odds ratio, 95% CI: adults 2.36 [2.29, 2.43]; high school students 1.61 [1.34, 1.92]). Middle school students' odds of meeting MPA or VPA guidelines did not change significantly, but they had higher proportions of participants meeting guidelines at baseline than either adults or high-school students. Adults from the intervention group were significantly more likely to meet guidelines at follow-up compared with control group adults at follow-up (1.10 [1.04, 1.17]), but middle-school and high-school students were not. Due to control data being collected at

follow-up only (no baseline data for control group), comparisons between intervention and control are not conclusive.

An uncontrolled before and after study conducted by **O'Brien and Morris** (2009) [-] for the Forestry Commission considered the impact of three woodland projects (part of the Active England programme) in the UK on visitor demographics and physical activity. Projects included creating new play areas, visitor centres, cycle and walking tracks, climbing walls and so on in woodland areas, as well as behavioural groups and promotional events. Counts were conducted, as well as surveys, for which there were 1,467 participants across the three sites over the study period.

Results from between 1 and 5 years after baseline data collection show increases in visitor numbers in all three sites (427%, 2,143% and 47% increases). In all three sites combined, there was no significant change in number of visitors with blue badges (actual numbers not given), however there was a decrease in proportion of visitors reporting having a long term illness (13.9% at baseline, 7.2% at follow-up; p = <0.001; actual numbers not reported). Black and Minority Ethnic (BME) individuals as a proportion of all visitors increased from 1.7% at baseline to 5.2% at follow up (p = <0.001). Those visiting every day or 4-6 times per week declined as a proportion of all visitors. Those visiting 1-3 times per month and 4-6 times per year saw the greatest increase as a proportion of all visitors. Average visit length reportedly increased from 1.74 (standard error 0.04) to 2.33 (standard error 0.04) (presumed unit is hours – not stated in paper), but there is no indication of whether this equates to increased physical activity. Between baseline and follow-up, greatest increases in activities as a proportion of all those undertaken by visitors appear to be use of play area, cycling, and mountain biking (interpretation by NICE team from bar chart with no numbers given). Proportion of visitors taking ≥5 days exercise/week declined significantly from 55.9% to 36.1% between baseline and follow-up (p = <0.001).

Key limitations to the multicomponent studies

Key limitations to the multicomponent studies included: An important limitation is the frequent inclusion of promotional activity which cannot be separated in the results from environmental interventions, thereby making it difficult to attribute outcomes to environmental interventions. Additionally, follow-up times are often too short to observe meaningful effects of interventions, large variation in types of intervention within one study

meaning that conclusions about which are most effective cannot be drawn (Droomers et al 2016); self-selection of intervention areas where the intervention required an application for funding, different data collection methods used at follow-up compared with baseline (Norwood et al 2014) low response rates reducing representativeness of the sample, use of 'non-equivalent' controls, control data only collected at follow-up (Chomitz et al 2012); data collection by untrained and unblended staff potentially introducing bias, incomplete outcome data obscuring changes, and grouping of multiple locations inhibiting assessment of locations individually (O'Brien and Morris, 2009).

Applicability: The evidence is partially applicable to the UK because two studies were conducted in the UK. The remaining two studies were conducted in the Netherlands and the USA.

[1] Droomers et al (2016) [+]

[2]. Norwood et al (2014) [-]

[3]. Chomitz et al (2012) [-]

[4]. O'Brien and Morris (2009) [-]

4. Discussion

Strengths and limitations of the review

Overall, the quality of the studies was poor. As noted in section 3.3, none of the studies were rated [++] and only 6 studies were given a quality rating score of [+]. The remaining 16 studies were allocated [-]. No economic evaluations were identified, other than small sections on economic data within two studies (Cohen et al 2014 and Cohen et al 2015).

Consistent themes do emerge across the studies:

- Park interventions show mixed effects on park visits and physical activity expenditure, possibly due to factors outside of the scope of interventions affecting outcomes (i.e. cancellation of events programmes and incomplete construction at follow-up)
- Poor perception of safety (personal security) appears to be a significant deterrent to using existing or new parks and trails. While interventions tend to result in improved perceptions of safety (personal security), there is not always increased park or trail use and physical activity
- Neighbourhood interventions reported no significant effect on minutes of walking, moderate to vigorous physical activity, or frequency of outdoor activity. However, it

may be that active travel by walking is associated with plentiful access to bus stops and railway stations, and a larger number of mixed destinations within walking distance.

- Large scale programmes over multiple areas to increase physical activity through multiple interventions tend to show no significant effect. This may be obscuring variation by combining diverse interventions which, if analysed individually, may show more conclusive results

Several limitations were present across many of the studies, some of which are common to this field of study, and some of which are specific to this review.

Of the 22 studies in this review, 14 included control groups, and eight do not include a control to control for other influences on outcome measures. Of those that did include controls, several do not include enough information on the control group to determine whether it is was sufficient to reduce confounding. Others include controls which will cause contamination (i.e. control parks in the same neighbourhood as intervention parks, meaning that park users see the parks as alternatives to each other and the control does not truly measure a consistent state).

Other limitations are: self-selection of intervention groups where interventions require applications for grants. Use of controls which were unlikely to effectively reduce confounding due to contamination or methodologically poor data collection. Several interventions had behavioural elements which may have impacted the outcomes reported, but which could not be separated from environmental aspects. Where sample sizes (of people or parks) are small, generalisability is limited. Short observation periods usually in a single season are unlikely to be representative of long term outcomes. Lack of blinding in assessors could lead to observer bias. Inability to control for other factors which will influence results means lower confidence in effect of interventions. Low response rate for surveys potentially leading to bias. Incomplete interventions at follow-up, or interventions at varying stages of completeness, meaning that results are not showing embedded behaviours. Varied interventions in varied settings being combined in analysis obscuring more detailed results of what is effective where. Selective reporting of outcome measures, and no provision of raw data means effect size and magnitude cannot be determined. Finally, there is a lack of reporting on the impact of interventions on those with mobility problems or disabilities.

Further detail of the strengths and weaknesses of individual studies can be found in the evidence tables (Appendix 2).

Adverse effects

Few studies actively considered adverse effects, but some potential effects emerged:

- Moving to a neighbourhood recently constructed according to guidelines intended to increase physical activity may cause a decrease in active transport by walking in the short term. One study found that walking decreased before recovering over time, as the neighbourhood became more well established and connected (Christian et al 2013; Knuiman et al 2014).
- Home Zones or other neighbourhood changes affecting traffic may cause diversions in routes taken by vehicles attempting to avoid speed restrictions. This could simply displace dangerous driving or speeding to another location (Coulson et al 2011).
- Participants sometimes expressed fear about new paths or parks encouraging anti-social behaviour and feeling isolated (Trayers et al 2006; Coulson et al 2011; Gidlow et al 2010). It was found that adequate lighting and regular maintenance was required to allay these fears and to facilitate use (Trayers et al 2006; Coulson et al 2011; Gidlow et al 2010, Slater et al 2016).
- Park refurbishments or other interventions may bring about positive outcomes in some groups at the expense of positive outcomes in other groups, by either gender, age, or disability. One study found that park refurbishments resulted in decreases in physical activity among girls (significant in Bohn Goldbaum et al 2013). Another study found that although increases were seen among girls, their levels of use were lower at both baseline and follow-up (King et al 2015). Some studies found that park refurbishments resulted in decreases in park use by certain age groups (all age groups bar teens in Cohen et al, 2009; just teens in Tester and Baker 2009). Finally, one study found that, although there was no significant changes in number of visitors with blue badges, there was a decrease in proportion of visitors to woodlands reporting having a long term illness (O'Brien and Morris 2009).
- One study suggested that although seating may contribute to attractiveness of park environments, it may also increase sedentary behaviour in parks. However, this study relates mainly to mobile adults (Roemmich et al 2014).

Applicability

Of the 22 studies in this review, 10 were from the USA, six were conducted in the UK, four in Australia, one from New Zealand and one from the Netherlands. The applicability of studies from other countries may be limited if population acceptability and use of parks, acceptable

styles of neighbourhoods, and physical activities in open space are very different from those in the UK.

Gaps in the evidence

Insufficient evidence was identified to answer the following questions:

- Which parks / neighbourhood / multicomponent interventions are cost-effective? (minimal cost effectiveness evidence identified for parks interventions; none for neighbourhood or multicomponent interventions)

- Does the effectiveness and cost effectiveness of these interventions vary for different population groups? (No evidence on intervention effectiveness / cost effectiveness of interventions for groups less able to be physically active i.e. with disabilities; older populations etc. Some limited evidence in parks interventions on differential effectiveness by age and gender).

- Adverse or unintended effects (some adverse effects are reported, but these tend to be at a whole population level rather than particularly considering those with limited/low mobility or sensory impairment)

- Who needs to be involved to ensure interventions are effective and cost effective for everyone? (Although some studies report community level involvement, or 'coordinator' posts, little information on involved parties means this cannot be fully answered).

- What factors ensure that interventions are acceptable to all groups? (Some factors discussed, particularly safety (personal security), but not all groups represented).

For more information on gaps in the evidence and Expert Testimony, see Appendix 7.

5. Evidence Statements

The committee noted that the majority of studies included in the evidence reviews were considered poor quality. However, they also noted that the body of evidence as a whole indicated a consistent 'direction of travel' whereby sympathetic changes to the environment and/or public transport provision increase physical activity.

The committee noted that the complexity and scale of the interventions makes this an extremely challenging area of research. It may not be possible, practical or ethical to undertake a randomised controlled trial and natural experiments may be the most valid approach. They also noted that variations in methodology used to evaluate the impact of interventions in different groups over different time points meant that the committee did not feel comfortable pooling the heterogeneous outcome data. For example, for the following reasons:

- Physical activity outcomes being presented both as continuous (i.e change in METmins achieved) and dichotomous (i.e. whether guidelines on physical activity were met).

- Outcomes measured at follow-up points which were varied in length i.e. immediately after intervention implementation compared with 18 months after implementation.

Parks Evidence Statements

GRADE evidence statement 3.1: Upgrading park facilities

Five (2 Australian[1, 2]; 3 USA[3, 4, 5,]) studies presented very low quality evidence showing that upgrading park facilities (including at least one of the following: lighting, facilities (seating or toilets), paths, greenery, gyms or landscape designs) has mixed effects on the number of people engaging in moderate to vigorous physical activity. Three of the 5 studies provided evidence that the intervention increased physical activity at follow up ranging between 4 months and 2 years, however when considering differences by gender one study[1] presented evidence that there was a decline in girls engaging in MVPA at follow-up.

One USA study[6] presented very low quality evidence showing that upgrading park facilities (including at least one of the following: lighting, facilities (seating or toilets), paths, greenery, gyms or landscape designs) increased the amount of energy expended by an average of 250% across all age groups (children, teens, adults and seniors) at 3 years follow up.

Two studies (UK[7], Australian[1]) presented very low quality evidence showing that upgrading park facilities had no effect on the proportion of individuals reporting that they meet the recommended 30[7] minutes and 60[1] minutes physical activity per day at 12 months follow up.

Six (2 Australian[1, 2] 3 USA[3, 4] presented very low quality evidence showing that upgrading park facilities (including at least one of the following: lighting, facilities (seating or toilets),

paths, greenery, gyms or landscape designs) had mixed effects on the number of individuals visiting and using the parks with 4 of the 6 studies providing evidence showing an increase in the number of visits at follow up ranging between 4 months and 3 years. Two of the studies[5,6] had data by age group, and showed an increase for adults, children and seniors but not teenagers.

Two studies (Australian[2], USA[5]) presented very low quality evidence showing that upgrading park facilities (including at least one of the following: lighting, facilities (seating or toilets), paths, greenery, gyms or landscape designs) had mixed effects on sedentary behaviour when individuals are visiting the park; one study[5] shows a 5 fold increase in sedentary visitors, at 1 year follow up and another[2] shows a decrease in individuals observed being sedentary (lying or sitting down) at 3-8 months follow up.

Three USA[4, 6, 8] studies presented very low quality evidence showing that upgrading park facilities (including at least one of the following: lighting, facilities (seating or toilets), paths, greenery, gyms or landscape designs) improved perceptions of park safety, however this was not always linked to increases in park use or self-reported exercise at follow up ranging between 1 and 3 years.

One New Zealand[9] study presented low quality evidence showing that upgrading park facilities made no change to the mean total daily physical activities of individuals, even if they lived close to the park. The same study also presented low quality evidence showing that after upgrading park facilities, at 1 year follow-up, physical activity was associated with participant baseline age (the older the children the higher the mean total physical activity), school day (higher mean total physical activity on a school day), usual mode of travel to school (higher mean total physical activity if children usually walk to school), sex, and ethnicity.

[1]Bohn-Goldbaum et al 2013

[2] Veitch et al 2012

[3]Paton-Lopez et al 2014

[4]Slater et al 2016

[5]Taster and Baker 2009

[6]Cohen et al 2015

[7]Gidlow et al 2010

[8]Cohen et al 2009

[9]Quigg et al 2011

Non-grade evidence statement 3.2 – Attitudes to Parks

One mixed methods study[1] with a high risk of bias [-] based in the UK included qualitative interviews with 35 adults and 23 young people at baseline and 10 adults and no young people at follow up, investigated the general perception of green spaces, antisocial behaviour, park facilities and park safety.

Parks in general were viewed as good for health and wellbeing, however participants found it difficult to have positive views on the intervention park – highlighting high levels of antisocial behaviour and feeling unsafe. At follow up most of the participants had not noticed the changes made in the park and antisocial behaviour remained a concern.

[1]Gidlow et al 2010

GRADE evidence statement 3.3: New Parks

One USA study[1] with 432 participants presented very low quality evidence showing that introducing new pocket parks increased the proportion of adults reporting that they visit any park more than once per week (22.8 percentage point increase), engage in exercise in the park (4.8 percentage point increase) and engage in leisure time exercise (9.9 percentage point increase) at 2 year follow up.

One USA study[2] with 4525 participants presented low quality evidence showing that constructing a new park on undeveloped green space increased average monthly visits by three times the original number of visits, energy expended in the park 3-fold and the proportion of individuals observed as engaging in either moderate or vigorous physical activity by a 40.8 percentage point increase at 2 year follow up.

[1]Cohen et al 2014

[2]King et al 2015

Non- Grade Evidence Statement 3.4: Cost effectiveness of Park Interventions

Two studies[1, 2] with high risk of bias (both [-]) based in the USA included small amounts of data on cost effectiveness of park locations, showing that larger and busier parks may be more cost effective than smaller or quieter ones.

One study[1] presented evidence that the average cost per Metabolic Equivalent Task (MET) in intervention parks which had been refurbished ranged from $0.27/MET-hour at the larger renovated park to $2.66/MET-hour for the smaller park. The second study reported cost per MET-hour of new pocket parks*. Cost per MET-hour ranged from $0.43 at the busiest park to $2.63 at a quieter park. Both papers reported that previous benchmarks consider a physical activity intervention as cost-effective if the cost is less than $0.50–$1.00/ MET-hour (USA).

[1] Cohen et al 2015 [-]

[2] Cohen et al 2014 [-]

* Pocket parks are normally small (less than one acre) and generally serve the immediate population living within a quarter of a mile to half a mile of the park.

GRADE evidence statement 3.5: Changing micro-environment

One USA study[1] with 484 participants presented very low quality evidence showing that changing the micro-environment by moving park seating and picnic tables closer to the playground resulted in greater METs intensities. For adults, METS expended is significantly higher with no seating when compared with before seating was removed (mean difference 0.20, 95% CI 0.11, 0.29), and also when compared with after seating was removed (mean difference 0.60, 95% CI 0.51, 0.69). For children, METS expended is significantly higher with no seating when compared with before seating was removed (mean difference 0.70, 95% CI 0.54, 0.86), and also when compared with after seating was removed (mean difference 0.70, 95% CI 0.53, 0.87). The odds of adults engaging in moderate and vigorous physical activity were at least 4.1 times higher and adults standing rather than sitting were at least 4.7 times greater (follow up unclear).

[1]Roemmich et al 2014

<u>Neighbourhood Evidence Statements</u>

GRADE evidence statement 3.6: Moving to a 'Livable Neighbourhood'

One Australian study with two publications[1,2] and 1,047 participants presented very low quality evidence that moving to neighbourhoods complying with Livable Neighbourhood guidelines (which incorporate 4 design elements: 1) community design (mixed use planning, mixed lot sizes), 2) movement network (interconnected street networks, public transport access etc.), 3) public parklands (balance between small and large parks), 4) lot layouts (to maximise surveillance of streets / parks, increase density around activity hubs)) was not more effective than moving to conventional neighbourhoods for increasing active travel (walking) between baseline and 3-year follow-up (change over time in intervention and change over time in control not significantly different: $p > 0.05$); and very low quality evidence was presented that the intervention did not cause a significant change in leisure walking at 3-year follow-up (change over time in intervention and change over time in control not significantly different: $p > 0.05$).

One of the publications[2] reported low quality evidence that access to public transport stops, the presence of ≥8 types of destinations within the neighbourhoods (defined as within a 15 minute walk), and increased number and diversity of destinations (also called "land use mix") was associated with increased active travel by walking at 7-year follow-up.

One study[3] from the USA with 95 participants (children aged 9 - 13) presented very low quality evidence that living in a Smart Growth neighbourhood did not increase the proportion of journeys to places of recreation made by walking or bicycling, or time spent in Moderate to Vigorous Physical Activity (MVPA) at 6-12 month follow-up.

[1] Christian et al 2013

[2] Knuiman et al 2014

[3] Dunton et al 2012

GRADE evidence statement 3.7: DIY-Streets

One study[1] from the UK with 96 participants over 65 years of age presented very low quality evidence that various interventions, including increasing safety and improving appearance of streets through planters, parking space provision and layout, and some restrictions to the width of the road in places (to control traffic), made no change to self-reported levels of outdoor activity in summer at 2-year follow-up, although participants felt that they were more active generally. The same study reported improved perceptions of street safety and ease of walking in the street, but lowered perceptions of garden and parking facilities at home at 2-year follow-up.

[1]Ward Thompson et al 2014

Non-Grade evidence statement 3.8: Home Zone and Cycle Walkway

Two studies[1,2] with low risk of bias (both +) from the UK collected qualitative data through focus groups on the perceptions of residents in a neighbourhood to which a Home Zone and an extension of an existing Cycle Walkway would be implemented.

Prior to intervention implementation, personal safety was a concern of residents, who did not want the new walkway to be isolated. However, it was recognised that the Home Zone might improve road safety through reduced driving speeds. Anticipated opportunities for physical activity were not considered an important feature of the interventions[1].

During and after implementation, residents saw their own physical activity as unchanged, but mentioned increased outdoor activity and playing by children. The walkway was primarily used to walk dogs and take children to nursery, a limitation being that the route did not connect to a station / city centre and so was less useful for active travel. Concerns about personal and road safety remained.

[1] Trayers et al 2006

[2] Coulson et al 2011

<u>Multicomponent Evidence Statements</u>

GRADE evidence statement 3.9: Active Living By Design project

One USA[1] study with 484 participants presented very low quality evidence showing that a project which included the creation of city-level bike and pedestrian coordinator positions supporting implementation of environmental changes (crosswalks, park renovations etc.),

and extension of a walking path connecting intervention town with a city, increases the odds and proportions of adults and high school students meeting the recommended moderate and vigorous physical activity at 3-5 years follow up.

[1] Chomitz et al 2012

GRADE evidence statement 3.10: Improving Green Space

One study from the Netherlands[1] with 1018 participants presented low quality evidence showing that improving green spaces through the redevelopment of existing parks, creation of public parks, natural playgrounds, community gardens, fishponds and public allotments has no effect on the proportion of individuals engaging in leisure walks, leisure cycling trip or leisure sports at least once a week at 3.5 year follow up.

[1] Droomers et al 2016

GRADE evidence statement 3.11: Smarter Choices, Smarter Places (SCSP) programme

One UK study[1] with 9542 participants presented very low quality evidence showing that the Smarter Choices, Smarter Places (SCSP) programme which included introducing new bus services and shelters, ticketing improvements, promotional activity was associated with an increase the proportion of individuals meeting the moderate physical activity recommendation, however there was a reduction in the proportion of participants who were active at all at 3 year follow up. Those who were physically active were more likely to meet physical activity recommendations.

[1] Norwood et al 2014

GRADE evidence statement 3.12: Active England woodland projects

One UK study[1] with 1467 participants presented very low quality evidence showing that the Active England woodland projects, including new play areas, visitor's centre, cycle tracks, walking trails, shower facilities, butterfly trail, climbing wall, promotional groups and events, on average increased the frequency of visits to the woodland from 1.74 (standard error 0.04) to 2.33 (standard error 0.04) (unit not given), and increased visitors by between 47% and 2,143%. However the percentage of all visitors that visited daily decreased at one to five year follow-up.

The same study also presented very low quality evidence showing that the Active England woodland projects, including new play areas, visitor's centre, cycle tracks, walking trails, shower facilities, butterfly trail, climbing wall, promotional groups and events, was associated with a decrease in the proportion of visitors taking ≥5 days exercise/week (55.9% to 36.1% between baseline and follow-up ($p = <0.001$)) (follow up varied between 1 and 5 years).

1140 The same study presented very low quality evidence showing no change in the number of
1141 visitors with blue badges (actual numbers not given), however there was a decrease in
1142 proportion of visitors reporting having a long term illness (13.9% at baseline, 7.2% at follow-
1143 up; p = <0.001; actual numbers not reported). Black and Minority Ethnic (BME) individuals as
1144 a proportion of all visitors increased from 1.7% at baseline to 5.2% at follow up (p = <0.001).

1145 [1] O'Brien and Morris 2009

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