# Physical activity and the environment

# Review Five:

# BUILDING DESIGN

NICE guideline PH8 (published January 2008) has been updated and replaced by NG90.

New recommendations have been added on strategies, policies and plans to increase physical activity in the local environment (1.1.1 to 1.1.3); active travel (1.2.1 to 1.2.4 and 1.2.6 to 1.2.9); public open spaces (1.3.1 to 1.3.3). NICE has deleted some recommendations from the 2008 guideline because the evidence has been reviewed and the recommendations have been updated.

This evidence review is relevant to the updated guideline.

See the guideline for more details.

**NICE Public Health Collaborating Centre – Physical activity**
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## *Executive Summary*

This report examines the evidence for the effectiveness of interventions aimed at changing the design and amenities of buildings and the associated impact on levels of physical activity. This review covers a subset of the literature on physical activity and the environment which also includes the transportation system, local and regional scale design and planning features as well as the natural environment. The scope included interventions undertaken in a single building, in or across a set of buildings, or the environment surrounding a set of buildings (such as a university campus). Studies were included in this review if they assessed the effect of an intervention involving a modification or improvement to the physical structure of buildings. This included interventions that involve a modification to the physical building such as changes to the internal design of buildings, the provision of facilities or amenities (such as showers, bike storage), and internal decoration/ aesthetic qualities.

For inclusion a study had to include a measure of physical activity behaviour or use (such as walking/ cycling/ pedestrian counts). Only studies aiming to assess the impact of an intervention were included, cross sectional studies that examined the association (e.g. correlates research) between physical activity and building design were excluded. Ten studies were included, comprising 2 randomised controlled trials (1 randomised by worksite, and 1 randomised by the individual), 4 controlled before and after studies, 2 interrupted time series, 2 studies with post-intervention data only (1 with a comparison group). Studies were typically small scale and the number of environments under investigation was often limited, for example a study may involve only one building location (one worksite, or university campus) or a small number of schools.

The studies covered four main areas:

- **Workplaces**

**The evidence from three studies, one (1+), one (2+) quality, and one (2-) quality , suggests that interventions that include changes to the built environment of a worksite may lead to both short- and long-term changes in levels of physical activity (Emmons et al., 1999; Leslie et al., 2000; Linenger et al., 1991).**

**From this set of 4 studies conducted in diverse settings and involving different worksites and different interventions, it is difficult to interpret any clear trends on how the content of the intervention may have influenced effectiveness. It does appear, however, that the provision of facilities or trails for walking, jogging or cycling, and improvements to existing or provision of new facilities (such as new space, improved equipment, or improved aesthetics [painting, carpet]) may lead to increases in use and or levels of physical activity (Emmons et al., 1999; Leslie et al., 2000; Linenger et al., 1991; Reed and Wilson, 2006).**

- **Stairwells**

**The evidence from two (2+) quality studies aimed at improving the physical environment of a stairwell by physical improvements such as carpets, painting and addition of art work may lead to increases in stairwell usage in the short-term (Boutelle et al., 2001, Kerr et al., 2004).**

- **School playgrounds**

**The evidence from three studies (one (1++) RCT and two (2++) controlled before and after studies) suggests that colourful/fluorescent markings painted on a school playground can lead to objectively assessed increases in variables related to physical activity during playtime, such as time spent in moderate-vigorous physical activity, time spent in vigorous activity and**

**total energy expenditure during play, in the short-term (Stratton and Leonard, 2002; Stratton, 2000; Stratton and Mullan, 2005). However, there is no evidence available to assess the effect of school playground markings on physical activity beyond 4 weeks post implementation.**

- **School classrooms**

**Based on one (2-) post only study with a comparison school, there is insufficient evidence to make any overall conclusions about effectiveness but the evidence available suggests that equipping a classroom with ergonomic furniture, changing classroom layout and modified teaching styles may be associated with increases in physical activity during the school day.**

**Included studies**

Boutelle KN, Jeffery RW, Murray DM, Schmitz KH. (2001) Using signs, artwork, and music to promote stair use in a public building. American Journal of Public Health, 19(12): 2004-2006.

Cardon G, De Clercq D, De B, I, Breithecker D. (2004) Sitting habits in elementary schoolchildren: a traditional versus a "Moving school". Patient Education & Counseling, 54(2):133-142.

Emmons KM, Linnan LA, Shadel WG, Marcus B, Abrams DB. (1999) The Working Healthy Project: a worksite health-promotion trial targeting physical activity, diet, and smoking. Journal of Occupational & Environmental Medicine, 41(7):545-555.

Kerr NA, Yore MM, Ham SA, Dietz WH. (2004) Increasing stair use in a worksite through environmental changes. American Journal of Health Promotion, 18(4):312-315.

Leslie E, Fotheringham M, Veitch J, Owen N. (2000) A university campus physical activity promotion program. Health Promotion Journal of Australia, 10(1):51-54.

Linenger JM, Chesson CV and Nice DS. (1991) Physical fitness gains following simple environmental change. American Journal of Preventive Medicine, 7(5):298-310.

Reed JA, and Wilson DK. (2006) Awareness and use of a university recreational trail. Journal of American College Health 54(4):227-230.

Stratton G and  Leonard J. (2002) The effects of playground markings on the energy expenditure of 5-7 year old school children. Pediatric Exercise Sciences, 14:170-180.

Stratton G and Mullan E. (2005) The effect of multicolour playground markings on children's physical activity level during recess. Preventive Medicine, 41:828-833.

Stratton G. (2000) Promoting children's physical activity in primary school: an intervention study using playground markings. Ergonomics, 43(10):1538-1546.

# 1. Introduction

## *1.1. Background to this review*

The National Institute for Health and Clinical Excellence ('NICE' or 'the Institute') has been asked by the Department of Health (DH) to develop guidance on a public health programme aimed at modifying the environmental factors that promote physical activity.

This guidance is in response to a number of developments in the fields of physical activity and public health in recent years, including:

- A growing recognition of the influence of the environment as a determinant of the behaviour of individuals and communities;
- A corresponding increase in published research on the environment and physical activity;
- A desire by public health professionals to work in partnership with local authorities and other key agencies on public health programmes;
- A need to complement interventions targeted at individuals with programmes that have the potential to have a larger population impact.

## *1.2. The need for guidance*

### 1.2.1. Physical activity and ill health

Increasing activity levels will contribute to the prevention and management of over 20 conditions and diseases including coronary heart disease, diabetes, cancer, and weight management; and can help to improve mental health.

In 2004 the DH estimated the cost of inactivity in England to be £8.2 billion annually – including the rising costs of treating chronic diseases such as coronary heart disease and diabetes. The contribution of inactivity to obesity is estimated to cost a further £2.5 billion each year.

Around 35% of men and 24% of women (aged 16 plus) are physically active enough to meet the current national recommendations (achieving at least 30 minutes of at least moderate activity on 5 or more days a week). Seventy per cent of boys and sixty-one percent of girls aged 2-15 years achieve the recommended physical activity levels (at least 60 minutes of at least moderate intensity physical activity each day). Physical activity varies according to age, gender, class and ethnicity (Department of Health, 2006).

### 1.2.2. Trends in physical activity

Trends between Health Surveys for England in 1997, 1998, 2003 and 2004 found small increases in physical activity levels between 1997 and 2004 (Department of Health 2006). Other data from national travel surveys show that the distance people walk and cycle has declined significantly in the last three decades while travel by car has increased (Department for Transport, 1995; Department for Transport., 2005). Although there are limitations with these estimates, including the absence of published confidence intervals, the use of different questionnaire items and potential misclassification, there is concern about the generally low levels of physical activity undertaken by the population as a whole, and particular concern regarding the prevalence of participation amongst specific sub population groups (women, older adults, lower socio-economic class, minority ethnic groups).

### 1.2.3. Physical activity and the environment

The built environment can influence people's ability to be active (Department of Health., 2004). For example, the design and layout of neighbourhoods, towns and cities can encourage or discourage access on foot or by bike. Building design has the potential to encourage or discourage physical activity, for example, the use of stairs can be promoted by their placement and character; cycling to work can be encouraged by cycle and changing facilities provided at the destination. In addition to the built environment, access to open space such

as parks, countryside, woodlands, and forests can help people to be more physically active.

Components of the environment can be modified by public and or private sector through changes to policy and practice. Action to improve the health enhancing possibilities of the built environment can be taken in partnership with workplaces as well as other key organisations.

## *1.3. The nature of evidence on the environment*

The links between the environment and physical activity is based on a relatively new body of evidence and practice. Over the past decade or so, research has explored which features of the built environment and the design of buildings, are associated with physical activity and related outcomes. Thus far, much of the available evidence has focussed on the wider, larger scale, urban environment and the majority of these are cross sectional studies undertaken to identify the associations (correlates) of physical activity rather than to test modifications or interventions involving a change to the environment aimed at changing physical activity behaviour.

Although studies testing the effect of a change to the building design on physical activity are few, one area that has received some research attention is stair use, with the aim being to encourage more stair use as an alternative to escalators and lifts. Most of these studies use an educational/ awareness raising component such as posters to act as a 'point-of-decision' intervention and encourage individuals to make the 'active and healthy choice'. Within the context of stair promotion, environmental interventions may include laying (new) carpet, painting and decorating, and adding music to the stairwell. Studies assessing the effectiveness of stairwell interventions are included in this review. However, as the focus of the programme is the effectiveness of environmental interventions, for inclusion studies must have involved a physical change to the stairs environment rather than being limited to only informational / motivational prompts approaches. Other building related interventions might include the

provision or improvement of facilities within buildings to encourage walking and cycling to work (for example, shower provision, bike storage, locker facilities) or interventions that involve a change to the environment immediately surrounding a building or set of related building, (for example, improvements to school playgrounds, provision of facilities accessible from groups of buildings on a business park or physical changes to facilities within a university campus such as walking or cycle paths to encourage employees and other users to participate in physical activity).

It is recognised that focussing a review specifically on buildings, a sub set of the wider environment and physical activity literature, may lead to a small evidence base. Nonetheless, this area represents an important field of potential public health interventions, should effective interventions be identified. Modifications to the building environment are of potential importance across a number of settings including schools, workplaces, hospitals and prisons and these settings were within the scope of this review.

There are a number of challenges associated with undertaking a review of the evidence on interventions within the built environment. As with other reviews in the series, the search strategy needed to be broad enough to capture studies from non-traditional sources including sources and journals not indexed in electronic or public health databases. Furthermore, identified studies may not report any outcome measures on physical activity or present unvalidated measures that are difficult to equate to established measures of physical activity. Finally, a wider range of study types may be used with more of a focus on case studies, post only measures or uncontrolled pre and post studies, increasing the risk of bias and causality being very difficult to demonstrate.

## *1.4. Scope of the reviews*

### 1.4.1. Aspects of the environment that will be covered

NICE guidance will be based on the findings from five reviews on specific aspects of the environment:

- Transport
- Urban planning and design
- The natural environment (urban and rural)
- Building design
- National, regional or local policy influencing physical activity through the environment.

This report presents the findings from the building design review. The scope includes interventions that involve a modification to the physical building such as changes to the internal design of buildings, provision of facilities or amenities (such as showers, bike storage), and internal decoration/ aesthetic qualities. The scope included interventions undertaken in a single building, in or across a set of buildings or the environment surrounding a set of related buildings (such as a university campus).

### 1.4.2. Population groups that will be covered

This guidance will cover the general population, including both children and adults. The guidance will investigate the effectiveness of interventions across the broad social gradient, including those in the poorest circumstances and those in the poorest health.

### 1.4.3. Areas that will not be covered

The influence of national fiscal policy on physical activity levels is not addressed. Studies that tested interventions that did not involve any physical changes to the environment were excluded. For example, studies aiming to increase stair use were not included if the intervention *only* included the provision of signs and/ or

motivational prompts placed at the point of decision. These are regarded as educational/ behavioural interventions and are not the focus of this review. This review did not include intervention studies that were conducted in the broader urban environment (such as neighbourhoods, community, city-wide) as these were addressed in previous reviews undertaken within this programme of research (NICE, 2006a; 2006b).

### 1.4.4. Outcomes

The primary aim is to recommend environmental interventions that are likely to increase physical activity levels in the general population by: incorporating physical activity into every day life; increasing formal or informal recreational activity (including active play); increasing active travel (cycling and walking). In addition, secondary outcomes were reviewed and those relevant or potentially related to physical activity (for example, awareness of physical activity facilities or programmes, perceptions of the importance of fitness) were summarized in both the evidence tables and in summary text.

### 1.4.5. Review team

This review has been carried out by a team from the Public Health Collaborating Centre (CC) for Physical Activity. The Collaborating Centre is an alliance between the British Heart Foundation Health Promotion Research Group (University of Oxford) and the British Heart Foundation National Centre for Physical Activity and Health (Loughborough University).

# 2. Methodology

## *2.1. Literature Search*

Literature searches were conducted using the terms and databases listed below. References were downloaded into a Reference Manager database and de-duplicated resulting in 13,497 references. An additional 1,215 citations were obtained from the UrbaDoc databases: Acompline (838), Archinet (195), Orlis (80), Urbamet (65), and Urbaterr (37). A further 213 citations were retrieved from British Architectural Library online – although these citations could not be imported into Reference Manager. This produced a total of 14,925 hits altogether.

In addition to the electronic searches five references were identified from the search strategies of previous reviews in this series and these were also followed up; 1 from the Transport review, 2 from the Urban planning review and 2 from the Natural environment review. Furthermore, contact was made via e-mail with authors of included papers, key international and national experts, lead organisations and members of NICE's Physical activity and the environment Programme Development Group (PDG), this identified a further 8 possible references. Reference list of all included studies and key review papers that had been identified by the electronic search were also checked which resulted in 6 additional references

It was noted that the electronic search strategy picked up no papers that studied playground interventions. The terms 'play' and 'playthings' were included in the search terms however this did not include 'playground'. However it was known that research studies have been published examining the effect of playground markings on physical activity levels in children. Therefore an additional specific electronic search was undertaken using sportDISCUS, Medline and Pubmed, and in addition authors of key papers were directly contacted. This resulted in a further 8 references.

From all the methods of searching - the electronic searches, previous reviews, contact with key authors and PDG members and additional searching for interventions studies in playgrounds - a total of 14952 hits were identified.

### 2.1.1. Search terms

All search strategies were designed by the CC and NICE. Tailored search terms were used appropriate to a particular database. Search terms followed the same order (1) building design terms and (2) physical activity terms. Typical search terms included:

Building, build, built, landscape, space, design, structure, layout, facilities, environment, surrounding, location, lift, elevator, stair, path, parking, aesthetics AND physical, activity, exercise, leisure, sport, walk, running, bicycle, roller skating, stair, dancing, yoga, play.

A full search for MEDLINE is presented in Appendix A.

All searches were performed from January 1990 to the most recently published version of the database (July 2006).

### 2.1.2. Databases searched

Medline; Embase; Cinahl; PsycInfo; SportDISCUS; Global Health; Geobase; SIGLE; Cochrane Library; PAIS; ISI Science Citation Index and Social Science Citation Index; Cambridge Scientific Abstracts (CSA) Physical Education Index; CSA ERIC; CSA DAAI (Design and Applied Arts Index), Urbadoc, British Architectural Library online.

### 2.1.3. Selection of studies for inclusion

The agreed search strategy resulted in 14,952 titles, which were initially screened for potential relevance by one person resulting in 1,882 titles. In order to assess sensitivity of screening a pilot screening was performed by a second reviewer on 15% of the total hits downloaded into the Reference Manager database.

The 1,882 titles and abstracts were added to 27 studies identified by other searches and a total of 1,909 hits were assessed for relevance by one person and consistency was assessed by two researchers checking relevance on a 30% sample. In total 99 titles were assessed to be relevant, the full papers were retrieved and were checked against in-out criteria (see Appendix B) by one person. Where any uncertainty existed, the full paper was assessed independently by a second reviewer. If further clarification was needed, attempts were made to contact the primary author for further information. Any discrepancies were resolved by a third reviewer. Ten studies were accepted for full data extraction (see Appendix C) and 89 were rejected (see Appendix D).

Studies were included if they assessed the effect of an intervention related to modifying the physical built environment. The outcome of the intervention had to include a measure of physical activity behaviour (including total physical activity/ walking/ cycling counts) although other 'proxy' measures such as amenity usage were accepted. Other variables related to physical activity were also accepted, for example, heart rate was used to estimate rate of energy expenditure and total energy expenditure during play in children, and heart rate data were used to calculate the percentage of playtime spent in moderate-intensity and moderate-vigorous intensity physical activity.

Only intervention (experimental or quasi-experimental) study designs were included. Studies that examined the association (or correlation) between physical activity and characteristics of the built environment were excluded.

The main reasons for exclusion of studies was that they did not involve a change to the built environment, they did not include a measure of physical activity as an outcome, or the paper was purely a description of the area or an opinion piece (Appendix D provides the main exclusion criteria for each excluded study). Ten of these excluded studies were review articles but they were not specific to the built environment and therefore could not be included, however the reference list of each article was hand searched and potentially relevant papers were followed up.

Effectiveness was examined over the following timescales:

- in the short-term (up to and including one year)
- in the longer-term (over one year)

**Table 1 Search strategy results by source**

| | Searching | | | | | |
|---|---|---|---|---|---|---|
| | Data sources | | | | | Total |
| | Electronic databases | Other NICE review searches | Expert & lead organisations | Hand searching | Search for playground interventions – electronic and hand searching | |
| Number of hits | 14925 | 5 | 8 | 6 | 8 | 14952 |
| **Assessing relevance for review** | | | | | | |
| Number of studies assessed | 1882 | 5 | 8 | 6 | 8 | 1909 |
| **Assessed against in/ out criteria** | | | | | | |
| Number of studies assessed | 83 | 5 | 2 | 6 | 3 | 99 |
| **Data extraction and quality appraisal** | | | | | | |
| Number of studies included in review | 5 | 2 | 0 | 0 | 3 | 10 |

## 2.2. *Study Type and Quality Appraisal*

Each study was categorised by study type (categorised as type 1-4) and graded for quality using a code '++', '+' or '-', based on the extent to which the potential

sources of bias had been minimised (NICE, 2006c, p27.). The studies were categorised into the following study types:

Type 1 Systematic reviews, meta-analyses of RCTs (randomised controlled trials), or RCTs.

Type 2 Systematic reviews of, or individual, non-randomised controlled trials, case-control studies, cohort studies, controlled before-and-after (CBA) studies, interrupted time series (ITS) studies, correlation studies.

Type 3 Non-analytic studies (for example, case reports, case series studies).

Studies were quality appraised against NICE quality criteria (NICE, 2006b) appropriate for study types, and subsequently classified into one of three categories (++, + or -). The included studies were quality assessed independently by 2 reviewers and any discrepancies were resolved through discussion.

**NICE Quality Criteria**

Does the study describes its methods and results
Where was the study published?
Who published the study?
Was the study peer reviewed?
Who funded the study?
Were the study samples shown to be representative of the study population in baseline and follow-up (where applicable)?
Was the method/instrument used to assess physical activity or travel mode appropriate to the research question(s) of the study? (i.e. capable of measuring the outcome under consideration)
Did the study provide details of the measures used?
Did the study take into account any potential confounders?

**++** **All or most** of the data are adequately described and the conclusions of the study are thought very unlikely to alter (low risk of bias).

\+ **Some** of the data are adequately described and the conclusions of the study are thought unlikely to alter (risk of bias).

\- **Few or no** data are adequately described and the conclusions of the study are thought likely to alter (high risk of bias).

Two type 1 studies were found, six studies were categorised as type 2 with the remaining two as type 3. Table 2 shows 3 studies were categorised as (++), 5 studies were categorised as (+) and 2 were categorised as (-). The main reasons for studies being assessed as (-) quality were not showing the sample to be representative of the study population and failure to take potential confounders into account.

**Table 2. Study type and quality**

| Study type and quality | Authors |
|---|---|
| 1++ | Stratton and Leonard, (2002) |
| 1+ | Emmons et al., (1999) |
| 2++ | Stratton (2000), Stratton and Mullan (2005), |
| 2+ | Leslie et al., (2000), Kerr et al., (2004), Boutelle et al., (2001) |
| 2- | Linenger et al., (1991) |
| 2- | Cardon et al., (2004) |
| 3+ | Reed and Wilson, (2006) |

## *2.3. Study categorisation*

### 2.3.1. Description of studies

The 10 studies are described in Section 4 and presented in the Evidence Table (see pages 45-50). They included:

- 2 randomised controlled trials, one randomised by worksite (Emmons et al., 1999) and one randomised by the individual (Stratton and Leonard, 2002).
- 4 controlled before and after studies (Stratton (2000), Stratton and Mullan (2005), Linenger et al., (1991); Leslie et al., (2000))
- 2 interrupted time series (Kerr et al., (2004), Boutelle et al., (2001))
- 1 after measures only study with a comparison group (Cardon et al., 2004)
- 1 after measures only study (Reed and Wilson, (2006)

These studies tested a range of different environmental interventions related to the built environment and fell into 4 different categories (see section 3-6 for full definitions):

- Workplaces (4 studies)
- Stairwells (2 studies)
- School playgrounds (3 studies)
- School classrooms (1 study)

All interventions included some form of change or modification to the building design either by changing the internal design, provision of facilities or amenities, or internal decoration/ aesthetics of a building or set of buildings or the environment surrounding buildings.

### 2.3.2 Country of studies

Three of the studies were conducted in the UK. Table 3 presents the studies by country and lead author.

**Table 3 Summary of studies by country of origin**

| Country of origin | Authors |
|---|---|
| UK | Stratton (2000); Stratton and Mullan (2005); Stratton and Leonard (2002) |
| USA | Boutelle et al., (2001); Kerr et al., (2004); Emmons et al., (1999); Linenger et al., (1991); Reed and Wilson (2006) |
| Australia | Leslie et al., (2000) |
| Belgium/ Germany | Cardon et al., (2004) |

### 2.3.3 Length of outcome measures

Eight studies measured short-term outcomes only (up to and including 1 year) (Leslie et al., 2000; Linenger et al., 1991; Reed and Wilson, 2006; Stratton 2000; Stratton and Mullan, 2005; Stratton and Leonard, 2002; Kerr et al., 2004; Boutelle et al., 2001), and two studies measured long-term outcomes only (over 1 year) (Emmons et al., 1999; Cardon et al., 2004).

## *2.4. Assessing applicability*

Each study was assessed on its external validity: that is, whether or not it was directly applicable to the target population(s) and setting(s) in the scope. This assessment took into account whether the study was conducted in the UK, and any barriers to implementing each intervention in the UK identified either by studies or the review team, with references as appropriate , (NICE, 2006b). Studies were deemed to be directly applicable, somewhat applicable or not applicable to implementation in the UK.

## *2.5. Synthesis*

It was not appropriate to use meta-analysis to synthesise the outcome data as interventions, methods and outcomes were heterogeneous. This review is restricted to a narrative overview of all studies that met the inclusion criteria and

contained sufficient data for data extraction and quality assessment. The effects of studies were examined within four categories defined either by the setting (for example, workplaces or schools) or the type of urban planning intervention (for example, stairwells or classroom modifications), and stratified by study quality. These categories were defined from the evidence identified and were not predetermined. The evidence statements were developed using NICE criteria (NICE, 2006b, p37), outlined below.

- The best available evidence of the effect of an intervention
- The strength (quality and quantity) of supporting evidence and its applicability to the populations and settings in question
- The consistency and direction of the evidence base

It is noted that for one category of interventions contained within this review – school classrooms, only one study met the inclusion criteria. Evidence statements were drafted for this section but due caution should be taken in generalizing due to this limitation. This review did not produce any evidence statements based upon any cost-effectiveness data. Where relevant studies with economic data were found these were highlighted for consideration in the economic review.

# 3. Workplaces

## *3.1. The studies*

This section includes intervention studies involving changes to the built environment of workplaces. This includes internal changes to workplace buildings and changes that take place between a set of related buildings such as a university campus. Studies included in this section all involve an element of change to the built environment, however this was often in combination with other changes such as an educational programme. Studies were aimed at those who work at the worksite as well as other users or visitors to these buildings.

A total of four studies, one (1+) quality study, one (2+) quality study, one (2-) quality study and one (3+) quality study were identified that provide evidence on the effectiveness of changes to the workplace environment to increase physical activity levels. Three were conducted in the USA and one in Australia.

Emmons et al., (1999; cluster RCT (1+)) examined the effects of a multiple risk factor workplace intervention on healthy behaviours, including physical activity, nutrition and smoking cessation. Subjects were all employees of twenty-six worksites based in California, USA. Worksites were randomised, stratified after completion of baseline measures and matched into pairs, followed by random assignment of worksites within pairs to the intervention or control group. During the intervention period 4 worksites were dropped leaving 22 worksites; 11 intervention worksites and 11 control worksites. The intervention included various elements including the allocation of space for exercise equipment and a measured distance line was painted around the worksite to promote lunch time walking. The primary physical activity related outcome was participation in regular exercise assessed using a self-report survey at baseline, interim (1¼ years) and at the end of the programme (2½ years). Data were analysed at the level of the individual (employee) and assessed change between baseline and follow-up comparing the intervention worksites with control worksites.

Leslie et al., (2000; controlled before and after study (2+)) assessed the impact of a physical activity intervention implemented on an Australian university campus aimed at increasing physical activity levels amongst students. A pre and post intervention (8 week) survey was conducted in the intervention and control university campuses to compare leisure-time physical activity levels. The pre-intervention survey was used to help design the 8-week physical activity programme delivered on the intervention campus. The intervention involved conducting physical activity classes, demonstrations and displays for various activities and environmental changes to an existing exercise facility; which included painting walls and laying new carpet. The programme was marketed and promoted through student publications, newsletters and flyers and demonstrations were held on campus.

Linenger et al., (1991; controlled before and after study (2-)) evaluated the effect of a multi-component environment/ social change programme which aimed to facilitate a more active lifestyle amongst US 'active duty' military personnel and to enable local community members to become more active. The intervention included building cycle paths along roadways, marking a 1.5 mile run course at various sites and building a new fitness centre for women. All active duty military personnel were initially eligible for the 'physical readiness test' which consisted of a 1.5-mile timed run, sit-ups, push-ups, and percentage body fat components and measures were taken at baseline and after one year to assess change in physical fitness. In addition a self report questionnaire was used to assess leisure time kilocalories.

Reed and Wilson (2006; after measures only (3+)) evaluated students' awareness and usage of a newly built recreational trail on a university campus in the South East region of the USA. The recreational trail was built in spring 2003 and impact was assessed via an on-line questionnaire, completed by students in autumn 2003 (n= 467; response rate 17.5%) to determine awareness, use, the types of activities that were undertaken on the trail, and the intensity of the activity.

## *3.2. Evidence of efficacy*

One (1+) cluster RCT reported long-term outcomes of a multiple risk factor workplace intervention which involved changes to the workplace such as allocating space for exercise equipment, purchasing new equipment for exercise rooms and painting measured distance lines around the worksite to promote lunch-time walking (Emmons et al., 1999). In addition all intervention worksites had an employee advisory board which met at least once a month and a worksite coordinator (Emmons et al., 1999). Pooled analyses of all employees from the 11 intervention worksites showed a significantly higher proportion of employees were likely to report engaging in regular exercise at 1 ¼ years compared with the 11 control worksites ($p<0.001$). Furthermore at the final assessment point at 2 ½ years employees in the intervention workplaces were significantly more likely to report engaging in regular exercise (51.2%) compared with employees in the control workplaces (41.1%) ($p<0.03$).

Three studies (one (2+) quality, one (2-) quality and one (3+) quality) reported short-term physical activity outcomes. One (2+) controlled before and after study found a self reported increase in the proportion of vigorously active students (from 21% to 41%) after an 8 week physical activity intervention involving changes to an existing exercise facility which included painting walls and laying new carpet (Leslie et al., 2000). One (2-) controlled before and after study, Linenger et al., (1991) found that at 1 year there was no significant change in leisure-time kilocalorie expenditure (baseline 4140 kcal per week, follow-up 3864 kcal per week) following an intervention on a naval base in the USA which included building bicycle paths along road ways, providing new exercise equipment at gyms, opening a women's fitness centre and marking 1.5 mile running courses at various sites. The authors also reported change in various physical fitness outcomes (such as 1.5 mile run time, number of sit-ups and push-ups, and physical readiness test (PRT)) and results showed significant improvements in all these variables within the intervention group. However, for the purpose of this review, the primary physical activity outcome measure used was leisure-time kilocalorie expenditure rather than PRT score because this

outcome reflects the potential impact of the environmental changes on volitional physical activity. Moreover, the PRT score would likely be influenced by the active nature and training undertaken as part of the participants' occupation; this would likely be a confounding factor.

One (3+) quality study Reed and Wilson found that following the opening of a new recreation trail built on a university campus, 91% of students completing an online survey were aware of the trail and 73% of these students used the trail. Of this 73%, 79% reported using the trail in the past month, 67% reported using the trail in the last week. Whilst on the trail 52% reported engaging in activities other than walking. Of this 52%, 45% reported jogging or running and 18% reported biking. 17% of students reported engaging in vigorous activities over the previous week and 43% reported engaging in moderate intensity physical activity. No measure of change in activity was reported for any outcomes and no indication of significance was presented.

**The evidence from three studies, one (1+), one (2+) quality, and one (2-) quality , suggests that interventions that include changes to the built environment of a worksite may lead to both short- and long-term changes in levels of physical activity (Emmons et al., 1999; Leslie et al., 2000; Linenger et al., 1991).**

## *Key questions*

### *3.2.1. What is the aim/objective of the intervention?*

All four studies included in this section assessed the impact of a change to the physical workplace environment. Two studies aimed to change the environment of a university campus in order to increase physical activity levels; a recreational trail was introduced in one study (Reed and Wilson, 2006), whilst improvements to existing exercise facilities, such as painting an existing weight room and adding new carpets, were completed in the other (Leslie et al., 2000).

One study (Emmons et al., 1999) tested a multiple risk-factor workplace intervention which aimed to promote healthier behaviours, such as increasing physical activity levels, eating a healthy diet and encouraging smoking cessation. Initially 26 worksites were involved, however 4 worksites were dropped during the intervention period leaving 22 worksites and a total of 2291 employees; 11 intervention and 11 control worksites. Environmental changes to the workplaces included allocating space for exercise equipment, the provision of new equipment to enhance existing exercise rooms and a painting a measured distance line around the worksite to encourage walking during lunch breaks.

In the study by Linenger et al., (1991) an environmental and social change intervention was delivered in order to facilitate more active lifestyles in active duty personnel based at a US naval air station. The environmental modifications included building bicycle paths along road ways, marking 1.5 mile run courses at various sites and opening a women's fitness centre.

### *3.2.2. How does the content of the intervention influence effectiveness?*

In two of the four studies the environmental alterations to the workplace setting were included as part of a wider physical activity/ health promotion programme and involved improvement in access and quality of facilities (Emmons et al., 1999; 1+ ; Leslie et al., 2000; 2+). Both intervention programmes resulted in an increase in physical activity.

In three studies alterations were made to the surrounding workplace environment to encourage walking, cycling or running. Two studies introduced new trails which resulted in an increase in self-reported physical activity (Emmons et al., 1999; 1+) and an increase in trail use (Reed and Wilson, 2006; 3+). One study built bicycle paths and 1.5 mile running courses, however the results of this study found no change in leisure-time energy expenditure (Linenger et al., 1991; 2-).

New equipment for existing facilities was purchased in two of the studies (Emmons et al., 1999; 1+; Linenger et al., 1991; 2-). Emmons et al., (1999) report an increase in the likelihood of intervention participants to engage in

regular exercise, whereas there was no change in leisure-time energy expenditure in the study by Linenger et al., (1991).

**From this set of 4 studies conducted in diverse settings and involving different worksites and different interventions, it is difficult to interpret any clear trends on how the content of the intervention may have influenced effectiveness. It does appear, however, that the provision of facilities or trails for walking, jogging or cycling, and improvements to existing or provision of new facilities (such as new space, improved equipment, or improved aesthetics [painting, carpet]) may lead to increases in use and or levels of physical activity (Emmons et al., 1999; Leslie et al., 2000; Linenger et al., 1991; Reed and Wilson, 2006).**

### *3.2.3. How does the way that the intervention is carried out influence effectiveness?*

There is insufficient evidence available to make any conclusions about the way in which the intervention is carried out and effectiveness.

### *3.2.4. Does the effectiveness depend on the job title/position of the deliverer?*

None of the papers provided data addressing this question. Therefore, there is insufficient evidence to make clear inferences about the impact of the job title/position of the deliverer of the intervention.

### *3.2.5. Does the site/setting of delivery of the intervention influence effectiveness?*

The setting varied between the four studies. Two studies were conducted in university campuses, one in the USA (Reed and Wilson, 2006) and one in Australia (Leslie et al., 2000). One study was based across a number of workplaces in USA (Emmons et al., 1999) and one in a USA naval air station (Linenger et al., 1991).

Increases in physical activity and trail use were seen in the university and workplace-based interventions. No change in self reported energy expenditure was observed in the study based at a naval air station (Linenger et al., 1991). Overall, there is insufficient evidence to make clear inferences about the impact of the setting on the intervention.

### *3.2.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?*

The four included studies detail interventions that lasted from 8-weeks, to several months, to 1-year and 2 ½ years to implement. The follow-up measurements were typically completed at the end of the intervention period, with the exception of one study where it was several months later (Reed and Wilson, 2006).

Due to the variation in the length of the intervention among the four studies and the difference in follow-up periods, there is insufficient evidence to make any conclusions about the intensity (or length) of the intervention and the impact.

### *3.2.7. How does the effectiveness vary with age, gender, class, ethnicity etc?*

None of the papers provided data addressing this question. Therefore, there is insufficient evidence to make clear inferences about the impact of the intervention by age, gender, class or ethnicity.

Two studies however specifically targeted young adults based on university campuses (Leslie et al., 2000; Reed and Wilson, 2006). The remaining two studies targeted adult employees in the workplace (Emmons et al., 1999) and employees in a naval air station (Linenger et al., 1991).

### *3.2.8. What are the barriers to implementation?*

There was insufficient evidence from the studies to make clear inferences about barriers to implementation.

### *3.2.9. What are the non-physical activity outcomes of the intervention?*

Three of the four studies presented non-physical activity outcome data. One study implemented a multiple risk-factor health promotion programme and reported nutrition and smoking related outcomes (Emmons et al., 1999), however these measures are outside the scope of this review.

One study including environmental changes as part of a physical activity programme reported on the awareness of physical activity facilities and/ or programmes as a result of the programme (Leslie et al., 2000). An increase in the percentage of students who were correctly aware of the programmes/ facility existence was found and the awareness of the walking/ running track increased by 48%, although no changes were made to the track.

## *3.3. Implementability of intervention.*

Three of the four studies included in this section would be highly feasible to implement in UK workplaces settings and university campuses with appropriate political, public and employee support and the necessary resources for the capital investment. The study by Linenger et al (1991) would require some modifications or adaptations if it were to be implemented in a general workplace population rather than a military-base.

**Workplaces summary evidence statement:**

**The evidence from three studies, one (1+), one (2+) quality, and one (2-) quality , suggests that interventions that include changes to the built environment of a worksite may lead to both short- and long-term changes in levels of physical activity (Emmons et al., 1999; Leslie et al., 2000; Linenger et al., 1991).**

**From this set of 4 studies conducted in diverse settings and involving different worksites and different interventions, it is difficult to interpret any clear trends on how the content of the intervention may have influenced effectiveness. It does appear, however, that the provision of facilities or**

**trails for walking, jogging or cycling, and improvements to existing or provision of new facilities (such as new space, improved equipment, or improved aesthetics [painting, carpet]) may lead to increases in use and or levels of physical activity (Emmons et al., 1999; Leslie et al., 2000; Linenger et al., 1991; Reed and Wilson, 2006).**

# 4. Stairwells

## *4.1. The studies*

This section includes studies that implemented an intervention aimed at encouraging the use of stairs, rather than the lift (elevator), to travel between floors within buildings. Interventions were considered for inclusion if they involved a change to the physical environment of a stairwell, for example, painting the stairwell, installing new carpet, adding artwork, relocating the stairwell and changing the height of the steps. Studies were not included if the intervention *only* included the provision of informational signs and/ or motivational prompts placed at the point of decision. These are regarded as educational/ behavioural interventions providing information and are not the focus of this review.

Two, (2+) quality before and after studies, both based in the USA, provide evidence for the effectiveness of changes to the physical environment of stairwells in increasing stair usage.

Boutelle et al., (2001; interrupted time series (2+)) evaluated the efficacy of two sequential interventions, each lasting 4 weeks to increase stair usage within a workplace building in the USA. The intervention components included (i) signage alone, followed by (ii) changing the physical environment by adding music and artwork. Stair and elevator use was observed throughout each 4-week intervention period on 3 days of each week for 3 hours per day. The percentage

of people using the stairs during each 4-week intervention period and the 3-week baseline period were compared.

Kerr et al., (2004; interrupted time series (2+)) assessed the impact of four sequential environmental interventions on stair use within a workplace building in the USA. The 4 interventions included; (i) installing new carpet and painting the stairwells, (ii) adding framed artwork, (iii) displaying motivational signage, and (iv) playing music in the stairwell. These interventions were implemented at months 0, 2, 11 and 36, respectively. Once an intervention was implemented it remained in place throughout the rest of the 3 ½ year intervention period. Using infrared beam sensors stairwell usage was assessed at two time periods for each intervention; 1-3 months and >3months. Results are presented as mean trips per day and percentage change between interventions.

## *4.2. Evidence of efficacy*

Two (2+) studies reported short-term outcomes (Boutelle et al., 2001; Kerr et al., 2004). One study observed stairwell usage during two, 4-week intervention periods; the first 4-week intervention period comprised only the provision of stair signage, the second 4-week intervention involved adding artwork and music (Boutelle et al., 2001). No significant increase in the percentage of people using the stairs was found between baseline (11.1% of people) and the signage only intervention (12.7% of people) but there was a significant increase in usage between the first intervention (signage only; 12.7% of people) and the second intervention involving the physical changes of adding art-work and music (15.5% of people; $p<0.01$). Furthermore, this study reported a significant increase in stair use between baseline (11.1% of people) and the music-artwork intervention (15.5% of people) ($p<0.01$). During the 4-week follow-up period (weeks 8-12), after the implementation of both signage, and music and artwork, a significant increase in stairwell usage was observed compared to baseline (signage plus artwork and music, 13.8% of people; baseline, 11.1% of people) ($p<0.01$).

One (2+) quality study assessed stairwell usage over a 3 year period, during which time four interventions were sequentially implemented (Kerr et al., 2004).

The physical changes to the built environment were the installation of new carpet and painting the stairwell at 0 months and subsequently the addition of artwork at 2 months. After the first phase of the intervention (new carpet and paint) had been in place for 2 months a non significant decrease in mean trips per day was found when compared with baseline (0.5% decrease). The artwork intervention was implemented at 2 months, and over the next 9 months resulted in a non significant increase in mean trips per day from baseline (3.7% increase). Phase 3 (signage) and phase 4 (music) were added at months 11 and 36 from baseline respectively and mean trips per day was assessed. During the period >39 weeks from baseline, after all interventions had been in place for at least 3 months a significant increase (8.9%) in mean steps per day revealed when compared to baseline (baseline 2.14 trips per day; >3months post all interventions being in place 2.33 trips per day) ($p<0.05$). The final result at >39 months reflects the long-term change possibly due to the physical changes implemented (new carpet, paint and artwork) but this effect may also be due to the signs and music. We can not determine which component of the multi component intervention contributed to the significant change seen >39 months.

**The evidence from two (2+) quality studies aimed at improving the physical environment of a stairwell by physical improvements such as carpets, painting and addition of art work may lead to increases in stairwell usage in the short-term (Boutelle et al., 2001, Kerr et al., 2004).**

## *Key questions*

### *4.2.1. What is the aim/objective of the intervention?*

Both interventions aimed to increase use of the stairwell through physical improvements of the stairwell environment such as by the provision of carpet, artwork and music. Both interventions used an additional component of adding signage. This strategy is a 'point-of-decision' method and directs individuals to the choice between using the stairs and the elevator. In one study 2 sequential interventions were delivered, each over a 4-week period; signage alone followed by signage plus artwork and music (Boutelle et al., 2001). The second study

implemented 4 sequential interventions; new carpet and paint, framed artwork, signage, and lastly the addition of music (Kerr et al., 2004).

### *4.2.2. How does the content of the intervention influence effectiveness?*

Boutelle et al., (2001) implemented 2 sequential interventions each over a 4-week period; signage alone followed by signage plus artwork and music. The signage intervention included a free-standing floor sign that was placed at the decision point for the stair and elevator, and signs were placed over all of the elevator buttons and on all stairwell doors in the building. During the second intervention phase, the signage remained in place and artwork and music were added to the stairwell. The artwork that hung on the stairwell walls was changed every week and the music was changed daily. As signage was present throughout both intervention phases it is possible that the increase in stair use observed during the second 4-week intervention phase was a delayed response to the first intervention phase. However it is more likely that the increase in usage was due to the addition of artwork and music. Moreover it is possible that the music played during the artwork and music intervention was responsible for the increase in stair use rather that the artwork, but it is not possible to differentiate between the effect of the music and that of the artwork alone. In addition, it is not possible to discern whether it was the aesthetic appeal of the music and artwork or the novelty of the intervention that influenced stair usage.

The second study implemented 4 sequential interventions (Kerr et al., 2004); initially only new carpet and paint was installed (Oct 1998) which was followed 2 months later by the addition of framed artwork (Dec 1998), signage was added a further 9 months later (Sept 1999) and lastly, music was added 25 months later (Oct 2001). Once an intervention was in place it remained in place for the rest of the 3 ½ year intervention period. The physical changes to the built environment were the installation of new carpet and painting the stairwell at 0 months and subsequently the addition of artwork at 2 months. Following the installation of new carpet and paint stair use fell by 0.5% when compared with baseline, however following the addition of artwork at 2 months an overall increase of 4.2%

was observed during the subsequent 9 month data collection period compared to the previous intervention, although this was not significant. The addition of motivational signs and music appeared to be associated with modest increases in stairwell use compared to the previous intervention of 0.5% and 0.4% respectively. However, because the interventions were not independent and the mean stair trips per person each day were more or less equivalent for the artwork, signs and music interventions it is not possible to identify whether one specific intervention or a combination of all three interventions influenced people to use the stairs. Nor is it possible, given the study designs to differentiate the individual effect of individual components of the interventions.

**The evidence from two (2+) quality studies aimed at improving the physical environment of a stairwell by physical improvements such as carpets, painting and addition of art work may lead to increases in stairwell usage in the short-term (Boutelle et al., 2001, Kerr et al., 2004).**

### *4.2.3. How does the way that the intervention is carried out influence effectiveness?*

Both studies implemented sequential interventions with more than one change being in place during periods of the intervention. Boutelle et al., (2001) implemented signs followed by artwork and music, whereas Kerr et al., (2004) installed new carpet and paint followed by the addition of artwork then signs which were followed by music. However, there is insufficient evidence available to make any conclusions about the way in which the intervention is carried out and effectiveness.

### *4.2.4. Does the effectiveness depend on the job title/position of the deliverer?*

Neither of the 2 included studies provided data addressing this question. Therefore, there is insufficient evidence to make clear inferences about the impact of the job title/position of the deliverer of the intervention.

### *4.2.5. Does the site/setting of delivery of the intervention influence effectiveness?*

Both interventions were conducted in workplace buildings based in the USA. Boutelle et al., (2001) conducted the intervention in a School of Public Health building based within a University. Similarly, Kerr et al., (2004) implemented an intervention in a building which provides office space for a public health related organisation, the National Centre for Chronic Disease Prevention and Health Promotion. Therefore, employees may have been more aware of the health benefits of being active and the contribution that stair climbing can make to physical activity.

Both studies were conducted in the USA, however the interventions described are potentially applicable to similar settings in the UK.

There is insufficient evidence to make clear conclusions about the impact of the specific setting on the effectiveness of the intervention.

### *4.2.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?*

One intervention took place over an 8 week period (Boutelle at al., 2001) and the other over a 3 ½ year period (Kerr et al., 2004). Due to the possibility that environmental interventions such as prompts to use stairwells may have their strongest effects when the intervention is new, Kerr et al., assessed the effect of each intervention element (e.g., carpet, paint, artwork and music) over 2 time periods: <3 months and >3 months after implementation. No significant changes were reported for the artwork intervention during either time period, however, following the implementation of all intervention components a significant increase is stair use was found during the period >3 months after implementation but not < 3months. The design of this study makes it difficult to discern the impact of each individual component, furthermore, the impact may be delayed as it takes some time for the change to influence use. It is quite plausible that the benefit of incremental improvements to the stairwell environment are cumulative and

therefore these types of interventions require sustained evaluation over the longer-term.

#### *4.2.7. How does the effectiveness vary with age, gender, class, ethnicity etc?*

Neither study presented overall results looking at the effect of the intervention on stair use by socio-demographic characteristics. However, across the observation period, one study noted that women (mean 13.7%) were significantly more likely to use the stairs than were men (mean 12.71%) (p=0.04) (Boutelle et al., 2001).

#### *4.2.8. What are the barriers to implementation?*

There was no data presented in any study to make any conclusions about barriers to implementation.

#### *4.2.9. What are the non-physical activity outcomes of the intervention?*

Neither study reported data on non-physical activity outcomes.

### *4.3. Implementability of intervention.*

Both of these studies would be feasible to implement in the UK with appropriate support. Some adaptations may be necessary to reflect differing preferences, for example the type of artwork displayed or the colour of paint.

**Stairwells summary evidence statement:**

**The evidence from two (2+) quality studies aimed at improving the physical environment of a stairwell by physical improvements such as carpets, painting and addition of art work may lead to increases in stairwell usage in the short-term (Boutelle et al., 2001, Kerr et al., 2004).**

# 5. School playgrounds

## *5.1. The studies*

This section includes studies reporting on interventions involving a change to the physical environment of school playgrounds.

A total of three studies, one (1++) quality randomised controlled trial and two (2++) quality controlled before and after studies were identified that provide evidence on the effectiveness of changes to the school playground environment to increase physical activity levels. All three studies were conducted in the UK.

Stratton and Leonard (2002; RCT (1++)) examined the effect of a painting a school ground with fluorescent markings upon the energy expenditure of children aged 5-7 years. Heart rate was assessed using a heart rate monitor and used to calculate energy expenditure.

Stratton (2000; controlled before and after (2++)) investigated the effects of painting a school playground with bright and colourful markings on the moderate-vigorous physical activity levels of primary school children, which was estimated using heart rate monitors.

Stratton and Mullan (2005; controlled before and after (2++)) examined whether painting playgrounds with multicolour markings would increase the percent of playtime time spent in moderate to vigorous physical activity and vigorous physical activity in girls and boys. Heart rate was assessed using heart rate monitors, to estimate time spent in moderate-vigorous physical activity and vigorous physical activity.

## *5.2. Evidence of efficacy*

One (1++) quality study (Stratton and Leonard, 2002) and two (2++) quality studies reported short-term outcomes (Stratton, 2000: Stratton and Mullan, 2005). All studies were conducted in the UK and each collected data during a 4-week baseline period and during a 4-week intervention period immediately post changes made to a school playground. Two studies reported change in

moderate-vigorous physical activity (MVPA) and vigorous physical activity (VPA) during playtimes (Stratton 2000, Stratton and Mullan 2005).

Stratton (2000) found the percentage of time spent in MVPA during playtime increased significantly in the intervention school (intervention: before 35.1%, after 46.2%; control: before 40.5%, after 39.1%) compared to a non significant reduction in the control school ($p<0.05$). The percentage of time spent in VPA during playtime almost doubled following painting the playground in the intervention school compared to a very small decrease in the control school (intervention; before 5.3%, after 10.0%; control: before 7.0%, after 6.8%). After adjusting for the duration children spent in playtime, these significant interactions (between group and time) remained ($p<0.01$).

Stratton and Mullan (2005) found the amount of MVPA during playtime increased significantly in the intervention group of schools (from 36.7% to 50.3%) compared to a decrease in the control group of schools (39.9% to 33.4%) ($p<0.01$) and the amount of VPA during playtime increased in the intervention group of schools (7.9% to 12.4%) compared to no change in the control group of schools (8.0% to 8.0%) ($p<0$ 03).

The third study (Stratton and Leonard, 2002) reported change in mean heart rate, rate of energy expenditure and total energy expenditure and found that each of these three variables increased significantly after the playground was painted when compared to the control school. Data comparing change between control and intervention groups before and after the intervention were not presented for any of these variables.

**The evidence from three studies (one (1++) RCT and two (2++) controlled before and after studies) suggests that colourful/fluorescent markings painted on a school playground can lead to objectively assessed increases in variables related to physical activity during playtime, such as time spent in moderate-vigorous physical activity, time spent in vigorous activity and**

**total energy expenditure during play, in the short-term (Stratton and Leonard, 2002; Stratton, 2000; Stratton and Mullan, 2005).**

## *Key questions*

### *5.2.1. What is the aim/objective of the intervention?*

All studies aimed to assess the impact of painting a school playground with multicolour/ fluorescent makings on variables related to physical activity (Stratton, 2000; Stratton and Leonard, 2002; Stratton and Mullan, 2005).

### *5.2.2. How does the content of the intervention influence effectiveness?*

All studies involved children in the intervention school designing a series of 10 markings that were painted in bright fluorescent colours on the tar macadam playground surface; a castle, dragon, clock face, flower maze, fun trail and dens, hopscotch, letter squares, snakes and ladders and a circular maze were evenly spaced throughout the playground area (Stratton, 2000; Stratton and Leonard, 2002; Stratton and Mullan, 2005).

In two schools the playground markings were linked to the school curriculum (Stratton 2000, Stratton and Leonard 2002) although this was not reported to influence the results. In addition these two studies allowed intervention schools to provide 1 ball in the playground and the control schools were allowed limited equipment in the playground.

One study involved 4 intervention schools which were matched to 4 control schools, and included ‘late primary schools’. These late primary schools included additional markings for netball, football and short tennis to target games related skills (Stratton and Mullan, 2005). Control schools had no playground makings but small pieces of sports equipment such as skipping ropes and footballs were prevalent in all school playgrounds.

Overall, these three similar interventions, one (1++) quality study and two (2++) quality studies, appear to increase physical activity related outcomes and tend to

suggest that painting colourful/fluorescent markings on a school playground can increase children's levels of physical activity.

### *5.2.3. How does the way that the intervention is carried out influence effectiveness?*

In two studies the children using the playgrounds were involved in designing the markings that were painted (Stratton 2000, Stratton and Leonard 2002). In addition to painting bright fluorescent colours, one study included playground markings to target games related skills in 'late primary schools' and also employed 2 supervisors in each school playground who were not informed of the aims of the investigation, neither were they trained in promoting physically active behaviour (Stratton and Mullan, 2005). In one study the playgrounds of 4 intervention schools were marked during the summer vacation (Stratton and Mullan, 2005) although this detail was not presented in the other 2 studies.

There are insufficient differences between these interventions to make any conclusions about the way in which the intervention is carried out and effectiveness.

### *5.2.4. Does the effectiveness depend on the job title/position of the deliverer?*

Minimal data was available on the job title/ position of the deliverer in any study; therefore, there is insufficient evidence to make conclusions about the impact of the job title/position of the deliverer of the intervention.

### *5.2.5. Does the site/setting of delivery of the intervention influence effectiveness?*

All three studies were conducted in school playgrounds in the UK. One study included 4 schools from areas of deprivation in Northwest Wales which were matched on playground dimension and socio-economic status with 4 schools from Northwest Wales (Stratton and Mullan, 2005). Two interventions studied the same basic population from 2 schools situated in an urban industrialised area in Northwest England (Stratton, 2000; Stratton and Leonard, 2002).

There is insufficient evidence to make conclusions about the impact of the specific setting on the intervention.

### *5.2.6. Does the intensity (or length) of the intervention influence effectiveness/duration of effect?*

All three studies were conducted over an 8-week period and collected baseline data during a 4-week period prior to the intervention and then during the 4-week intervention period immediately following the changes being made to the school playground.

The evidence from 3 studies suggests that playground makings can affect physical activity in the short term but there is no evidence available to assess the effect of school playground markings on physical activity beyond 4 weeks post implementation.

### *5.2.7. How does the effectiveness vary with age, gender, class, ethnicity etc?*

One study combined data for girls and boys to increase statistical power and therefore did not present any results by gender (Stratton, 2000). One study found no significant interactions by age or gender for moderate-vigorous physical activity (boys: before 40.6%, after 44.8%; girls: before 35.2%, after 39.8%) or vigorous physical activity (boys: before 9.8%, after 12.6%; girls: before 5.9%, after 7.9%) (Stratton and Mullan, 2005). The third study reported almost identical time spent in daily playtime for boys and girls at about 84 minutes. However, mean heart rate was higher in boys (130.9 bpm) than girls (127.7 bpm), boys rates of energy expenditure results were 22% higher than girls and total energy expenditure during play was 23% higher in boys compared to girls (Stratton and Leonard, 2002).

There is insufficient evidence to assess any differential effect of the interventions by socio-demographic or cultural factors.

#### *5.2.8. What are the barriers to implementation?*

There was no data presented in any study to make any conclusions about barriers to implementation.

#### *5.2.9. What are the non-physical activity outcomes of the intervention?*

None of the studies reported data on non-physical activity outcomes.

### *5.3. Implementability of intervention.*

All of these studies were implemented in the UK. Some adaptations may be necessary to reflect differing preferences and the needs of children of different ages, for example the type of images/ designs painted or colours used.

**School playgrounds summary evidence statement:**

**The evidence from three studies (one (1++) RCT and two (2++) controlled before and after studies) suggests that colourful/fluorescent markings painted on a school playground can lead to objectively assessed increases in variables related to physical activity during playtime, such as time spent in moderate-vigorous physical activity, time spent in vigorous activity and total energy expenditure during play, in the short-term (Stratton and Leonard, 2002; Stratton, 2000; Stratton and Mullan, 2005). However, there is no evidence available to assess the effect of school playground markings on physical activity beyond 4 weeks post implementation.**

## 6. School classrooms

### *6.1. The studies*

This section includes studies that involve a change to the built environment within a school building and classrooms. For example, this would include modifications to exiting facilities or the provision of new facilities, changing the spatial-configuration of the classroom and installing new furniture.

One study (Cardon et al., 2004; after measures only study with a comparison group (2-)) provides evidence for the effectiveness of changes to the built environment inside school buildings. 'Moving School' was a school based intervention, with post-intervention data only, undertaken in one school based in Germany. A no intervention school in Belgium was chosen as a control group. The intervention involved equipping a classroom with ergonomic furniture allowing varying working postures and movement called 'dynamic sitting'. The classroom had a stand-at-desk, tables with inclinable tops and the room was reorganised to make more floor space available for variations on the working routine. The control school was randomly selected from a representative sample of traditional elementary schools in Flanders, Belgium, where it was found that very few teachers implement any of the principles of a 'Moving School' and no changes were made to classroom furniture. Outcomes were assessed by observations and accelerometer counts; pupils were filmed during 30 minutes of a language or mathematics lesson and the films were analysed for different postures and activities. In addition, to obtain objective information about physical activity levels during lessons children wore accelerometers during the lessons of one morning.

## *6.2. Evidence of efficacy*

One (2-) study met the inclusion criteria that detailed an intervention involving a change to the built environment within school classrooms. This study (Cardon et al., 2004) found that children attending the intervention school spent a larger amount of time in dynamic sitting (intervention 53.11, comparison 3.25), standing (30.63 intervention, 2.42 comparison) and walking (intervention 10.47, comparison 1.75) in the 'moving school' compared to the comparison school. Children from the 'moving school' were significantly more active than children in the comparison school (538 counts per minute compared to134 counts per minute) ($p<0.001$).

Based on one (2-) quality after measures only study there is insufficient evidence to draw any conclusions on the effect of interventions aimed at assessing change

to the built environment within school classrooms. It is therefore not possible to identify any features potentially related to effectiveness in terms of the intervention content, delivery, setting or intensity, nor can any statements be made about any potential differential impact for specific socio-demographic groups or cultural factors. No conclusions can be made regarding the applicability or implementability of this type of intervention.

**Based on one (2-) post only study with a comparison school, there is insufficient evidence to make any overall conclusions about effectiveness but the evidence available suggests that equipping a classroom with ergonomic furniture, changing classroom layout and modified teaching styles may be associated with increases in physical activity during the school day.**

# Evidence Tables

| Category | Author and Date | Study design and research type/ quality | Research question | Study population, setting, country, sample size | Description of intervention | Length of follow-up | Physical activity outcome variables (inc measures) | Short term findings (<1 year) | Long term findings (>1 year) | Non-physical activity outcomes | Confounders/ potential sources of bias | Applicability to the UK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Worksite** | Emmons et al (1999). | Cluster Randomised Controlled Trial (1+) | Does a multiple risk factor intervention (Working Healthy Project) delivered at the worksite lead to changes in behaviour? | The Working Healthy Project involved 26 worksites in Rhode Island, Massachusetts, USA, with an average of 337 employees per worksite.<br><br>Worksites were randomised, stratified after completion of baseline measures and matched into pairs, followed by random assignment of worksites within pairs to the intervention or control group.<br><br>4 worksites were dropped during the intervention period, therefore leaving 22 worksites.<br>Total n=2291 (Intervention = 11, Control = 11) | Within each intervention worksite an employee advisory board (EAB) was set up and they met at least once per month. In addition, each intervention site had a worksite coordinator.<br>Within the intervention group, the worksites conducted an assessment of current physical activity options for employees (space, showers, equipment, discounts on memberships etc).<br>Following recommendations from the assessment, the following environmental interventions were introduced:<br>• the allocation of space for exercise equipment<br>• the purchase of new equipment for existing exercise rooms,<br>• a measured distance line was painted around the plant to promote lunch-time walking. | At end of intervention period. This was 2.5 years from baseline measures. | The primary outcome for physical activity was self-reported participation in regular exercise (3x20mins or more per week, defined by the American College of Sports Medicine). This was measured through a survey at baseline, interim (1.25 years) and at the end of the intervention (2.5years). | None reported | Subjects in the intervention group were significantly more likely to report engaging in regular exercise at the interim assessment compared with subjects from the control group ($p<0.001$).<br><br>Subjects in the intervention group were significantly more likely to report engaging in regular exercise (51.2%) at the final assessment, compared with subjects in the control condition (41.1%) ($p<0.03$). | None reported | No detail whether the self-report tool was validated. Details of the survey administration process are not reported in this paper. They are detailed in another reference. More men in the intervention compared to the control ($p<0.0005$). | Yes |
| | Leslie et al (2000) | Controlled before and after study. (2+) | Does a settings-based PA programme impact on university student's PA levels? | 2 university campuses in Australia were selected in order to target university students. One site received the intervention whilst the second acted as a comparison site.<br><br>The total number of students receiving the intervention was not reported.<br><br>The total number of respondents to the | This is a controlled before and after study design. A pre and post programme survey was conducted in 2 university programme sites. In one campus a PA programme was introduced. A post programme survey was used to determine the effects on PA levels.<br><br>A PA programme was carried out on one campus as a demonstration project to assess whether it could be practically implemented.<br><br>Activities were designed using results from the pre-programme survey data. The programme was marketed and promoted through student publications, newsletters, | At end of intervention – 8 weeks from baseline survey. | A self-report survey was used to determine leisure time PA levels.<br><br>Two surveys were conducted: one at baseline and another at the end of the intervention period. | There was a significant increase in the proportion of vigorously active students (from 21% to 41%) at the intervention campus only ($p<0.001$).<br><br>Respondents at the intervention campus were more likely to be sufficiently active for long-term health benefits (i.e. expending more than 800 kcal/wk) following the intervention and were less likely to be | None reported | **Awareness of PA facilities/ programmes**<br><br>For those facilities actually available, the % of students who were aware of their existence increased by an average of 29% at the intervention campus.<br><br>Awareness of the existing running/ walking track increased by 48%.<br><br>51% of students on | Not clear what survey was used and whether PA questions were based on a validated measure. | Yes |

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| | | | | baseline or follow-up survey was not reported.<br><br>Baseline survey response rate; intervention 48% control 58%.<br><br>Follow-up survey response rates; intervention 77% control 81%. | and flyers. Information pamphlets about PA were also created and distributed across the campus.<br><br>Access to nearby community PA facilities was promoted and incentive schemes were introduced.<br><br>Demonstrations and displays for various activities were also demonstrated on campus.<br><br>Some modest environmental changes to the existing building were implemented. This included;<br>• A new carpet was laid in the weights/aerobics room; and<br>• The weights room's walls were painted to make the room more attractive and brighter. | | | sedentary than the respondents at the comparison campus site (p<0.001).<br><br>A significantly greater proportion of respondents at the control campus were insufficiently active (p<0.001). | | the intervention campus indicated that they were aware of the programme.<br><br>No data was presented on awareness on at the control campus. | | |
| | Linenger et al (1991) | Controlled before and after study (2-) | Does a simple environmental/ social change programme facilitate a more active lifestyle and enable community members to adopt more easily active lifestyles? | The study population was active duty military personnel, whose worksite was a naval air station in San Diego, California, USA.<br><br>At outset the number of participants was 3402. | Involved 3 cohorts; (1) intervention community which was a naval base that underwent changes (2) control community which was a naval base that underwent no change (3) navy-wide sample<br><br>The intervention proceeded in the following stages: 1) Physical readiness test; 2) Intervention community underwent changes; and 3) Physical readiness test, 1 year later.<br><br>Note, the physical readiness test (PRT) is a mandatory semiannual requirement for all naval personnel and individuals cannot refuse this testing. The PRT consisted of a 1.5-mile timed run, sit-ups, push-ups, and percentage body fat components.<br><br>The community intervention sample received intervention which included specific environmental interventions;<br>• Bicycle paths built along road ways<br>• New exercise equipment at gyms<br>• 1.5 mile run courses marked at various sites<br>• Women's fitness centre opened | 1 year post baseline | Primary physical activity outcome:<br>Leisure-time Kilocalories expended, assessed by a self-report questionnaire. | **Leisure time Kilocalories expended**<br>Total kcals expended per week did not change significantly in any group.<br>Intervention group;<br>Baseline 4140 kcals/week<br>Follow-up 3864kcals/week | None reported | **Physical fitness changes at 1 year**<br>Within the intervention community there were statistically significant changes from baseline to 1 year follow-up (p<0.05);<br>• 1.5 mile run time (mean of 18 second improvement from baseline)<br>• sit-ups (+2.5)<br>• push ups (+1.9)<br><br>These changes were significantly greater than in the control communities (p<0.01).<br><br>**Questionnaire responses**<br>Intervention community – both personal perceptions of the importance of fitness and perceived utility of exercise dropped significantly from baseline.<br>None of the scales showed significant improvement over time.<br>When compared to the control group the intervention community significantly increased their knowledge of | Other training in which personnel engaged is not reported and may have affected fitness.<br><br>Individuals could not refuse the physical readiness test. | Somewh at |

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| | | | | | | | | | | 'opportunity for exercise' (increased 0.6 points on the scale compared to a 2.6 point drop at control 1 and no change at the navy-wide control). | | |
| | Reed & Wilson (2006) | Intervention with post-only data. (3+) | Does a newly built university recreational trail result in an increase in trail use and awareness? | 467 of 2654 college students, based at a college/university campus in South East USA, responded to the questionnaire. | Student's use of a recently built recreational trail (Spring 2003) in a university campus was assessed. A questionnaire was located on the university intranet. Students were alerted to this questionnaire by fliers placed in their mail boxes drawing their attention to the survey. | Trail was built in Spring 2003 and Questionnaires were completed in Fall 2003 (<1y). | Awareness of the trail, the percentage of students using the trail, frequency of use and activities engaged in on the trail and intensity of activity were measured using a modified version of a validated questionnaire, the National College Health Risk Behaviour Survey.<br><br>This was completed after the trail was built. | Of 91% of students who were aware of the trail 73% reported using the trail. Of this 73%;<br><br>**Percentage of students using the trail and frequency of use**<br>79% reported using the trail between 1 and 5 times in the last month.<br>67% reported using the trail in the last week.<br>Close to 8% reported using the trail between 6 and 10 times, 2.8% reported between 11 and 15 times and 3% reported more than 15 times in the past month.<br><br>**Activities engaged in on the trail**<br>52% reported engaging in activities other than walking on the trail. Of the 52%; 45% jogging or running, 18% reported biking.<br><br>**Intensity of activity**<br>17% of students reported engaging in vigorous activities over the last week and 43% reported engaging in moderate intensity physical activity. | None reported | None reported | The study did not have pre-intervention measures, or use a no-intervention control site for comparison. Therefore no change data on the effect of the intervention on physical activity levels was presented. | Somewh at |
| **Stairwell** | Kerr et al., (2004) | Before and after study (2+) | To assess the impact of four sequential environmental interventions on stair use. | Employees in their workplace, USA. n = 663 | Four passive interventions were implemented throughout a 3 year period;<br>1. New carpet installed and stairwells were painted<br>2. Framed artwork was added<br>3. Motivational signage was displayed<br>4. Various types of music were | 3 years | Stairwell use. Infrared beam sensors.<br><br>Sensors were located on each floor and data were downloaded | The carpet and paint intervention resulted in a non significant decrease in stairwell use from baseline of -0.5%.<br>Overall (combining data from months 0-3 (4.7% increase in use) | None reported | None reported | None reported | Yes |

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| | | | | | added to the stairwell. | | weekly for analysis. The number of stair trips per day was calculated by summing the total stair passages for each floor and dividing by 2. The number of building occupants was measured at several intervals during the study and was used to calculate the rate of stairwell trips per occupant per. | and >3 months (3.3% increase in use), the artwork intervention resulted in a non-significant increase from baseline of 3.7%, Combining all interventions – carpet and paint, artwork, signage and music, resulted in an overall non significant. increase in stairwell use from baseline of 4.7%.<br>When comparing mean daily usage from one intervention to the next no significant increases were found between any intervention periods. (Carpet and paint to artwork 4.2%, artwork to signage 0.5%, signage and music 0.4%).<br>During the period >3 months of the combination of all interventions being in place, there was a significant increase from baseline of 8.9% (p<0.05). | | | | |
| | Boutelle et al., (2001) | Before and after study (2+) | To evaluate the efficacy of an intervention designed to increase the aesthetic attractiveness of a stairwell in addition to providing signs with health messages to increase stair use. | Employees in their workplace, USA.<br>n = approx 700 | 2 interventions were delivered;<br>*Signage*<br>Included a standing up floor sign reading 'take the stairs for your health'. The sign was placed at the decision point for the stair or elevator. The same sign was placed above all of the elevator signs in the building. Signs were also placed in the stairwell doors to identify that the door led to the stair well.<br>*Music and artwork*<br>Signs (above) remained in place, and artwork and music were added in the stairwell. The artwork and that hung on the stairwell walls was changes every week of the 4 week intervention period. A CD player was placed between the 2nd and 3rd floors of the stairwell and repeated music throughout the day. The music was changed daily and could be heard on all floors of the stairwell. | Baseline (3 weeks) followed by 2 intervention periods (4 weeks each) and a follow-up (4 weeks) | Stairwell use.<br>Observation.<br><br>Lift and stair use was directly observed by observers who were inconspicuously located at a decision point at the foot of the stairs and lifts in a lobby area 3 days per week, and 3 hours per day. Observers kept count of the number of people entering and leaving the stairwell and recorded sex and direction of usage. | Significant differences in usage were found between;<br>Baseline (11.1%) and the music-artwork intervention (15.5%) (p<0.01)<br><br>Baseline (11.1%) and follow-up (13.8%) (p<0.01)<br><br>Music-artwork (15.5%) intervention and signs only (12.7%) (p<0.01)<br><br>Music-artwork (15.5%) and follow-up (13.8%) (p<0.01) | None reported | Women (mean 13.7%) were significantly more likely to use the stairs than were men (mean 12.71%) (p=0.04). | None reported | Yes |

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| **School playgrounds** | Stratton and Leonard (2002) | Randomised controlled trial (1++) | To examine the effect of a paining a school ground with fluorescent markings upon the energy expenditure of children aged 5-7 years. | Children attending primary school, UK<br><br>Initial consent to participate<br>n = 60<br>(intervention = 36, Control = 24)<br><br>Final analysis<br>n = 47<br>(intervention = 27, Control = 20) | 1 intervention school and 1 control school were studied in an urbanised area in north west England.<br>Children designed a series of 10 markings that were to be painted in bright fluorescent colours on the tar macadam playground surface; a castle, dragon, pirate ship, clock face, flower maze, fun trail and dens, hopscotch, letter squares, snakes and ladders and circular maze. These markings were linked to 10 themes through which the school delivered its curriculum.<br>With the exception of 1 ball no other equipment was allowed into the playground.<br>The control school had no playground markings, but allowed limited equipment into the playground. | 4 weeks | Heart rate telemeters were used to measure heart rate and heart rate was used to calculate rate of energy expenditure and total energy expenditure during play. | Mean HR increased significantly in the intervention group compared to the compared to the control ($p<0.01$).<br>The rate of energy expenditure and total energy expenditure increased significantly in the intervention group compared to the compared to the control ($p<0.02$). | none reported | Almost identical time spent in daily playtime for boys and girls at about 84 minutes.<br>Mean heart rate was higher in boys (130.9 bpm) than girls (127.7 bpm)<br>Boys rates of energy expenditure results were 22% higher than girls<br>Total energy expenditure during play was 23% higher in boys compared to girls | none reported | Yes |
| | Stratton (2000) | Controlled before and after study (2++) | To investigate the effects of painting a school playground with bright and colourful markings on the moderate-vigorous physical activity levels of primary school children. | Children attending primary school, UK<br><br>Initial consent to participate<br>n = 60<br>(intervention = 36, Control = 24)<br><br>Final analysis<br>n = 47<br>(intervention = 27, Control = 20) | 1 intervention school and 1 control school were studied in north west England.<br>Children in the experimental school designed a series of 10 markings, each linked to a school curriculum theme that were painted in bright fluorescent colours on the tar macadam playground surface; a castle, dragon, clock face, flower maze, fun trail and dens, hopscotch, letter squares, snakes and ladders and a circular maze were evenly spaced throughout the playground area. With the exception of a single football, other play equipment was not allowed in the playground area.<br>The control school had no playground markings, but allowed limited equipment into the playground. | 4 weeks | Output from a heart rate telemeter was used as a measure of playtime duration.<br>Heart rate was used to calculate the amount of time spent in moderate-vigorous PA and vigorous physical activity. | MVPA increased significantly in the intervention group compared to the control ($p<0.05$) (intervention: before 35.1%, after 46.2%; control: before 40.5%, after 39.1%). After adjusting for duration spent in playtime the significant interaction remained ($p<0.01$).<br>VPA almost doubled in the experimental group (before 5.3% of playtime, after 10.0% of playtime) compared to a very small decrease in the control school (before 7.0% of playtime, after 6.8% of playtime) and resulted in a significant interaction between groups ($p<0.05$). After adjusting for duration spent in playtime the significant interaction remained ($p<0.01$). | none reported | none reported | none reported | Yes |
| | Stratton and Mullan (2005) | Controlled before and after study (2++) | To examine whether painting playgrounds with multicolour markings would increase the percent of recess time spent in moderate to | Children attending primary school, UK.<br><br>Initial consent to participate<br>n = 120.<br>15 girls and 15 boys were randomly selected from each school. | 4 schools from northeast Wales underwent playground markings and were compared to 4 control schools in the northwest England.<br>Playgrounds were painted in bright fluorescent colours that varied according to school preference; castles, dragons, clock faces, mazes, fun trail, dens, hopscotch, letter squares and snakes and ladders were all popular in early | 4 weeks | Heart rate was used to calculate the amount of time spent in moderate-vigorous PA and vigorous physical activity. | The amount of MVPA during playtime increased in the intervention group (from 36.7% to 50.3%) compared to a decrease in the control group (39.9% to 33.4%) ($p<0.01$).<br>The amount of VPA during playtime | No significant interactions by age or gender for moderate-vigorous physical activity (boys: before 40.6%, after 44.8%; girls: before 35.2%, after 39.8%) or vigorous physical activity (boys: before 9.8%, after 12.6%; | none reported | none reported | Yes |

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| | | | vigorous PA and vigorous PA in girls and boys. | Final analysis n = 99 (intervention = 67, Control = 32) | primary schools. Late primary schools included markings for netball, football and short tennis, and targets for games related skills. Playgrounds were painted during summer vacation. Control schools had no playground markings. Small pieces of sports equipment such as skipping ropes and footballs were prevalent in all school playgrounds. Each school playground employed 2 supervisors, who were not informed of the aims of the investigation, neither were they trained in promoting physically active behaviour. | | | increased in the intervention group (7.9% to 12.4%) compared to no change in the control group (8.0% to 8.0%) (p<0 03). | girls: before 5.9%, after 7.9%) | | | |
| **School buildings** | **Cardon et al., (2004)** | Intervention with post data only and a 'no intervention' comparison group. (2-) | To evaluate differences in sitting habits in the classroom between the project 'moving school' and a traditional school in 8 year old children. | Children attending primary school. Belgium and Germany. n = 47 (Intervention = 22 Control = 25) | In a 'moving school' the classroom is equipped with ergonomic furniture allowing varying working postures and contributing to physiologically correct sitting with movement, called dynamic sitting. All tables have an inclinable top with a minimum inclination of 16 degrees. The classroom has a stand-at desk. The classroom was reorganised to make more floor space available for variations in the daily working routine. | 1.5 years | Accelerometer counts<br><br>Observations | none reported | **Accelerometer counts:** Children from the 'moving school' (538 counts per minute) were significantly more active than children in the comparison school (134 counts per minute). (p<0.001).<br><br>**Observations:** A significantly larger amount of time was spent on dynamic sitting (intervention 53.11, comparison 3.25), standing (30.63 intervention, 2.42 comparison) and walking (intervention 10.47, comparison 1.75) in the 'moving school' compared to the comparison group.<br><br>Dynamic sitting, standing, walking around and being active were observed significantly more frequently in pupils of the 'moving school' than in the pupils of the comparison school. | none reported | none reported | Somewh at |

# Appendix A – Example search strategy

### OVID Medline

### Building design search terms

1. building$.tw.
2. build$1.tw.
3. built$.tw.
4. built-up.tw.
5. urban$.tw.
6. exp Workplace/
7. exp Cities/
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. landscap$.tw.
10. planning.tw.
11. space$.tw.
12. development$.tw.
13. design$.tw.
14. structur$.tw.
15. layout$.tw.
16. facilit$.tw.
17. environment$.tw.
18. feature$.tw.
19. surrounding$.tw.
20. amenit$.tw.
21. location$.tw.
22. view$1.tw.

23. (aesthetic$1 or esthetic$1).tw.

24. lift$1.tw.

25. elevator$.tw.

26. stair$.tw.

27. shower$.tw.

28. path$.tw.

29. sign$3.tw.

30. (changing room$ or exercise room$).tw.

31. (gym$1 or gymnasium$).tw.

32. parking.tw.

33. exp Environment Design/

34. exp Parking Facilities/

35. exp Esthetics/

36. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35

37. 8 and 36

38. environment$ intervention$.tw.

39. exp Architecture/

40. 37 or 38 or 39

**Physical activity terms**

1. (physical adj5 (fit$4 or train$3 or activ$3 or endur$4)).tw.

2. (exercis$3 adj5 (fit$4 or train$3 or activ$3 or endur$4)).tw.

3. (leisure adj5 (centre$1 or center$1 or facilit$)).tw.

4. (fitness adj5 (centre$1 or center$1 or facilit$)).tw.

5. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 gym$).tw.

6. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 physical activit$).tw.

7. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 (circuits or aqua$)).tw.

8. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 exercis$).tw.

9. ((promot$ or uptak$ or encourag$ or increas$ or start$ or adher$) adj5 (keep fit or fitness class$ or yoga)).tw.

10. ((decreas$ or reduc$ or discourag$) adj5 (sedentary or deskbound)).tw.

11. sport$3.tw.

12. walk$3.tw.

13. running.tw.

14. jogging.tw.

15. bicycl$3.tw.

16. (bike$1 or biking).tw.

17. (exercis$3 adj5 aerobic$1).tw.

18. rollerblading.tw.

19. rollerskating.tw.

20. skating.tw.

21. exertion$1.tw.

22. recreation$1.tw.

23. stair$.tw.

24. exp Exertion/

25. Physical Fitness/

26. exp "Physical Education and Training"/

27. exp Dancing/

28. exp Sports/

29. exp Yoga/

30. pilates.tw.

31. Exercise Therapy/

32. exp Fitness Centers/

33. Recreation/

34. "Play and Playthings"/

35. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34

Combine 40 (building design) AND 35 (physical activity)

# Appendix B – Example In/ Out form

Author and year .....  Today's date .....
Study ID Number .....  Reviewer .....

| Question | Yes | Not Clear | No | Further information: |
|---|---|---|---|---|
| Is the study an **intervention study** or review of intervention studies? | | | | State the main purpose of the study: |
| Is the study relevant to **buildings** [changing the internal design; spatial-configuration; provision of facilities or amenities; or internal decoration / aesthetics of a building or set of buildings or of the environment surrounding building(s)] | | | | |
| Does the intervention include (some form of) **modification to the physical building and/or surrounding environment**?<br>(might include stairwell improvements, cycle rack provision, landscaping of grounds, building of walking trail, playground markings or/and characteristics) | | | | |
| Is an outcome reported on **physical activity behaviour** (includes a measure of walking or cycling, usage) | | | | State the primary measure reported:<br>If NO, is an outcome measure related to PA? |

**IF THE ANSWER TO ANY OF THE ABOVE IS NO, EXCLUDE THE STUDY (FROM THIS INITIAL SCREENING)**

| **This study is:** | **Included** | ☐ | **Excluded** | ☐ | **Not sure** | ☐ |
|---|---|---|---|---|---|---|
| Is the study primarily focussed on increasing PA | Details: | | | | | |

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| OR is the effect of PA (+ve or –ve) likely to be an unintended consequence of the interventions | | | | |
| Indicate if this study is relevant to another review? | Transport | ☐ | National Policy | ☐ |
| | Building design | ☐ | Economic | ☐ |
| | Natural environment | ☐ | | |
| Other information: | | | | |

# Appendix C – Included studies

Boutelle KN, Jeffery RW, Murray DM, Schmitz KH. (2001) Using signs, artwork, and music to promote stair use in a public building. American Journal of Public Health, 19(12): 2004-2006.

Cardon G, De Clercq D, De B, I, Breithecker D. (2004) Sitting habits in elementary schoolchildren: a traditional versus a "Moving school". Patient Education & Counseling, 54(2):133-142.

Emmons KM, Linnan LA, Shadel WG, Marcus B, Abrams DB. (1999) The Working Healthy Project: a worksite health-promotion trial targeting physical activity, diet, and smoking. Journal of Occupational & Environmental Medicine, 41(7):545-555.

Kerr NA, Yore MM, Ham SA, Dietz WH. (2004) Increasing stair use in a worksite through environmental changes. American Journal of Health Promotion, 18(4):312-315.

Leslie E, Fotheringham M, Veitch J, Owen N. (2000) A university campus physical activity promotion program. Health Promotion Journal of Australia, 10(1):51-54.

Linenger JM, Chesson CV and Nice DS. (1991) Physical fitness gains following simple environmental change. American Journal of Preventive Medicine, 7(5):298-310.

Reed JA, and Wilson DK. (2006) Awareness and use of a university recreational trail. Journal of American College Health 54(4):227-230.

Stratton G and  Leonard J. (2002) The effects of playground markings on the energy expenditure of 5-7 year old school children. Pediatric Exercise Sciences, 14:170-180.

Stratton G and Mullan E. (2005) The effect of multicolour playground markings on children's physical activity level during recess. Preventive Medicine, 41:828-833.

Stratton G. (2000) Promoting children's physical activity in primary school: an intervention study using playground markings. Ergonomics, 43(10):1538-1546.

# Appendix D – Excluded Studies

| Reference | Reason for exclusion |
|---|---|
| Adams TB, Anderson DR. (2002) Research and evaluation results. Using signs, artwork, and music to promote stair use in a public building. American Journal of Health Promotion 17(2):158-159. | Abstract of study detailed in another paper |
| Adams TB. (2004) Examination of risk status transitions among active employees in a comprehensive worksite health promotion program. (Review). American journal of health promotion 18(4):335. | Review – did not focus solely on the built environment |
| Age Concern (1998). The future of the built environment: interim report. Age Concern, London. 1998. | Not an intervention study |
| Appleby C (1995). Fit to be cared for. Crozer-Keystone has a new design for health care. Hospitals & Health Networks 69(16):34-36. | Not an intervention study |
| Arbeit ML, Johnson CC, Mott DS, Harsha DW, Nicklas TA, Webber LS, et al (1992). The Heart Smart cardiovascular school health promotion: behaviour correlates of risk factor change. Preventive Medicine 21(1):18-32. | Intervention did not involve a change to the building design |
| Bauman A (2005). Environment - The physical environment and physical activity: moving from ecological associations to intervention evidence. Journal of Epidemiology and Community Health 59(7):535-536. | Not an intervention study |
| Bell AC, and Dyment J (2006). Grounds for Action: promoting physical activity through school ground greening in Canada. Evergreen. | Not an intervention study |
| Bertera RL (1990). Planning And Implementing Health Promotion In The Workplace: A Case Study Of The du Pont Company Experience. Health Education Quarterly 17;177:307-328. | Intervention did not involve a change to the building design |
| Bitgood S, Dukes S (2006). Not another step! Economy of movement and pedestrian choice point behaviour in shopping malls. Environment and Behaviour 38(3):394-405. | Not an intervention study |

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| Brownson RC, Haire-Joshu D, Luke DA (2006). Shaping the context of health: A review of environmental and policy approaches in the prevention of chronic diseases. Annual Review of Public Health 27:341-370. | Not an intervention study |
| Building for the future (1997). An analysis of sports facility provision in Wales 1997. R Report. Sports Council for Wales, Cardiff (GB); Report No: SCW-SS-29. | Not an intervention study |
| Burgdorf RL, Jr (1991). Equal access to public accommodations. [Review] [114 refs]. Milbank Quarterly 69 Suppl 1-2:183-213. | Not an intervention study |
| Central London Partnership, Transport for London, Gehl Architects (2004). Making London a walkable city: the walking plan for London. 119. RB55812pp | Not an intervention study |
| Cleary J, McClintock H (2000). The Nottingham Cycle-Friendly Employers Project: lessons for encouraging cycle commuting. Local Environment (5)2:217-222. | Not an intervention study |
| Cooke M (1998). Quality designs for living streets. Urban Environment Today (42):10-12. | Not an intervention study |
| Cooper Marcus C and Barnes M. (1995) Gardens in health care facilities; uses, therapeutic benefits, and design recommendations. The Centre for Health Design, Inc., Martinez, CA. | Intercept survey of use >5 years post intervention. No measure of change presented. |
| Craig B (2001). A King Size Gym. New Zealand Physical Educator 33(2):8-10. | Discusses the building of a new sports facility and presents no outcome data |
| Crandall W, Brabyn J, Bentzen BL, Myers L (1999). Remote infrared signage evaluation for transit stations and intersections. Journal of Rehabilitation Research & Development 36(4):341-55. | Intervention did not involve a change to the building design |
| Cybriwsky R (1999). Changing patterns of urban public space. Observations and assessments from the Tokyo and New York metropolitan areas. Cities 16(4):223-31. | Discussion of changing trends in usage following redevelopment - urban planning focus |
| Davis SM, Clay T, Smyth M, Gittelsohn J, Arviso V, Flint-Wagner H, et al (2003). Pathways curriculum and family interventions to promote healthful eating and physical activity in American Indian schoolchildren. Preventive Medicine 37(6):S24-S34. | Intervention did not involve a change to the building design |

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# Appendix E - Glossary

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| CBA | Controlled before and after |
| CPHE | Centre for Public Health Excellence |
| DfT | Department for Transport |
| DH | Department of Health |
| CC | Collaborating Centre |
| NHS | National Health Service |
| NICE | The National Institute for Health and Clinical Excellence |
| NSF | National service frameworks |
| PDF | Portable document format |
| PHCC | Public Health Collaborating Centre |
| PDG | Programme Development Group |
| QALY | Quality-adjusted life year |
| RCT | randomised controlled trial |

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