research and consultancy

NICE

Rapid review of the economic evidence of physical activity interventions

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Contents

1.0 Executive Summary

A systematic review was undertaken to identify economic studies of the following interventions aimed at improving physical activity: brief interventions in primary care, pedometers, exercise referral, and walking and cycling programmes in the community.

1.1 Evidence statements

Figure 1: Evidence statements

Statement	Grade[1]	Evidence
Brief interventions in primary care		
There is limited evidence to suggest that interventions aimed at increasing physical activity are less cost-effective than usual care	Effect: RCT 1 -	Two low quality RCTs, one low quality before-after study.
	Econ: CEA 1-	One low quality CEA, one low quality CBA, one high quality CEA
Walking and cycling programmes in the community		
There is no cost-effectiveness evidence of the cost effectiveness of walking and cycling programmes in the community.		
Exercise referral		
There is some cost-effectiveness evidence to suggest that exercise prescription is both more effective and more costly than usual care. It is difficult to determine the ICER for exercise prescription, due to the different outcome measures employed in the studies reviewed.	Effect: RCT 1+	One very high quality RCT, two high quality RCTs, one low quality RCT, and one low quality review of RCTs
	Econ: CEA 1+	Two high quality CEAs, one high quality CCA, and two low quality CEAs
Pedometer		
There is no evidence of the cost effectiveness of pedometers		

[1] Figures 3 and 6 describe the grading structure

1.2 Brief interventions in primary care

Three studies of brief interventions in primary care were identified:

- Finkelstein et al. (2002) - a low quality randomised control trial (RCT) with a low quality cost-effectiveness analysis (CEA) undertaken in the US found that the addition of building group work focusing on physical activity and nutrition onto the existing cardiovascular disease (CVD) screening and one-to-one counselling was more expensive, but was no more effective at increasing physical activity levels among 50-64 year old women with no medical insurance;
- Lindgren et al. (2003) - a low quality RCT with a high quality CEA undertaken in Sweden found that asking participants to keep an activity log and giving them the opportunity to join an exercise group was less cost-effective than a dietary intervention; and
- Johannesson et al. (1991) - a low quality before-after with a low quality cost-benefit analysis (CBA) undertaken in Sweden found that, among 30-69 year old men receiving anti-hypertension drug therapy, home visits by nurses and doctors to test blood pressure and offer dietary and activity advice cost SEK2,100 more than conventional drug treatment over a two year period. However, if the health cost savings due to reduced subsequent care were continued, the treatment may prove cost-beneficial in the longer-term.

1.3 Walking and cycling programmes in the community

No economic evaluations of walking and cycling programmes in the community were identified in the review.

1.4 Exercise referral

Five studies of exercise referral were identified:

- Elley et al. (2004) - a low quality RCT with a low quality CEA undertaken in New Zealand found that exercise prescriptions from a general practitioner (GP) and telephone advice from an exercise specialist was both more effective and more costly than usual care. The incremental cost to convert one sedentary 40-79 year old to being active was NZ$1,750;

- Lowensteyn et al. (2000) - a low quality review of RCTs with a good quality CEA undertaken in Canada found that supervised and unsupervised exercise was both more effective and more expensive than no exercise;
    - unsupervised exercise has an incremental cost effectiveness ratio of less than US$12,000 / year of life saved (YOLS); and
    - supervised exercise has an incremental cost effectiveness ratio of less than US$20,000 / YOLS for men with CVD and 45-64 year old women with CVD; and a greater incremental cost effectiveness ratio for other groups.
- Sevick et al. (2000a) - a high quality RCT with a high quality cost-consequence analysis (CCA) undertaken in the US found that exercise prescription and usual tuition based interventions were equally effective at increasing the activity levels of 35-60 year old sedentary adults, and that exercise prescription was more expensive ($190 per person over six months compared with $46.53 per person for the lifestyle intervention after six months);
- Sevick et al. (2000b) - a very high quality RCT with a high quality CEA undertaken in the US found that both aerobic and resistance training for 60 year olds with osteoarthritis are not only more effective at improving activity levels than health education programme but also less expensive; and
- Stevens et al. (1998) - a high quality RCT and a high quality CEA undertaken in the UK found that prescribing 45-74 year olds exercise rather than sending them information about local exercise facilities reduced the number of sedentary people by 10.6% at a cost of £623 per person.

1.5 Pedometers

No economic evaluations of pedometers in the community were identified in the review.

2.0 Background

The National Institute of Health and Clinical Excellence (NICE) has been asked by the Department of Health to develop public health intervention guidance on physical activity as part of its 11th Wave.

Public health intervention guidance consists of recommendations on types of activity provided by local organisations to help to promote or maintain a healthy lifestyle or reduce the risk of developing chronic diseases or conditions. This guidance will provide recommendations for good practice, based on the best available evidence of effectiveness, including cost effectiveness.

NICE has been asked to develop public health intervention guidance on four commonly used methods to increase physical activity. These are brief interventions in primary care, pedometers, exercise referral schemes and community based exercise programmes for walking and cycling:

- **brief interventions in primary care**. Brief interventions in primary care were defined as any intervention involving verbal advice, encouragement, negotiation or discussion with the overall aim of increasing physical activity. The intervention should also be delivered in a primary care setting by a health or exercise professional, with or without written or other support or follow-up.

- **exercise referral**. Exercise referral was defined as referral by a member of the primary care team to facilities such as leisure centres or gyms for supervised exercise programmes.

- **pedometers**. Pedometer interventions are defined as any intervention using pedometers to promote physical activity, including purchase by individuals for personal use, provision of a pedometer with or without other advice by a member of the healthcare team, and provision of a pedometer with or without advice by another professional or agency.

- **walking and cycling programmes in the community**. Walking and cycling programmes in the community were defined as projects and groups with the aim of increasing participation in walking and cycling through involvement in organised walks or rides.

This review has been carried out by a team from Matrix Research & Consultancy (“Matrix”). Matrix provides professional research and consultancy services to those involved in the commissioning and delivery of public services.

2.1 The need for the guidance

2.1.1 Physical activity and ill health

There is a clear link between physical inactivity and ill health. The extent of this link is set out in publications such as the Chief Medical Officer’s (CMO) report ‘At least five times a week.’

Increasing physical activity levels will contribute to the prevention and management of over 20 diseases and conditions, including coronary heart disease, diabetes, cancer, positive mental health and obesity; in addition to reducing the human costs of physical inactivity in terms of mortality, morbidity and quality of life. The CMO report estimated the cost of inactivity in England to be £8.2 billion annually. This excludes the contribution of physical inactivity to overweight and obesity, whose overall cost might run to £6.6–£7.4 billion per year according to recent estimates.

The current level of activity recommended for achieving the basic health benefits of physical activity are for adults to achieve at least 30 minutes of at least moderate intensity physical activity on five or more days of the week.

2.1.2 Current activity levels

The Health Survey for England (2003) gives the most accurate national data on current physical activity levels of the adult population. It estimates that around six out of ten men and seven out of ten women are not active enough to benefit their health. Activity declines dramatically with age: 53% of men aged 16-24 were active at recommended levels compared to 8% of men aged 75 and over. Among women, the proportion active at the recommended level was fairly steady at 29-31% to 32% in women aged 16-54, before falling to just 3% among women aged 75 and over.

Physical activity levels vary between different ages, genders, classes and ethnicities. The Health of Minority Ethnic Groups (1999) measured participation in physical activity among the main minority ethnic groups in England. The survey found that compared with the general population, South Asian and Chinese men and women were much less likely to participate in physical activities, whether sport and exercise, walking, heavy housework or DIY. Bangladeshi men and women had the lowest level of physical activity: they were almost twice as likely as the general population to be classified as sedentary.

The effect of social class and income on participation in physical activity is complicated. The CMO report indicated that surveys which include both work-related and leisure-time activity show higher levels of physical activity in the lowest social classes for men, but little class difference among women. However, people in higher socioeconomic groups take part in more leisure-time activity than those in lower socioeconomic groups. This is the case for both men and women.

2.1.3 Trends

There have been few measured changes in overall participation in physical activity in England in the last decade. Walking and cycling as transport are important forms of physical activity. Data from the National Travel Surveys provides evidence of the changes in physically active travel over the years. They show that the average distance walked has fallen from 255 miles in 1975/6 to 192 miles in 2003. Bicycle mileage for the same years fell from 51 to 34 miles.

3.0 Methodology

3.1 Literature Search

A systematic review was undertaken to identify economic studies of the following interventions aimed at improving physical activity, where the change in physical activity is defined as meeting the Chief Medical Officer's (CMOs) guidelines of 30 minutes of moderate exercise five times a week:

- brief interventions in primary care;
- pedometers;
- exercise referral; and
- walking and cycling programmes in the community.

3.1.1 Search terms

Figure 2: Search terms

Brief Interventions		**Exercise referral**	**Cycling and Walking**	**Pedometers**	
Search one	Search two	Search one	Search one	Search one	Search two
Counselling Counselling Therapy AND Primary care General practice Physical activity Exercise Fitness	Counselling Counselling Therapy AND Primary care General practice AND Physical activity Exercise Fitness	Exercise Physical activity Physical fitness AND Referral Primary health care Prescription	Walk Walking Bicycling Bike Cycling Cycle Bike riding Led walks Health walks Group walks Pedal back the years Rides Riding AND Community Project Programme Program Trial	Pedometers	Step counters

Limits: English Language only

3.1.2 Databases searched

The NHSEED database (1994 to August 2005) and the HEED database (1958 to August 2005).

3.2 Selection of studies for inclusion

Following the initial search, the titles and abstracts of all identified studies were screened and irrelevant studies discarded. Full papers, where relevant were then reviewed against standard in-out criteria. Included studies were then read in full and appraised by two researchers. The results of the search strategy are summarised in section 2.4. Once the final list of included studies were agreed data were extracted using a standard form (Appendix C).

Studies were included if they assessed the cost effectiveness of one of the four interventions to increase physical activity in the adult population.

The main reasons for exclusion of studies were:

- the intervention studied uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines;
- the studies were not a test of physical activity interventions. Instead they investigated different ways of administering intervention; and
- the intervention studied is not included in the scope of this review (for instance, an exercise programme which is delivered in the community but is not cycling/walking, referral etc.)

A list of excluded papers is presented in Appendix B.

3.3 Summary of study grades

3.3.1 Efficacy studies

Figure 3 summarises the grading system for the efficacy studies included in the review. The remainder of this section then discusses the criteria used to grade determine the level of bias in each type of research designed identified.

Figure 3: Level of evidence for efficacy studies[2]

Level of evidence	Type of evidence
1++	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias
1-	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias
2++	High-quality case-control, before-after studies or cohort studies with a very low risk of confounding, bias or change and a high probability that the relationship is causal.
2+	Well-conducted case-control, before-after studies or cohort studies with a **low risk** of confounding, bias or change and a **moderate probability** that the relationship is causal.
2-	Case-control, before-after studies or cohort studies with a high risk of confounding, bias or change and a high risk that the relationship is not causal.
3	Non-analytical studies (for example, case reports, case series)
4	Expert opinion, formal consensus

RCTs

Figure 4 summarises the grading of the RCT studies included in the review. Each of the studies was assessed against the following criteria, taken from those set out in Appendix C of NICE's Guideline Development Method[3]:

- the assignment of subjects to treatment groups is randomized;
- an adequate concealment method is used;
- subjects and investigators are kept 'blind' about treatment allocation;
- the treatment and control groups are similar at the start of the trial and the only difference between groups is the treatment under investigation;
- the percentage of the individuals or clusters recruited into each treatment arm of the study that dropped out before the study was completed; and

[2] Adapted from: NICE (2004), Guideline Development Methods: Information for National Collaborating Centres and Guideline Developers. London: Nation Institute for Clinical Excellence, www.nice.org.uk

[3] NICE (2004), Guideline Development Methods: Information for National Collaborating Centres and Guideline Developers. London: Nation Institute for Clinical Excellence, www.nice.org.uk

- all the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention-to-treat analysis).

Figure 4: Grading of RCT effectiveness studies

Criteria	Finkelstein 2002	Lindgren 2003	Elley 2004	Sevick 2000a	Sevick 2000b	Stevens 2004
Random assign	Site level	Yes	Yes	Yes	Yes	Yes
Conceal	Not report	Not report	Not report	Not report	Not report	Not report
Blind	No	Not report	Not report	Not report	Single	Not report
Comparable groups	Not report	Not report	Not report	Yes	Yes	Yes
Drop out rate	24%	Not report	Not report	Not report	17%	42%
Intention to treat	Not report	Not report	Not report	Unclear	Yes	Yes
Assessment	**-**	**-**	**-**	**+**	**++**	**+**

Reviews

Figure 5 summarises the grading of the reviews included in the review. Each of the studies was assessed against the following criteria, taken from those set out in Appendix B of NICE's Guideline Development Method[4]:

- the types of study included in the review;
- the literature search is sufficiently rigorous to identify all the relevant studies;
- study quality is assessed and taken into account; and
- there are enough similarities between the studies selected to make combining them reasonable.

Figure 5: Grading of reviews

Criteria	Lowensteyn 2000
Type of studies	17 RCTs
Rigorous search	Not stated
Study quality	Not stated
Similar studies	Yes
Assessment	**-**

[4] NICE (2004), *Guideline Development Methods: Information for National Collaborating Centres and Guideline Developers*. London: Nation Institute for Clinical Excellence, www.nice.org.uk

Before-after studies

No explicit criteria for grading the quality of before-after studies are specified by NICE. As the main methodological limitation of the before-after design is its inability to measure the counterfactual, studies that employed this design were graded on the extent to which they attempted to measure the counterfactual through identification and measurement of potential confounders.

3.3.2 Economic studies

Figure 6 summarises the criteria used to grade the economic analysis undertaken in the studies included in the review.

Figure 6: Matrix economic evidence grading system

Type and quality	Economic study
1++	Cost-effectiveness or cost-utility analysis *All costs and outcomes; well defined alternative; clinically sensible sensitivity analysis*
1+	Cost-effectiveness or cost-utility analysis *Limited costs and outcomes; well defined alternative; clinically sensible sensitivity analysis*
1 -	Cost-effectiveness or cost-utility analysis *No sensitivity analysis*
2 ++	Cost-consequence and cost-benefit analysis *All costs and outcomes; well defined alternative; clinically sensible sensitivity analysis*
2 +	Cost-consequence analysis *Limited costs or outcomes; well defined alternative; clinically sensible sensitivity analysis*
2 -	Cost-consequence analysis *No sensitivity analysis*

3.4 Summary of studies selected for inclusion

3.4.1 Number of studies

The general nature of the terms used to define the interventions meant that a large number of irrelevant hits were achieved. The number of relevant hits reduced dramatically once the titles and abstracts were examined, and again when the papers were collected. The result of the search strategy are summarised in figure 7.

Figure 7: Summary of search strategy outcomes

Intervention	Total hits	Round 1*	Round 2*
Brief interventions in primary care	1330	24	3
Walking and cycling programmes	1002	0	0
Exercise referral schemes	227	3	5
Pedometers	0	0	0
	2559	**27**	**8**

*Round 1: inclusion based on title and abstracts only. Round 2: inclusion based on full papers.

The eight included studies were found to be distributed across four levels of evidence of efficacy, as described in figure 8. The study grades used are described in 2.3.1 above. The main reasons for studies being assessed as (-) quality were: analysis not done on an ‘intention to treat’ basis and the outcome assessment not being blind.

Figure 8: Quality of studies included: Efficacy

Level of evidence	Brief intervention	Exercise referral
1++	None	1 study
1+	None	2 studies
1-	2 studies	2 studies
2-	1 study	None

The included studies were found to be distributed across five levels of evidence of economics, as described in figure 9. The study grades used are described in 2.3.2 above.

The main reason for studies being assessed as (-) quality was the lack of sensitivity analysis having been undertaken.

Figure 9: Quality of studies included: Economic evidence

Level of evidence	Brief intervention	Exercise referral
1++	1 study	None
1+	None	3 studies
1 -	1 study	1 study
2 +	None	1 study
2 -	1 study	None

3.4.2 Description of studies

The included studies are shown in detail in section 4.

The brief intervention studies included one cluster RCT, one individual RCT and one before-after study. Two of these were cost-effectiveness analyses (CEA) while one was a cost-benefit analysis (CBA).

The exercise referral studies included four individual RCTs and one review of RCTs. Four of these studies were CEAs while one was a cost-consequences analysis (CCA).

Of the brief intervention studies, two were set in Sweden and one in the USA. Of the exercise referral studies, two studies were set in the USA and one each in New Zealand, Canada and the UK.

None of the included studies measured short-term outcomes. All three brief intervention studies measured outcomes over very long terms (ranging from one to two years). Two exercise referral studies measured outcomes over long terms (six months, eight months – the former also measured outcomes over a very long term) while three of the studies measured outcomes over very long terms (one to two years).

3.4.3 Included studies

The following papers were included in the review:

Brief interventions

Finkelstein et al. Cost-effectiveness of a Cardiovascular Disease Risk Reduction Program Aimed at Financially Vulnerable Women: The Massachusetts WISEWOMAN Project. Journal of Women's Health and Gender-based Medicine, 2002: 11, 6: 519 – 526.

Johannesson et al. Cost-benefit analysis of non-pharmacological treatment of hypertension. Journal of Internal Medicine, 1991: 230: 207-312

Lindgren et al. Cost-effectiveness of primary prevention of coronary heart disease through risk factor intervention in 60-year-old men from the county of Stockholm – a stochastic model of exercise and dietary advise. Preventative Medicine, 2003: 36: 403 – 409.

Exercise referral

Elley et al. Cost-effectiveness of physical activity counselling in general practice. The New Zealand Medical Journal, 2004: 117 (1207)

Lowensteyn et al. The Cost-effectiveness of Exercise Training for the Primary and Secondary Prevention of Cardiovascular Disease. Journal of Cardiopulmonary Rehabilitation, 2000: 20(3): 147 – 155

Sevick et al. Cost-effectiveness of Lifestyle and Structured Exercise Interventions in Sedentary Adults: Results of Project ACTIVE. American Journal of Preventative Medicine, 2000a: 19(1): 1-8

Sevick et al. Cost-effectiveness of aerobic and resistance exercise in seniors with knee osteoarthritis. Medicine and Science in Sports and Exercise, 2000b: 32: 1534 – 1540

Stevens et al. Cost-effectiveness of a primary care based physical activity intervention in 45-74 year old men and women: a randomised controlled trial. British Journal of Sports Medicine, 1998: 32: 236 - 241

4.0 Summary of Economic Evidence

4.1 Brief interventions in primary care

Brief interventions in primary care were defined as any intervention involving verbal advice, encouragement, negotiation or discussion with the overall aim of increasing physical activity. The intervention should also be delivered in a primary care setting by a health or exercise professional, with or without written or other support or follow-up.

Three economic evaluations of brief interventions in primary care were identified in the review of which[5]:

- two of the three studies employed randomised controlled trials; and
- two of the three studies presented a cost-utility or cost-effectiveness analysis.

Figure 10 summarises the results of these evaluations. It demonstrates that:

- two of the interventions were both more costly and produced improved health outcomes compared with the alternative; and
- one of the evaluations concluded that the brief intervention cost more than the alternative without improving health outcomes.

Figure 10: Permutations of results of economic evaluations of brief interventions in primary care

		Health outcomes		
		+	o	-
Costs	+	2	1	
	o			
	-			

Finkelstein et al. (2002) concluded that the intervention was more costly than the comparison without improving health outcomes. The study compared CVD screening with an enhanced lifestyle intervention (counselling and group activities focused on increasing physical activity and nutritional advice), with CVD screening with only a minimal intervention (one-to-one counselling). However, the validity of this result is undermined by the potential bias in the

[5] For further information on the studies of brief interventions in primary care, see figure 12.

RCT and CEA on which it is based. Furthermore, there are concerns over the baseline comparability of the treatment and control groups and the lack of sensitivity analysis. There are also concerns about the ability to generalise this result to a UK setting, as the study was set in the USA and the population was women without health insurance.

The two evaluations that identify a trade off between improved health outcomes and greater cost provide further information on whether the trade off is worthwhile:

- Johannesson et al. (1991) compared a non-pharmaceutical treatment programme (monthly visits by a nurse, six-monthly visits by a doctor, home blood pressure measurement, dietary advice, relaxation, and stress management, and physical activity) with conventional drugs (which also included monthly visits by a nurse, six-monthly visits by a doctor, and home blood pressure measurement). They concluded that the costs of the physical activity intervention outweigh the benefits (reduced future treatment costs and willingness to pay for the intervention) by SEK 2,100 per participant. This cost could be offset by an investment effect if the health benefits of the intervention continued beyond the two-year period of the study. However, whilst the CBA undertaken was of high quality, the RCT on which it was based is potentially bias; and
- Lindgren et al. (2003) compared an ‘exercise programme’ against a ‘control’. No further information was given about the interventions. They concluded that, from a healthcare payers perspective, the extra cost per Life Year Gained is SEK124,294 if the effect of the physical activity intervention is assumed to decline with time, and SEK15,633 if the effect is assumed to remain. This proves to be cost-ineffective when compared with a dietary intervention, but cost-effective when compared with a cholesterol lowering intervention in secondary prevention, but only if the effect is assumed to remain. Again, whilst the CEA undertaken was of high quality, the RCT on which it was based is potentially bias.

Once again, the ability to generalise from either of these studies to a UK setting is undermined by:

- none of the studies being undertaken in the UK. Both of the studies are undertaken in Sweden. The resources used and the costs used to value them are unlikely to be applicable in a UK setting;

- the longest follow-up period is two years. This will tend to underestimate the benefits of the interventions; and
- the populations sampled in each study are quite specific:
    - o the first study sampled 30-69 year old men receiving anti-hypertension drug therapy; and
    - o the second study sampled people who had not experienced CVD, diabetes, or other severe illness, who were not using medicines, whose cholesterol was between 5.2-7.8mmol/L, and whose diastloci blood pressure was less than 100mm Hg, 5.6mmol/L TCG, and 6.7mmol/L HbA1.

4.2 Walking and cycling programmes in the community

Walking and cycling programmes in the community are defined as projects and groups with the aim of increasing participation in walking and cycling through involvement in organised walks or rides.

No economic evaluations of walking and cycling programmes in the community were identified in the review.

4.3 Exercise referral

Exercise referral is defined as referral by a member of the primary care team to facilities such as leisure centres or gyms for supervised exercise programmes.

Five economic evaluations of exercise referral interventions were identified in the review[6]:

- all five of the studies employed randomised controlled trials; and
- four of the studies presented a cost-utility or cost-effectiveness analysis.

Figure 11 summarises the results of these evaluations. It demonstrates that:

[6] For further information on the studies of exercise referral interventions, see figure 13.

- one of the interventions dominates the alternative, not only improved health outcomes but also proved cheaper than the alternative that it was measured against;
- three of the interventions were both more costly and produced improved health outcomes compared with the alternative; and
- one of the evaluations concluded that the exercise referral intervention cost more than the alternative without improving health outcomes.

Figure 11: Permutations of results of economic evaluations of exercise referral interventions.

		Health outcomes		
		+	o	-
Costs	+	3	1	
	o			
	-	1		

Sevick et al. (2000b) compared two types of exercise intervention (an aerobic exercise intervention involving 60 minutes sessions, including a warm-up, stimulus, cool-down phases; and a resistance exercise programme involving 60 minute sessions including leg extension, leg curl, bicep curl, pelvic tilt, heel raise, chest fly, step up, upright row, military press – both programmes involves a three-month programme in a facility followed by a15-month home based programme) with a health education programme that involved a one and a half hour videotaped educational session and the opportunity to regularly discuss medicines and arthritis status with nurse. They concluded that both the exercise interventions dominate the health education programme.

There are possible problems with the validity of the cost estimates used in this study, which were estimated post-hoc. For instance, more expensive exercise alternatives were available, but not used to estimate costs. The author also used assumptions to measure home visit costs – though these were involved in both treatment and comparator. However, overall the CEA was of high quality and based on a high quality RCT.

Once again, that the study was undertaken in the USA the specific population sampled in the study – over 60 year olds with osteoarthritis – reduces the ability to generalise from the study to the UK setting.

The three evaluations that identify a trade off between improve health outcomes and greater costs provide further information on whether the trade off is worthwhile:

- Elley et al. (2004) compared a 'Green Prescription' programme (verbal advice and written exercise prescription by GP; and telephone exercise specialist) with usual care (no details were given regarding what constituted usual care). They concluded that the total funder cost of the programme was NZ$170.43 per participant per annum, and that the personal exercise cost was NZ$26.90 per participant per annum. The incremental cost to convert one sedentary adult to an 'active' state over 12 months was calculated NZ$1,750.

  The validity of this result is called into question by the fact that the RCT and CEA on which it is based were both of low quality. The control group may have taken part in an exercise trial, and that one third of eligible participants declined to take part in the study.

  Further, the study is set in New Zealand, and sampled 40-79 year olds who were 'less active' (took less than two and a half hours moderate activity per week) slightly undermines the ability to generalise the findings.

- Lowensteyn et al. (2000) compared supervised and unsupervised exercise (30 minutes, three times a week, at 69-85 per cent maximum heart rate) against doing no exercise. They concluded the cost per year of life saved (YOLS) depends on the whether the exercise is supervised and the cohort participating in the exercise:
  - unsupervised exercise costs less than $12,000 / YOLS;
  - supervised exercise costs less than $20,000 / YOLS for all men with CVD and women with CVD ages 45-64;
  - supervised exercise costs between $20,000 and £40,000 / YOLS for men aged 25-64 without CVD and older women 65-74 years with CVD; and
  - supervised exercise costs more than $40,000 / YOLS for all other groups.

  Once again, the fact that the study is set in Canada and uses Ontario and Quebec health costs reduces the study's ability to generalise to the

UK setting. Furthermore, the review of RCTs and the CEA upon which the conclusions are based are both of low quality.

- Stevens et al. (1998) compare a health promotion programme involving prescription for exercise based on consultation against an intervention which just sent information to participants about health, physical activities, and local leisure centres and health clubs. They concluded that the cost of converting one sedentary adult to an ‘active’ state is £623.

  The study was set in the UK, but provides no dates for the base-year against which costs were calculated, and the result is specific to 45-74 year old men and women. However, overall the RCT and CEA undertaken are both of high quality.

Finally, Sevick et al. (2000a) concluded that the physical activity intervention is more costly than the alternative, but did not improve health outcomes. They compared a structured treatment intervention (exercise prescription designed by the American College of Sport Medicine) against a lifestyle intervention (tuition and cognitive behaviour). They concluded that the interventions were equally effective, but the structured exercise programme cost $190 per person compared with $46.53 per person for the lifestyle intervention after six months.

The RCT and CEA upon which these results are based are both of high quality. However, the specific population sampled – 35 to 60 year old, sedentary adults with greater than 140 per cent of ideal body weight, a baseline energy expended value less than 36 kcal/kg/day for men, or 34 kcal/kg/day for women, and excluding pregnant women, people consuming greater than 3 alcohol drinks per day, people with a history of myocardial infarction, stroke, type 1 diabetes, osteoporosis or osteoarthritis – reduces the ability to generalise from this study.

4.4 Pedometers

Pedometer interventions are defined as any intervention using pedometers to promote physical activity, including purchase by individuals for personal use, provision of a pedometer with or without other advice by a member of the healthcare team, and provision of a pedometer with or without advice by another professional or agency.

No economic evaluations of pedometers were identified in the review.

5.0 Evidence Tables

Figure 12: Brief interventions in primary care evidence table

First author	Study efficacy[7]		Economics[6]		Research question and design	Population	Follow-up	Results	Confounders, potential sources of bias and other comments
	Type (grade)	Qual.	Type	Qual.					
Finkelstein et al, 2002	RCT (1)	-	CEA (1)	-	Aim: Reduce CVD risk Treatment: CVD screening and enhanced lifestyle intervention (counselling and group link focused on increases physical activity and nutrition). Control: CVD screening and minimum intervention (one to one counselling). Setting: community Length of intervention: ?	Women, 50-64 years old, without medical insurance.	1 year	Efficacy: Ten-year probability of CHD decreased from 9.4 per cent to 9.2 per cent and for minimum intervention group the fall was 10.3 per cent to 9.8 per cent. It was not possible to reject the hypothesis that the enhanced lifestyle intervention did not result in greater reductions in CHD risk relative to the minimal lifestyle intervention (mean reduction in probability of CHD = 0.3, p = 0.5). Economic: Incremental cost of enhanced intervention was $191. It would cost $637 to achieve a 1 per cent larger decrease in 10 year probability of coronary heart disease for women enrolled in the enhanced intervention.	Economic: USA study. No price year stated. The perspective was not stated. The source of cost data was not clear. Problems generalising to other settings. Effectiveness: The unit of randomisation was the site rather than the individuals and the baseline comparability of treatment and control groups not discussed. Neither patients nor outcome assessors where blinded to the allocation of the sites to the study.
Johannesson et al, 1991	Before – after study (2)	-	CBA (2)	-	Aim: treat mild hypertension Treatment: NPT (non pharmaceutical treatment) of hypertension Alternative: conventional drugs. Both treatment and control include monthly visits by nurse and every 6 months by a doctor, home blood pressure measurements, The treatment also includes dietary advice, relaxation, stress management and	Men, 30-69 years olds, receiving anti-hypertension drug therapy	2 years	Economic: The treatment programme costs SEK 5,300 per person greater than normal treatment The WTP for the programme (beyond those costs already captured) and reduced treatment costs after the programme are SEK 3,200 per person. Thus, the treatment cost SEK 2,100 per person more than conventional drugs. However, there are possible investment affects due to cost savings beyond the two-year period after the programme that were not captured by the study.	The study was undertaken in Sweden The variation in costs is not reported There is a question over the reliability of the WTP estimates.

[7] The system used to grade the methodology employed can be found in section 3.3

First author	Study efficacy[7]		Economics[6]		Research question and design	Population	Follow-up	Results	Confounders, potential sources of bias and other comments
	Type (grade)	Qual.	Type	Qual.					
					physical activity. Setting: health centre Length of intervention: 2 years				
Lindgren et al, 2003	RCT (1)	-	CEA (1)	++	Aim: reduce CHD risk Four interventions: 1. dietary advice 2. exercise 3. dietary advice and exercise 4. control Exercise intervention: maintained an activity log, opportunity to join an exercise group. Setting: community Length of intervention: three month compliance follow up	No CVD, diabetes, other severe illness. Not using medicines. Cholesterol: 5.2-7.8mmol/L Diastolic BP: < 100mm Hg, <5.6mmol/L TCG, and <6.7mmol/L HbA1	18 months	Effectiveness: results not reported. Economic (exercise v control): ICER (SEK/life year gained) for declining effect: Societal perspective = 180,470 Payer perspective = 124,294 ICER for remaining effect: Societal perspective = 149,810 Payer perspective = 15,633 This does not prove cost-effective when compared with the dietary intervention. When compared with a cholesterol lowering intervention in secondary prevention, the exercise intervention is cost-effective from a healthcare payer's perspective, but only if the effect is assumed to remain.	Study conducted in Sweden. Intervention results for 35-60 year olds applied to a cohort of 60 year olds. Very specific sample characteristics. Uses risk factors calculated for UK and German men.

Figure 13: Exercise referral evidence table

First author/ ID	Study efficacy[8]		Economics[7]		Research question and design	Population	Follow-up	Results	Confounders, potential sources of bias and other comments
	Type (grade)	Qual.	Type	Qual.					
Elley et al, 2004	RCT (1)	-	CEA (1)	-	Aim: increase physical activity Target : 'Green Prescription' programme (verbal advice and written exercise prescription by GP; and telephone exercise specialist) Control: Usual care. Setting: general practice Length of intervention: 3 months	40-79 years old and 'less active' (less than 2.5 hours of moderate activity per week).	1 year	Efficacy: The intervention results in a significant increase in physical activity: • Energy expenditure increase 9.4 kcal/kg/week (p=0.001) • Leisure exercise increased 2.7 kcal/kg/week (p=0.02) • Leisure exercise increased 34 mins/week (p=0.04) Economic: Costs • Total funder costs NZ$170.43 • Personal exercise cost NZ$ 26.90 per person per annum • Can't calculate significant difference of societal cost due to individual variation. CEA: • Monthly CE ratio: $11 kcal/kg/day • Incremental cost convert one 'sedentary' adults to 'active' state over 12 months = NZ$1,750 (programme costs).	Study set in New Zealand Control group may have taken part an exercise trial, contaminating the results. One third of eligible participants declined to participate. Individual variability means that a larger study is needed to calculate economic variables from societal perspective.
Lowensteyn et al, 2000	Review of RCTs (1)	-	CEA (1)	+	Aim: reduce CVD Treatment: supervised and unsupervised exercise (30 minutes/ 3x week at 69-85 per cent maximum heart rate). Control: no exercise. Setting: community Length of intervention: varied between studies reviewed	35-74 years old, with and without symptomatic CVD.		Effectiveness: • 0.7 YOLS for men without CVD aged between 35 and 54 years old • YOLS less for older men and all women without CVD • YOLS greater for those with CVD ICER: • Unsupervised, 35-54 year old men without CVD: incremental discounted costs saving = $182.70 • Unsupervised, with and without CVD: ICER < $12k/YOLS • Supervised, all men with CVD and women with CVD ages 45-64: < $20k/ YOLS • Supervised, men aged 25-64 without CVD and older women 65-74 years with CVD:	The author reviews a number of studies but does not state search or inclusion criteria. Study set in Canada, and uses Ontario and Quebec health costs. The study makes conservative assumptions. For instance it excludes QOL benefits due to the prevention of non-CVD events, and it assumes benefits stop at age 75.

[8] The system used to grade the methodology employed can be found in section 3.3

First author/ ID	Study efficacy[8]		Economics[7]		Research question and design	Population	Follow-up	Results	Confounders, potential sources of bias and other comments
	Type (grade)	Qual.	Type	Qual.					
								$20k- $40k/ YOLS, and • Supervised, all other: >$40k/ YOLS.	
Sevick et al, 2000a	RCT (1)	+	CCA (2)	+	Aim: increase physical activity Treatment: structured intervention – exercise prescription (designed by American College of Sport Medicine). Control: lifestyle intervention – tuition / cognitive behaviour. Setting: community Length of intervention: 6 months	35- 60 yr old sedentary adults with greater than 140 per cent of ideal body weight, with a baseline energy expended value less than 36 kcal/kg/day for men, or 34 kcal/kg/day for women. Excludes pregnant women, people consuming greater than 3 alcohol drinks per day; people with a history of myocardial infarction, stroke, type 1 diabetes, osteoporosis or osteoarthritis	6 and 24 months	Efficacy: Lifestyle and structured interventions are equally effective. For instance, energy expenditure (kcal/kg/day) varies over time and between interventions: • 6 month lifestyle intervention: 1.53 • 6 month structured intervention: 1.34 • 24 month lifestyle intervention: 0.84 • 24 month structured intervention: 0.69 (p-value not reported) Economic: Lifestyle more cost effective than structured. Cost (6 month total cost): Lifestyle = $33,778 ($46.53 per person). Structured = $130,123 ($190 per person). Cost (24 month total cost): Lifestyle = $49,805 ($17 per person). Structured = $134,910 ($49 per person).	Study set in USA Very specific study population. A high (5 per cent) discount rate is used and no base year was reported.
Sevick et al, 2000b	RCT (1)	++	CEA (1)	+	Aim: increase physical activity Health education programme only: 1.5hr videotaped educational session during first 3 month, and the opportunity to regularly discuss medicines and arthritis status with nurse. Aerobic exercise training 3x week, 3-months facility based, 15-month home based programme. 60min session's including warm-up, stimulus, cool-down phases. Stimulus was slow walking, arm circles. Resistance exercise 3-month facility based programme, 15-	Over 60 year olds with osteoarthritis	18 months	Efficacy: Exercise (both aerobic and resistance) is superior to education in improving a range of physical activity outcomes (p<0.05). Economic: Total cost of education = $347.98 per person. Aerobic exercise and resistance exercise were cheaper than education intervention: • Aerobic exercise resulted in a cost saving of $20.43 per person, and • Resistance exercise resulted in a cost saving £18.78 per person	USA study. Possible problem with the accuracy of post hoc estimates of costs. For instance, more expensive exercise options are available. Specific study population. Author assumptions are used to measure home visit costs.

First author/ ID	Study efficacy[8]		Economics[7]		Research question and design	Population	Follow-up	Results	Confounders, potential sources of bias and other comments
	Type (grade)	Qual.	Type	Qual.					
					month home based programme. 60min session's including leg extension, leg curl, bicep curl, pelvic tilt, heel raise, chest fly, step up, upright row, military press. Setting: community Length of intervention: 18 months				
Stevens at al, 1998	RCT (1)	+	CEA (1)	+	Aim: increase physical activity A health promotion programme involving prescription for exercise based on consultation with an exercise development officer for inactive individuals. The programme had three stages: identification as inactive, invitation for consultation and completion of the programme. The consultation included medical/lifestyle questionnaire, physical measure, assessment of present activity level, options available to be more physically active, introduction to physical activity diary. The alternative included sending information to participants about health, physical activities, and local leisure centres and health clubs. Setting: general practice Length of intervention: 10 weeks	45-74 year old men and women.	8 months	Efficacy: The net reduction in number of sedentary people was 10.6% (4.5-16.9%). Economic: The total cost of the intervention was £24,043. Total cost by stage: ▪ Stage 1 identification as inactive = £2517 ▪ Stage 2 invitation for consultation = £1,580 ▪ Stage 3 completion of the programme = £24,044 Cost of inducing one sedentary person to undertake more physical activity (net decrease in proportion of sedentary people after the intervention net of the same decrease in the control group) = £623 per person. Cost of moving someone who is active but below min level (proportionate increase net of the control group for the number attaining the top group classification) = £2500 per person. Cost of increasing individuals level of physical activity = £327 for movement into a higher activity group or less than £200 for an absolute increase in physical activity.	UK Study, but difficult to generalise as no dates were given for effectiveness, resource use and price data.

APPENDIX A – Included Studies

Brief interventions

Finkelstein E A, Troped P J, Will J C, Palombo R. Cost-effectiveness of a Cardiovascular Disease Risk Reduction Program Aimed at Financially Vulnerable Women: The Massachusetts WISEWOMAN Project. Journal of Women's Health and Gender-based Medicine, 2002: 11, 6: 519 – 526.

Johannesson M, Aberg H, Agreus L, Borgquist L, Jonsson B. Cost-benefit analysis of non-pharmacological treatment of hypertension. Journal of Internal Medicine, 1991: 230: 207-312

Lindgren P, Fahlstadius P, Hellenius ML, Jonsson B, de Faire U. Cost-effectiveness of primary prevention of coronary heart disease through risk factor intervention in 60-year-old men from the county of Stockholm – a stochastic model of exercise and dietary advise. Preventative Medicine, 2003: 36: 403 – 409.

Exercise referral

Elley R, Ngaire K, Bruce A, Boyd S, Toni A, Elizabeth R. Cost-effectiveness of physical activity counselling in general practice. The New Zealand Medical Journal, 2004: 117 (1207)

Lowensteyn I, Coupal L, Zowall H, Grover S A. The Cost-effectiveness of Exercise Training for the Primary and Secondary Prevention of Cardiovascular Disease. Journal of Cardiopulmonary Rehabilitation, 2000: 20(3): 147 – 155

Sevick M A, Dunn A L, Morrow M S, Marcus B H, Chen G J, Blair S N. Cost-effectiveness of Lifestyle and Structured Exercise Interventions in Sedentary Adults: Results of Project ACTIVE. American Journal of Preventative Medicine, 2000a: 19(1): 1-8

Sevick M A, Bradham D D, Muender M, Chen G J, Enarson C, Dailey M, Ettinger W H Jr. Cost-effectiveness of aerobic and resistance exercise in seniors with knee osteoarthritis. Medicine and Science in Sports and Exercise, 2000b: 32: 1534 – 1540

Stevens W, Hillsdon M, Thorogood M, McArdle D. Cost-effectiveness of a primary care based physical activity intervention in 45-74 year old men and women: a randomised controlled trial. British Journal of Sports Medicine, 1998: 32: 236 – 241

APPENDIX B – Excluded Studies

Paper	Reason for Exclusion
Robertson M C, Devlin N, Scuffham P, Gardner M M, Buchner D M, Campbell A J. Economic evaluation of a community based exercise programme to prevent falls. Journal of Epidemiology & Community Health 2001: 55 (8): 600-606	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Robertson M C, Devlin N, Gardner M M, Campbell A J. Effectiveness and economic evaluation of a nurse delivered home exercise programme to prevent falls. 2: Controlled trial in multiple centres. British Medical Journal 2001: 322: 701-704	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Robertson MC, Devlin N, Scuffham P, Gardner MM, Buchner DM, Campbell AJ. Economic evaluation of a community based exercise programme to prevent falls: Randomised controlled trial. British Medical Journal 2001: 322: 697-701	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Linz D H, Shepherd C D, Ford L F, Ringley L L, Klekamp J, Duncan J M. Effectiveness of occupational medicine centre-based physical therapy. Journal of Occupational and Environmental Medicine 2002: 44: 48-53	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Ruchlin H S, Elkin E B, Allegrante J P. The economic impact of a multifactorial intervention to improve postoperative rehabilitation of hip fracture patients. Arthritis & Rheumatism 2001: 45 (5): 446-452	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Wiles C M, Newcombe R G, Fuller K J, Shawc S, Furnival-Doranc J, Pickersgilla T P, Morgan A. Controlled randomised crossover trial of the effects of physiotherapy on mobility in chronic MS. Journal of Neurology, Neurosurgery & Psychiatry 2001: 70 (2): 174-179	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Beaupre L A, Lier D, Davies D M, Johnston D B. The effect of a preoperative exercise and education program on functional recovery, health related quality of life and health service utilisation following primary total knee arthroplasty. Journal of Rheumatology 2003: 31(6): 1166-1173	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Parker L, Walker J. Effects of a pulmonary rehabilitation program on physiologic measures, quality of life and resource utilisation in a health maintenance organisation setting. Respiratory Care 1998: 43 (2): 177-182	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Grahn B E, Borgquist L A, Ekdahl C S. Motivated patients are more cost-effectively rehabilitated: a two-year prospective controlled study of patients with prolonged musculoskeletal disorders diagnosed in primary care. International Journal of Technology Assessment in Health Care 2000: 16(3): 849-863	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.

Paper	Reason for Exclusion
von Koch L, de Pedro-Cuesta J, Kostulas V, Almazan J, Widen Holmqvist L.. Randomised controlled trial of rehabilitation at home after stroke: one-year follow-up of patient outcome, resource use and cost. Cerebrovascular Diseases: 12(2): 131-138	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Moffett J K, Torgerson D, Bell-Syer S, Jackson D, Llewlyn-Phillips H, Farrin A, Barber J. Randomised controlled trial of exercise for low back pain: clinical outcomes, costs and preferences. British Medical Journal 1999: 319: 279-283	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Torstensen T A, Ljunggren A E, Meen H D, Odland E, Mowinckel P, Geijerstam S. Efficiency and costs of medical exercise therapy, conventional physiotherapy and self-exercise in patients with chronic low back pain. Spine 1998: 23: 2616-2624	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Hemmila H M. Quality of life and cost of care of back pain patients in Finnish general practice. Spine 2002: 27(6): 647-653	Rehabilitation: the intervention uses exercise but not with the intention of changing the lifestyle of participants in line with CMO guidelines.
Salkeld G, Phongsavan P, Oldenburg B, Johannesson M, Convery P, Graham-Clarke P, Walker S, Shaw J. Cost-effectiveness of a cardiovascular risk reduction program in general practice. Health Policy 1997 41: 105-119	Not testing physical activity intervention. Only investigating different ways of administering intervention.
Hatziandreu E I, Koplan J P, Weinstein M C, Caspersen CJ and Warner KE. A cost-effectiveness analysis of exercise as a health promotion activity. American Journal of Public Health 1998: 78(11): 1417-1421	Not intervention, just modelling physical activity.
Georgiou D, Chen Y, Appadoo S, Belardinelli R, Greene R, Parides M K, Glied S. Cost-effectiveness analysis of long-term moderate exercise training in chronic heart failure. American Journal of Cardiology 2001: 87 (8): 984-988	Cycling intervention in on a stationary exercise bike. Intervention is hospital based.
Patrick D L, Ramsey S D, Spencer A C, Kinne S, Belza B, Topolski T D. Economic evaluation of aquatic exercise for persons with osteoarthritis. Medical Care 2001; 39(5): 413-424	This intervention is not included in the scope. Exercise programme which is delivered in the community but is not cycling/walking, referral etc.
Munro J, Brazier J, Davey R, J Nicholl. Physical activity for the over-65s: Couls it be a cost-effective exercise for the NHS? Journal of Public Health Medicine. 1997: 19(4): 397-402	This intervention is not included in the scope. Exercise programme which is delivered in the community but is not cycling/walking, referral etc.

APPENDIX C – Data Extraction Forms

(Separate document)