

RESEARCH

Effect of exercise referral schemes in primary care on physical activity and improving health outcomes: systematic review and meta-analysis

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Abstract

Objective To assess the impact of exercise referral schemes on physical activity and health outcomes.

Design Systematic review and meta-analysis.

Data sources Medline, Embase, PsycINFO, Cochrane Library, ISI Web of Science, SPORTDiscus, and ongoing trial registries up to October 2009. We also checked study references.

Study selection Design: randomised controlled trials or non-randomised controlled (cluster or individual) studies published in peer review journals. Population: sedentary individuals with or without medical diagnosis. Exercise referral schemes defined as: clear referrals by primary care professionals to third party service providers to increase physical activity

or exercise, physical activity or exercise programmes tailored to individuals, and initial assessment and monitoring throughout programmes. Comparators: usual care, no intervention, or alternative exercise referral schemes.

Results Eight randomised controlled trials met the inclusion criteria, comparing exercise referral schemes with usual care (six trials), alternative physical activity intervention (two), and an exercise referral scheme plus a self determination theory intervention (one). Compared with usual care, follow-up data for exercise referral schemes showed an increased number of participants who achieved 90-150 minutes of physical activity of at least moderate intensity per week (pooled relative risk 1.16, 95% confidence intervals 1.03 to 1.30) and a reduced level of

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Extra material supplied by the author (see <http://www.bmj.com/content/343/bmj.d6462/suppl/DC1>)

Web appendix 1: Literature search strategies

Web appendix 2: Summary of excluded studies from systematic review

Web figure 1: Meta-analysis of patients' minutes spent in physical activity of at least moderate intensity per week, at 6-12 month follow-up

Web figure 2: Meta-analysis of patients' estimated energy expenditure (kcal/kg per day; from self reports) during exercise referral schemes versus usual care, at 6-12 month follow-up

Web figure 3: Meta-analysis of patients' total physical activity per week, at 6-12 month follow-up

Web figure 4: Meta-analysis of patients' estimated energy expenditure (kcal/kg per day; from self reports during exercise referral schemes versus alternative physical activity interventions, at 6-12 month follow-up

Web table 1: Summary of physical fitness outcomes at follow-up

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Web table 6: Summary of reported data for health related quality of life at follow-up

depression (pooled standardised mean difference -0.82 , -1.28 to -0.35). Evidence of a between group difference in physical activity of moderate or vigorous intensity or in other health outcomes was inconsistent at follow-up. We did not find any difference in outcomes between exercise referral schemes and the other two comparator groups. None of the included trials separately reported outcomes in individuals with specific medical diagnoses. Substantial heterogeneity in the quality and nature of the exercise referral schemes across studies might have contributed to the inconsistency in outcome findings.

Conclusions Considerable uncertainty remains as to the effectiveness of exercise referral schemes for increasing physical activity, fitness, or health indicators, or whether they are an efficient use of resources for sedentary people with or without a medical diagnosis.

Introduction

Physical activity contributes to the prevention and management of many medical conditions and diseases, including coronary heart disease, type 2 diabetes, some cancers, and mental illness, such as dementia and depression.^{1 2} Despite recommendations that adults should undertake at least 30 minutes of exercise of moderate intensity at least five times a week, only about a third are active to this level.³

Primary care is a key setting for the promotion of physical activity. Consequently, myriad primary care based interventions have developed over the past 20 years.⁴ A common model is the exercise referral scheme, in which a general practitioner (or another member of the primary care team) identifies and refers a sedentary individual with evidence of at least one cardiovascular risk factor to a third party service (often a sports centre or leisure facility). This service then prescribes and monitors an exercise programme tailored to the individual needs of the patient.⁵ In the United Kingdom, contemporary exercise referral schemes were first set up around 1990, with numbers growing rapidly; more than 600 schemes are now thought to be in operation. Many schemes operate across several sites, which all adhere to a core set of standards.⁶ The exercise referral scheme model is also being established in primary care practice in other areas, including Spain and Scandinavian countries.^{7 8}

Several systematic reviews have examined the evidence base for exercise referral schemes and concluded that these schemes can increase the physical activity of sedentary adults in the short term.⁹⁻¹² Although these reviews included several randomised controlled trials (21 in total), many of these were studies of physical activity interventions without a referral by a member of the primary care team to a third party exercise provider. Few randomised controlled trials, therefore, have assessed the specific impact of an exercise referral scheme. Furthermore, these trials have failed to address the impact of exercise referral schemes on health related outcomes (for example, changes in lipid profile and blood pressure) or for individuals with pre-existing conditions, who could be most likely to benefit from these schemes (for example, those with coronary heart disease or depression). In 2006, the UK's National Institute for Health and Clinical Excellence (NICE) called for more controlled research on the effectiveness of exercise referral schemes.¹¹

We therefore updated the evidence base for exercise referral schemes in the light of new controlled trials and revisited previous concerns about the applicability of this evidence to policy and practice. A cost effectiveness analysis of exercise referral schemes has also been undertaken.¹³

Methods

We conducted and reported this systematic review in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement.¹⁴

Search strategy

We searched the following electronic databases: Medline In-Process (Ovid) and Medline (Ovid), 1950 to October 2009; Embase (Ovid), 1980-2009, week 28; Cochrane Library (Wiley), 2009, issue 3 (*Cochrane Database of Systematic Reviews*, database of abstracts of reviews of effects, National Health Service economic evaluation database, and Health Technology Assessment database); SPORTDiscus, 1990 to October 2009; ISI Web Of Knowledge, 1900 to October 2009; *Science Citation Index Expanded*, 1900 to October 2009; and Social Sciences Citation Index, 1898 to October 2009. To maximise the specificity, we did an initial scoping search to develop "exercise referral" and other related synonym terms which we then combined with "primary care" search terms and a controlled trial filter. Studies were also sought by reviewing the bibliographies of included studies and those known to the researchers of the present study. Furthermore, we limited the search to studies in the English language and that were published from 1990 onwards. Web appendix 1 provides full details of the search strategies. Searches were updated until July 2011.

Inclusion criteria

We considered studies to be eligible for inclusion if they met criteria regarding study design, population, intervention, comparators, and outcomes (box).

We excluded studies not published in a peer reviewed journal (for example, annual reports of exercise referral scheme programmes), editorials, opinions, and studies available only as meeting abstracts; programmes or systems of exercise referral initiated in secondary or tertiary care, such as conventional comprehensive cardiac or pulmonary rehabilitation programmes; and exercise programmes in which individuals were recruited from primary care but received no clear statement of referral by a member of the primary care team.

Study selection process

We screened titles and abstracts in three stages. At stage 1, one reviewer (TP) initially ruled out clearly irrelevant titles and abstracts. At stage 2, two reviewers (TP and RT, KF, MH, or AT) then independently screened the remaining titles and abstracts. At stage 3, full papers of abstracts categorised as potentially eligible for inclusion were screened by a consensus meeting of least two reviewers (TP and RT, KF, MH, AT) and disagreements were resolved in real time by consensus.

Data extraction

Data were extracted by one reviewer (TP) using a standardised data extraction form and checked by another (RT). Discrepancies were resolved by discussion, with involvement of a third reviewer if necessary. Extraction included data for patient characteristics (for example, age or disease diagnosis), intervention (for example, duration, location, intensity, and mode of the exercise intervention delivered), comparator, study quality, and reported outcomes pertinent to the review. We contacted all included study authors to seek information not available in study reports.

Box: Inclusion criteria for eligible studies

- Study design: randomised controlled trials and non-randomised controlled (cluster or individual) studies
- Population: any individual with or without a medical diagnosis
- Intervention: an exercise referral scheme was defined as comprising three core components—(1) referral by a primary care healthcare professional to a third party service provider, designed to increase physical activity or exercise; (2) physical activity or exercise programme tailored to individual needs; and (3) initial assessment and monitoring throughout the programme. The exercise referral scheme and the physical activity or exercise programme had to be more intensive than simple advice and needed to include at least one form or a combination of counselling (in person or by telephone, by use of written materials, or by supervised exercise training)
- Comparator: any control, such as usual care (such as brief advice on physical activity); no intervention; or alternative forms of exercise referral schemes
- Outcomes: physical activity (as a self report or objectively monitored), physical fitness, clinical outcomes (for example, blood lipids), health related quality of life, and adverse events (for example, musculoskeletal injury)

Risk of bias assessment

We derived risk of bias criteria from previous instruments assessing quality or risk of bias that used published criteria relevant to controlled studies.^{15 16}

Data analysis and synthesis

In view of the heterogeneous nature of outcomes and variable quality of outcome reporting, the primary focus of our data synthesis was descriptive and detailed tabular summaries were presented. For a small number of outcomes, we were able to consistently extract data across studies to allow quantitative summaries using the meta-analysis. We expressed dichotomous outcomes as relative risks (95% confidence intervals) for each study. For continuous variables, we compared net changes (that is, the differences between the exercise group and control group) and calculated a weighted or standardised mean difference (95% confidence intervals) for each study.

We investigated heterogeneity by reviewing the study populations, methods, and interventions; by visualising the results; and by using the χ^2 test for homogeneity and the I^2 statistic. A fixed effects model for the meta-analysis was used unless statistical heterogeneity was identified (χ^2 test, $P \leq 0.05$, or $I^2 \geq 50\%$), where a random effects model was used. In view of the small number of studies consistently reporting outcomes in a format to allow a meta-analysis, we were not able to undertake a funnel plot and assessment of publication bias analysis. Analyses were conducted with RevMan version 5.0.

Results**Identification and selection of studies**

Our bibliographic search yielded 21 563 titles (fig 1). After a full review of the papers, the main reason for exclusion was that studies recruited primary care individuals into exercise programmes, with no clear statement of a referral by a member of the primary care team to a third party exercise provider. Web appendix 2 provides the full list of excluded studies.

In addition to the six trials that met the inclusion criteria,^{7 8 17-23} our searches identified published protocols for another two trials on exercise referral schemes.^{24 25} By contacting the trial authors, we were able to obtain the full unpublished trial report for one of these trials.²⁶ Although a report of the other trial was not made fully available to us and unpublished at the time of this review, it is now available as a press release.²⁷ We included both trials in our analysis.

Characteristics of included studies

The eight trials (13 publications) included 5190 participants (table 1). All studies were randomised controlled trials, six undertaken in the UK,^{18 20-22 26 27} one in Denmark,²³ and one in

Spain.⁸ Various geographical locations in England and Wales were provided for the UK based studies.

Duration of study follow-up ranged from 2 to 12 months. Six trials compared exercise referral schemes with a usual care control group that consisted of no exercise intervention or some simple advice on physical activity.^{8 18 20-22 27} Two trials compared exercise referral schemes with an alternative physical activity intervention: motivational counselling or an instructor led walking programme aimed at increasing daily physical activity.^{22 23} In their randomised controlled trial, Jolly and colleagues used a cluster design to compare exercise referral schemes alone with an exercise referral scheme plus a behaviour change intervention (that is, self determination theory).²⁶ The authors stated that the intracluster correlation was so low (0.01) that they did not take account of adjustment for clustering in their analyses. Nevertheless, for the purposes of the present meta-analysis, we reduced the effective sample size for binary outcomes and increased the standard deviations for continuous outcomes on the basis of the design factor of 1.12 (based on an intracluster correlation of 0.01 and 13 clusters).¹⁶

Trials mainly recruited sedentary, middle aged, white adults who had no medical diagnosis but had evidence of at least one cardiovascular risk factor (that is, high blood pressure, raised serum cholesterol, smoking, or being overweight). In those trials that recruited a proportion of individuals with diabetes, hypertension, depression, coronary heart disease, or obesity, only aggregated outcomes across all trial participants were reported, restricting the use of subgroup analyses to determine effectiveness of exercise referral schemes within specific populations.

The general practitioner was the main referrer, often using a bespoke referral form to a fitness or exercise instructor or officer. All exercise referral schemes apart from the Gusi study⁸ included an initial consultation by the third party provider, such as a qualified exercise professional (table 1). Scheme duration was typically 10-12 weeks, and took place in a leisure centre,^{18 20-22 26 27} a clinic,²³ or public parks and forest tracks.⁸ Exercise sessions were usually twice per week, between 30-60 minutes per session, and set at either a moderate or individually tailored intensity. Four studies reported the use of an exit assessment at the completion of the exercise referral scheme.^{20 21 26 27}

Risk of bias

All trials generated a random allocation sequence although details of concealment were poorly reported (table 2). All trials reported good balance between groups in participant characteristics at baseline. Although blinding of participants and intervention providers was not feasible, the Jolly and Murphy studies reported outcome blinding.^{26 27} For both studies, self reported physical activity using the seven day physical

activity recall was assessed via telephone by researchers blinded to group allocation. The reporting and handling of missing data were detailed for most studies, and all studies apart from one¹⁸ reported the use of intention to treat analyses. The level of missing data at follow-up ranged from 17% to 50%. Most studies used imputation methods (that is, the last observation carried forward or the average of complete case values) to replace missing data values at follow-up. Overall, three studies were judged to be at moderate overall risk of bias (Taylor,¹⁸ Harrison,²¹ and Stevens²⁰) and five at a low overall risk of bias (Gusi,⁸ Isaacs,²² Jolly,²⁶ Sorensen,²³ and Murphy²⁷).

Outcome findings

We reported outcome results according to the three categories of comparator group: usual care, alternative exercise interventions (or alternative physical activity interventions), and exercise referral schemes plus behaviour change interventions (or alternative exercise referral schemes).

Physical activity

All studies, with the exception of the Gusi study,⁸ relied on a self report measure of physical activity. No studies assessed physical activity using objective methods.

Exercise referral schemes versus usual care

The most consistently reported physical activity outcome across studies was the proportion of individuals achieving 90-150 minutes of activity of at least moderate intensity per week (table 3).²⁸ After pooling data across studies, we found a 16% (95% confidence intervals 3% to 30%) increase in the relative risk of achieving this outcome with exercise referral schemes, compared with usual care, at 6 to 12 months' follow-up (fig 2, using denominators as reported by the study authors). The Taylor and Harrison studies reported this outcome based on the number of individuals who were available at follow-up.^{18 21} To assess the potential (attrition) bias in using completers, we adjusted the denominators of these two studies to all individuals undergoing randomisation. Assuming that all missing cases did not meet the physical activity threshold, we found that exercise referral schemes no longer differed significantly from usual care (fig 2, using denominators adjusted to all randomised groups).

Murphy and colleagues showed a significantly higher level of total physical activity per week with exercise referral schemes than with usual care, but only if they omitted baseline measures of physical activity from the adjusted analysis (table 3).²⁷ There was no difference between exercise referral schemes and usual care in either the minutes of activity spent in at least moderate intensity per week or in the estimated energy expenditure from physical activity (web figs 1 and 2). Harrison and colleagues reported no significant interaction between the effect of exercise referral schemes and prespecified baseline variables such as risk factors for coronary heart disease, sex, and age.²¹

Exercise referral schemes versus alternative physical activity intervention

Overall, we found no significant difference in the proportion of individuals achieving the 90-150 minutes' increase in moderate activity threshold, total amount of physical activity, or energy expenditure between exercise referral schemes and alternative physical activity interventions (fig 2, web figs 3 and 4). The study by Isaac and colleagues observed an increase in the number of minutes spent in physical activity at moderate intensity for patients in the walking programme compared with those in the exercise referral scheme group.²²

Exercise referral schemes versus exercise referral schemes plus behaviour change intervention

Jolly and colleagues reported that the proportion of patients achieving at least 150 minutes of moderate physical activity per week increased in the standard exercise referral scheme group from 27% at baseline to 63% at three months and 46% at six months, compared with the group participating in the referral scheme plus behaviour change intervention.²⁶ However, we did not see a difference between the groups in these proportions (fig 2).

Physical fitness

Three studies reported physical fitness outcomes (web table 1).^{18 22 23} Pooling of the cardiorespiratory fitness measures showed no difference between exercise referral schemes and usual care or alternative physical activity intervention (fig 3). We found evidence of considerable statistical heterogeneity when comparing the schemes with usual care. The Jolly study did not assess physical fitness, so we could not compare standard referral schemes with those that included a behaviour change intervention.²⁶

Clinical outcomes

Five studies provided information on clinical outcomes (that is, blood pressure, serum lipids (web table 2), weight and obesity measures (web table 3), respiratory function (web table 4), and diabetes control.^{8 18 22 23 26}

Exercise referral schemes versus usual care

Taylor and colleagues reported a lower percentage of body fat in exercise referral scheme participants than in the usual care group at follow-up.¹⁸ However, overall there was no difference between the two groups in body mass index or body fat (fig 4). There was also no between group difference in diastolic or systolic blood pressure (fig 5), serum lipids (web table 2), and respiratory function (web table 4) at follow-up.

Exercise referral schemes versus alternative physical activity intervention

Isaacs and colleagues reported no significant differences between exercise referral schemes and alternative physical activity intervention at follow-up in resting blood pressure (web table 2), body mass index or body fat (fig 4, web table 3), serum lipids (web table 2), and respiratory function (web table 4).²² Sorensen and colleagues reported reduced concentrations of glycolated haemoglobin (HbA_{1c} %) in both the exercise referral scheme group (mean -0.26%, 95% confidence intervals -0.79 to 0.27) and physical activity counselling group (-0.23%, -0.47 to 0.02) at 4 months' follow-up, although there was no statistical difference between them.²³

Exercise referral schemes versus exercise referral schemes plus behaviour change intervention

Jolly and colleagues reported no differences between standard exercise referral schemes only and exercise referral schemes plus self determination theory in body mass index or blood pressure (web tables 2 and 3). Serum lipid samples were not collected in this trial.²⁶

Psychological wellbeing

Five studies reported outcomes on psychological wellbeing (web table 5).^{8 17 22 26 27} The Taylor and Fox studies showed improvements in physical self worth and in perceptions of physical condition and physical health in the exercise referral scheme group, compared with the usual care group at 16 and 37 weeks' follow-up (web table 5).¹⁷ The other studies showed a significant reduction in depression but not in anxiety for exercise referral schemes compared with usual care (fig 6). The Isaacs and Jolly studies reported no difference in anxiety or depression outcomes, respectively, between exercise referral schemes and the other two comparator groups at 6 months' follow-up.^{22 26}

Health related quality of life

Four studies reported outcomes on health related quality of life (web table 6).^{8 22 23 26} Because of the heterogeneity in outcome reporting, we were not able to undertake meta-analysis. Isaacs and colleagues did not see any differences between the exercise referral schemes and usual care groups at follow-up on the SF-36 mental health scale.²² Gusi and colleagues observed significantly higher EQ-5D scores in the exercise referral scheme group than in the usual care group at 6 month follow-up.⁸

The Isaacs study reported no differences between the referral schemes and walking groups (as an alternative physical activity intervention) at follow-up on the SF-36 mental health scale score.²² Similarly, Sorensen and colleagues found no differences between the groups at follow-up on the SF-12 mental and physical scales.²³ Jolly and colleagues reported no difference in overall Dartmouth Cooperative chart scores between standard referral schemes and those including a behaviour change intervention. However, they found a difference in the feelings subscale at six months' follow-up in favour of the schemes that included self determination (mean difference 0.21, 95% confidence intervals 0.01 to 0.40, $P<0.05$).²⁶

Discussion

Main findings

In this systematic review of eight randomised controlled trials (5190 participants), we found weak evidence of a short term increase in physical activity and a reduction in levels of depression of sedentary individuals after participation in an exercise referral scheme compared with usual care. We did not find consistent evidence in favour of exercise referral schemes in outcomes based on physical fitness, psychological wellbeing, overall health related quality of life, blood pressure, serum lipid levels, indices of obesity, glycaemic control, or respiratory function.

In addition, we found no difference in any outcomes when comparing an exercise referral scheme with an alternative physical activity intervention (for example, walking programmes) or with schemes plus an additional behavioural intervention. Although several trials included individuals with a pre-existing medical diagnosis (for example, hypertension, myocardial infarction, and depression), because outcomes were not separately reported for such individuals, we were unable to judge the effectiveness of an exercise referral scheme in these subgroups.

Strengths and limitations

We made every effort to reduce potential bias in this review. We used comprehensive electronic searches, including the searching of reference lists of included studies, and used

predefined inclusion criteria which were applied by consensus across two or more reviewers.

We carefully selected exercise referral scheme studies on the basis that there was a clear statement of referral of participants by a primary care health professional to a third party exercise provider. The referral process of the scheme is, in itself, a key motivator and driver for individuals to take up and adhere to exercise interventions.²⁹ Although this approach resulted in the exclusion of several trials investigating exercise intervention in primary care (for example, Elley,³⁰ Lamb,³¹ Harland³², and Munro³³), it allowed us to focus on the effectiveness of exercise referral schemes themselves.

We found several potential biases in the included trials. The methodological detail of trials was often poorly reported, in respect of allocation concealment and outcome blinding, and subsequently we saw potential for selection and assessment bias. With the exception of self reported physical activity, we found limited consistency in the collection and reporting of alternative outcomes across trials. Finally, we found considerable evidence of heterogeneity in the nature of exercise referral scheme interventions across studies, which could have contributed to the inconsistency in outcome findings.

Implications

NICE has previously commented that there was insufficient evidence to support the widespread adoption of exercise referral schemes, and recommended that the UK's National Health Service (NHS) should only make these schemes available as part of a controlled trial.¹¹ Although we have identified four additional trials since the NICE review, there remains very limited support for the potential role of exercise referral schemes on increasing physical activity and consequently improving public health. Arguably, such an uncertain impact provides a case for the disinvestment in exercise referral schemes. We also found little evidence of how the exercise referral scheme interventions sought to develop a sustainable active lifestyle in participants, as recommended in the NHS National Quality Assurance Framework.³⁴ Although exercise referral scheme programmes in our review aimed to increase physical activity in the medium term to long term, they were typically based on only a 10-12 week period in leisure centres. With the exception of the Jolly and Murphy trials,^{26 27} the studies made little reference to the delivery, theories, or techniques of health behaviour change that typically underpin interventions to promote an increase in long term physical activity.³⁵

This review has identified some key uncertainties. The impact of exercise referral schemes in people with a medical diagnosis, in terms of effects on prognostic outcomes such as blood pressure and serum lipids, remains unknown. Furthermore, are any short term gains in physical activity with exercise referral schemes maintained in the long term? Although others have argued to the contrary, we believe that there remains a need for further trials of these schemes.³⁶ Future trials should consider incorporating theory driven interventions to complement an exercise referral scheme, compare the outcomes and costs associated with alternative approaches to physical activity promotion in primary care (for example, advice on physical activity delivered at the primary healthcare level), and report outcomes and costs in individuals with pre-existing medical diagnoses. This evidence is essential in the light of new NHS reform, for both service delivery (that is, councils) and general practitioner based commissioning; councils, through health and wellbeing boards, will be expected to work closely with new

general practitioner commissioning consortiums and Public Health England to deliver public health.³⁷

Conclusions

We found weak evidence of a short term increase in physical activity and reduction in the levels of depression of sedentary individuals after participation in an exercise referral scheme (typically a 10-12 week, leisure centre based programme) when compared with usual care. We did not find consistent evidence to support the benefit of exercise referral schemes for other outcomes (for example, health related quality of life). In view of this limited evidence, exercise referral schemes remain a potentially valuable primary care intervention for promoting physical activity. Particularly, since outcomes were not separately reported for individuals with a pre-existing diagnosis, we were unable to judge the effectiveness of an exercise referral scheme in these subgroups. High quality, randomised controlled trials are still needed to incorporate theory driven approaches to behaviour change (such as self determination, goal setting) and compare the outcomes and costs of exercise referral schemes with alternative, primary care based interventions that promote physical activity⁵, especially involving individuals with a pre-existing medical condition.

Contributors: TGP coordinated the review, with RST (guarantor) and AT as principal investigators. TM developed the search strategy, in consultation with TGP, RST, AHT, KRF, and MH, and undertook the searches. TGP, RST, AHT, KRF, and MH screened abstracts and full papers against the inclusion criteria. TGP appraised the quality of the papers and abstracted data from them. TGP and RST analysed the data and drafted the review. All authors, including the Project Advisory Group (NA, JLC, CF, CG, NM, JS, PT) provided input to interpretation of findings, commented on various drafts of the chapters, and contributed to their editing.

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Ethical approval: not required.

Data sharing: no additional data available.

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What is already known on this topic

Exercise referral schemes are a common model of physical activity promotion in primary care

Previous reviews have concluded that exercise referral schemes can increase the physical activity of sedentary adults in the short term

What this study adds

We found weak evidence supporting an association between exercise referral schemes and a short term increase in physical activity and a reduction in the levels of depression in sedentary individuals with and without pre-existing disease

Further trials should clarify whether exercise referral schemes offer important benefits in terms of health related outcomes and how these benefits compare with other primary care interventions to promote physical activity

Tables**Table 1 | Summary of included study characteristics**

| Study | Location | No of patients in randomised groups | Population | | Exercise referral scheme intervention | | | | | | | Outcomes assessed | Follow-up periods |
|-------------------------------|---------------------|-------------------------------------|---------------------------|---|---|-----|-----|--------|--|---|---------------------------|-------------------|-------------------|
| | | | Mean age (years), men (%) | Disease groups | Exercise content, duration (per week), intensity, and provider | IC | EA | G or I | Control | | | | |
| Taylor et al ¹⁷⁻¹⁹ | UK (South East) | 97, 45 | 54, 37 | Hypertension, obesity | 10 weeks, 2×30-40 min, moderate intensity, leisure centre | Yes | NR | Both | No exercise programme | Physical activity, clinical outcomes, psychological wellbeing | 8, 16, 26, and 37 weeks | | |
| Stevens et al ²⁰ | UK (London) | 363, 351 | 59, 40 | Obesity | 10 weeks, NR, NR, leisure centre | Yes | Yes | Both | No exercise programme | Physical activity | 8 months | | |
| Harrison et al ²¹ | UK (North West) | 275, 270 | NR, 33 | NR | 12 weeks, 2×1 h, individually based, leisure centre | Yes | Yes | Both | No exercise programme | Physical activity | 6, 9, and 12 months | | |
| Isaacs et al ²² | UK (Greater London) | 317, 315, 311 | 57, 35 | Hypertension, obesity, raised cholesterol, type II diabetes | 10 weeks, 2×45 min, NR, leisure centre | Yes | NR | Both | No exercise programme; or 10 week walking scheme, 2×45 min/week, 60-80% of maximum heart rate, group setting | Physical activity, physical fitness, clinical outcomes, psychological wellbeing, health related quality of life | 10 weeks, 6 and 12 months | | |
| Sorensen et al ²³ | Denmark | 28, 24 | 54, 43 | Metabolic syndrome, depression, cardiovascular disease | 4 months, 2×1 h/1×1 h, >50% heart rate reserve (20 min), clinic | Yes | NR | Group | Motivational counselling (45-60 min/session) | Physical activity, physical fitness, clinical outcomes, health related quality of life | 4 and 10 months | | |
| Gusi et al ⁸ | Spain | 127, 160 | 71, 0 | Obesity, type II diabetes, depression | 6 months, 3×50 min, NR, walking scheme | NR | NR | Group | No exercise programme | Clinical outcomes, psychological wellbeing, health related quality of life | 6 months | | |
| Jolly et al ^{24,26} | UK (Midlands) | 184, 163 | NR, 24 | Hypertension, obesity, anxiety, depression | 12 weeks, NR, NR, leisure centre | Yes | Yes | Both | Usual programme of exercise referral scheme | Physical activity, clinical outcomes, psychological wellbeing, health related quality of life | 3 and 6 months | | |
| Murphy et al ^{25,27} | UK (Wales) | 1080, 1080 | NR, 34 | Mental health | 16 weeks, NR, NR, leisure centre | Yes | Yes | Both | No exercise programme | Physical activity, psychological wellbeing | 6 and 12 months | | |

IC=initial consultation; EA=exit intervention; G or I=group or individual sessions; NR=not reported; h=hours; min=minutes.

Table 2| Summary of risk of bias assessment

| Risk of bias criterion | Taylor et al ¹⁸ | Stevens et al ²⁰ | Harrison et al ²¹ | Isaacs et al ²² | Sorensen et al ²³ | Gusi et al ³ | Jolly et al ²⁶ | Murphy et al ²⁷ |
|---|----------------------------|-----------------------------|------------------------------|----------------------------|------------------------------|-------------------------|---------------------------|----------------------------|
| Method of random sequence generation described | Yes | Yes | Yes | Yes | Yes | Yes | Yes* | Yes |
| Method of allocation concealment described | Yes* | Yes | Unclear | Unclear | Yes | Yes | Yes* | Yes |
| Method of outcome (assessment) blinding described | Unclear | Unclear | Unclear | No | Unclear | Unclear | Yes | Yes |
| Groups similar at baseline | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Intention to treat analysis used | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Any statistical handling of missing data | Unclear | Yes | Unclear | Yes | Yes | Yes | Yes | Yes |
| Missing data reported (dropout and loss to follow-up) | Yes* | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*From correspondence with author.

Table 3| Summary of physical activity data at follow-up, where reported in meta-analysis studies

| Study comparison and follow-up | Patients achieving physical activity guidance* (n/N) | | Mean (SD) duration of at least moderate intensity (min/week) | | Mean (SD) duration of total physical activity (min/week) | | Mean energy expenditure (kJ/kg per day) | |
|---|--|-------------------|--|---------------------|--|-------------------|---|-------------------|
| | Exercise referral scheme | Comparator scheme | Exercise referral scheme | Comparator scheme | Exercise referral scheme | Comparator scheme | Exercise referral scheme | Comparator scheme |
| Exercise referral scheme v usual care | | | | | | | | |
| Taylor et al ^{18,†‡} | | | | | | | | |
| 8 weeks | 51/63 | 20/31§ | 247 (174)/49 (60) | 145 (178)¶/21 (61)¶ | — | — | 145 (1.2) | 141 (1.7)¶ |
| 16 weeks | 51/57 | 18/31§¶ | 226 (252)/59 (72) | 160 (262)/21 (72)¶ | — | — | 145 (1.2) | 142 (1.7)¶ |
| 26 weeks | 39/47 | 18/31§¶ | 183 (234)/56 (108) | 206 (251)/34 (111) | — | — | 144 (1.8) | 144 (1.2) |
| 37 weeks | 39/57 | 19/31§ | 158 (228)/42 (96) | 162 (245)/23 (106) | — | — | 143 (2.4) | 1 (2.2) |
| Stevens et al ^{20,**} | | | | | | | | |
| 8 months | 204/363 | 174/351§ | — | — | — | — | — | — |
| Harrison et al ^{21,‡} | | | | | | | | |
| 6 months | 38/168 | 22/162§¶ | — | — | — | — | — | — |
| 9 months | 36/149 | 31/140 | — | — | — | — | — | — |
| 12 months | 40/155 | 32/157 | — | — | — | — | — | — |
| Isaacs et al ²² | | | | | | | | |
| 10 weeks | 48/164 | 29/157§¶ | 93 (115) | 79 (114) | 584 (479) | 668 (555) | 142 (26) | 151 (32) |
| 6 months | 70/179 | 66/200§ | 65 (106) | 58 (98) | 692 (496) | 647 (463) | 159 (27) | 147 (27) |
| Murphy et al ^{27,**} | | | | | | | | |
| 12 months | — | — | — | — | 1.18 (0.99 to 1.42), 1.19 (1.00 to 1.42)¶¶†† | | — | — |
| Exercise referral scheme v alternative physical activity intervention | | | | | | | | |
| Sorensen et al ^{23,‡,‡‡} | | | | | | | | |
| 4 months | — | — | — | — | 63 (114) | 23 (107) | 43 (2.4) | 41 (4.8) |
| 10 months | — | — | — | — | 20 (124) | 20 (152) | 41 (2.1) | 40 (5) |
| Isaacs et al ²² | | | | | | | | |
| 10 weeks | 48/164 | 53/92§¶ | 93 (115) | 113 (291) | 584 (479) | 863 (1026)¶ | 142 (26) | 180 (38)¶ |
| 6 months | 70/179 | 62/141§ | 65 (106) | 89 (150)¶ | 692 (496) | 759 (539) | 159 (27) | 176 (27) |
| Exercise referral scheme v alternative exercise referral scheme | | | | | | | | |
| Jolly et al ²⁶ | | | | | | | | |
| 3 months ³ | — | — | 319 (338) | 331 (336) | — | — | — | — |
| 6 months ³ | 66/156 | 83/169§ | 249 (356) | 246 (343) | — | — | — | — |

*Referring to 90-150 minutes of physical activity per week of at least moderate intensity.

†Duration of at least moderate intensity presented as moderate/vigorous values.

‡Data refer to numbers of individuals with complete data or questionnaires.

§P value calculated by authors of present meta-analysis.

¶Significant difference at P≤0.05.

**Data refer to all participants in randomised groups.

††Only odds ratio (95% CI) data for physical activity available; odds ratios presented as data adjusted for all covariates (which shows a non-significant difference), and data with baseline physical activity measure omitted from adjustment (which shows a significant difference).

‡‡Data are mean change in score. Mean energy expenditure data presented as metabolic equivalent thresholds per hour per day.

Figures

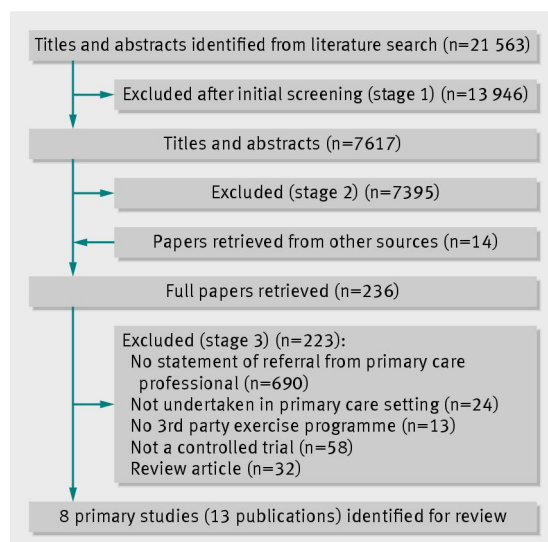


Fig 1 Flow diagram of study inclusion process

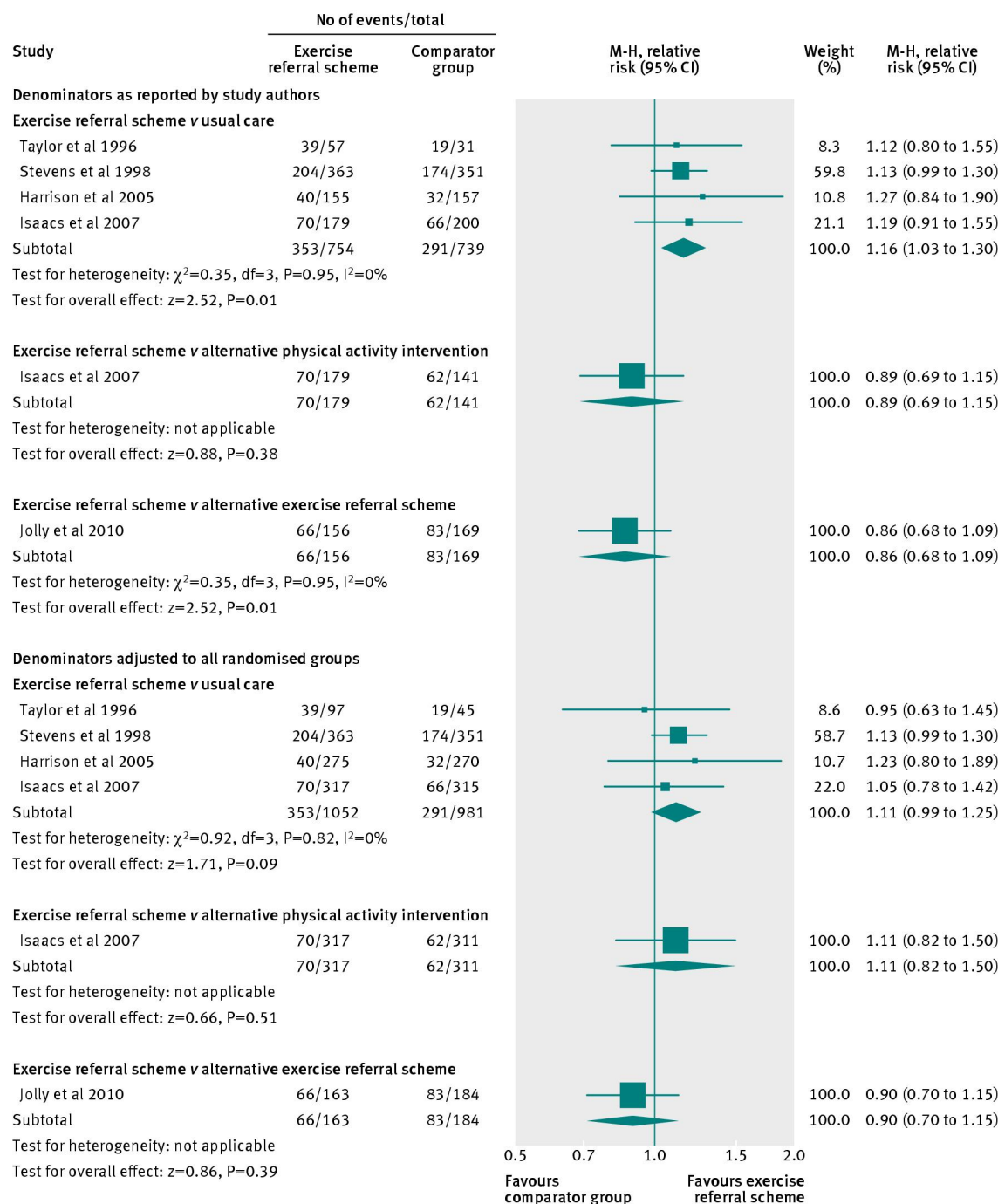


Fig 2 Meta-analysis of patients achieving 90-150 minutes of physical activity of at least moderate intensity per week, using denominators as reported by study authors and denominators adjusted to all randomised groups. Fixed effects model used. M-H=Mantel-Haenszel

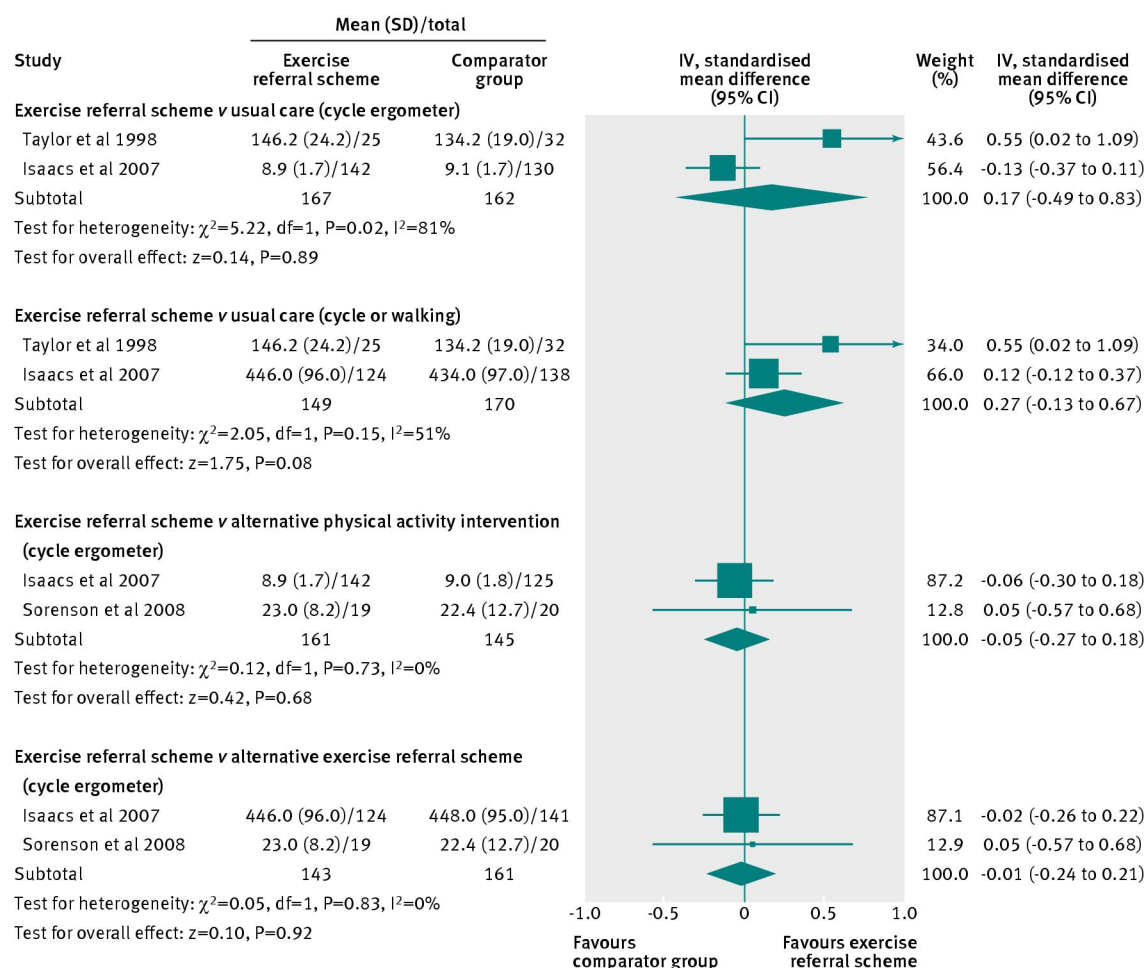


Fig 3 Meta-analysis of patients' cardiorespiratory fitness, at 6-12 month follow-up. SD=standard deviation. Random effects model used. IV=inverse variance

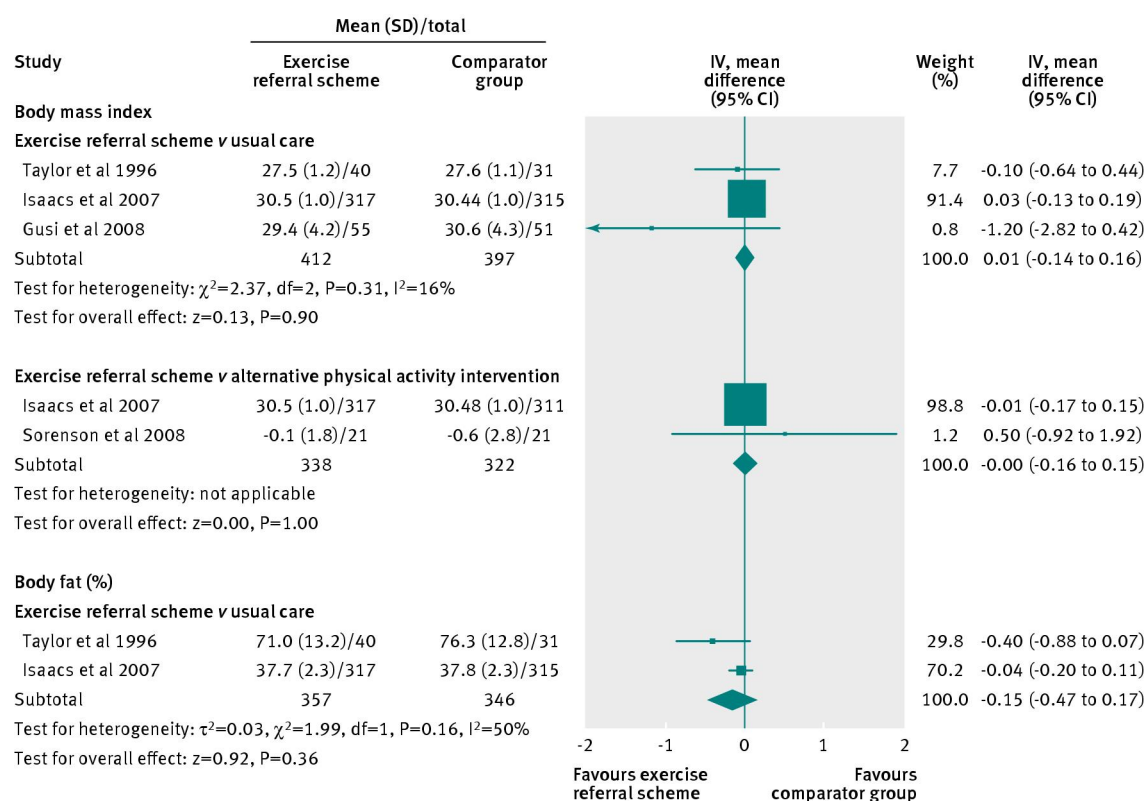


Fig 4 Meta-analysis of body mass index and body fat (%) in patients, at 6-12 month follow-up. SD=standard deviation. Fixed effects model used. IV=inverse variance. Data for body mass index are values for weighted mean difference and data for body fat are values for standardised mean difference

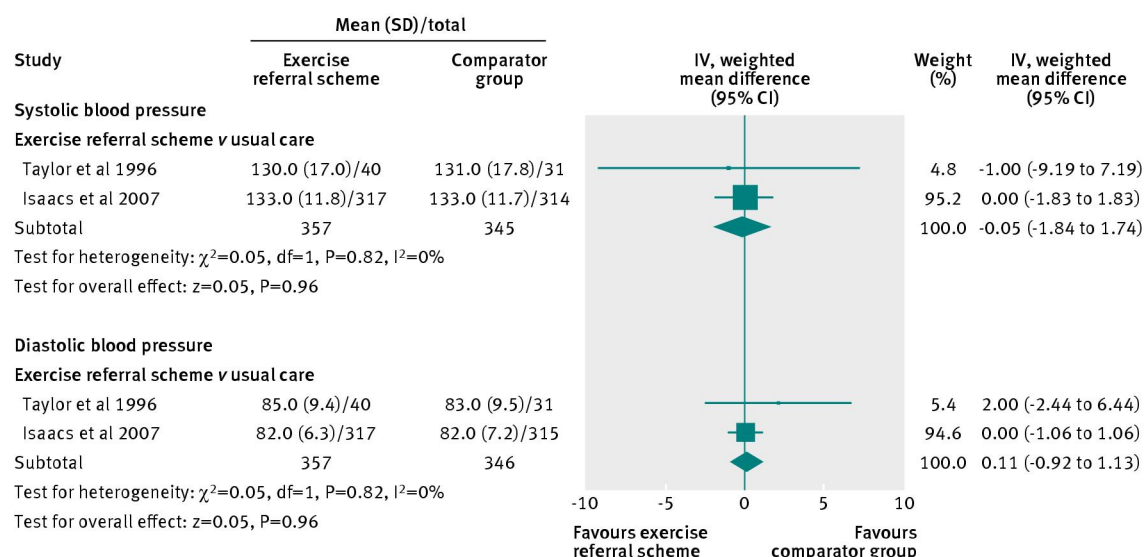


Fig 5 Meta-analysis of systolic and diastolic blood pressure in patients, at 6-12 month follow-up. SD=standard deviation. Fixed effects model used. IV=inverse variance

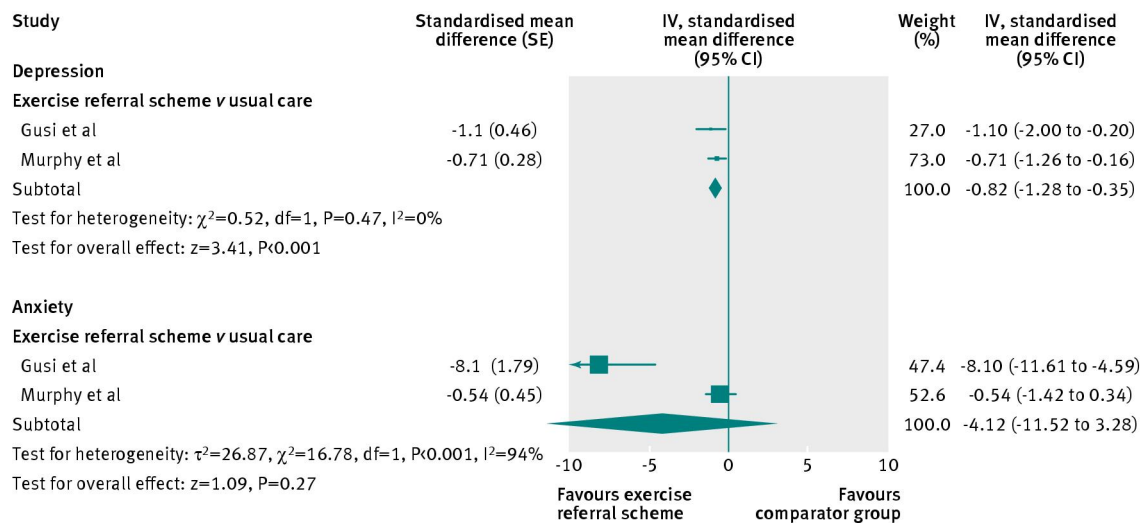


Fig 6 Meta-analysis of depression and anxiety in patients, at 6-12 month follow-up. SE=standard error. Fixed effects model used. IV=inverse variance