

REVIEW

Does exercise aid smoking cessation? A systematic review

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Abstract

Aims. To assess the effectiveness of exercise-based interventions in smoking cessation. **Design.** A systematic review was conducted of articles published between 1980 and 1999. The review focused on randomized controlled trials (RCTs) in which the specific effects of exercise on smoking abstinence were examined. The primary dependent variable was smoking abstinence. Other studies which had both exercise programming as an independent variable and smoking behaviour as a dependent variable are briefly discussed. **Participants.** The review included interventions targeting both healthy individuals and those with specific medical conditions. **Settings.** The interventions were delivered in both community and inpatient settings. **Measurements.** Information extracted from each article included details of the participants, exercise and smoking cessation programmes, control conditions, exercise adherence rates, length of follow-up and outcomes. **Findings.** Of the eight trials satisfying our inclusion criteria, only two trials found a positive effect for exercise on smoking abstinence. The others showed no effect. **Conclusions.** There is some evidence for exercise aiding smoking cessation. Of the two trials finding a positive effect one was rigorously designed, the other was found to have numerous methodological limitations. Trials showing no effect lacked sensitivity. This was principally because of small sample sizes and inadequate measurement and control of exercise adherence. There is a need for more rigorously designed studies in this area.

Introduction

Cigarette smoking is an important risk factor for cardiovascular disease, cancer, hypertension and premature mortality.¹ Stopping smoking prolongs life and reduces morbidity.² The majority of attempts to stop smoking are made unaided,³ with a success rate (≥ 12 -month continuous abstinence) of around 2–4%.⁴ Aided quit attempts, particularly through a combination of behavioural counselling and nicotine replacement therapy (NRT), can improve success rates, but these remain low at around 18%.⁵ More effective

smoking cessation interventions need to be developed.

Exercise has been proposed as an aid for smoking cessation.⁶ In this review the terms exercise and physical activity will be used interchangeably and will refer to both life-style physical activities, such as walking and gardening, as well as more formal structured activities, such as using a stationary cycle or rowing machine. The argument for using exercise in smoking cessation is supported by evidence which shows that exercise has a moderating effect on

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many of the variables negatively affected by nicotine withdrawal.⁷ For example, exercise has been shown to reduce nicotine cravings,⁸ mood disturbance,⁹ sleep disturbance,¹⁰ feeling tense,¹¹ subjective stress¹² and post-smoking cessation weight-gain.¹³ The weight control benefits of exercise may be particularly relevant to women smokers who frequently report fear of post-cessation weight-gain as a motivation for continued smoking¹⁴ and for smoking relapse.¹⁵ Exercise has also been shown to have a positive effect on other factors that may protect against smoking relapse, including perceived coping ability¹⁶ and self-esteem.¹⁷ In addition, being physically active has many general health benefits.¹⁸ This is notable for the smoker who has quit,¹⁹⁻²¹ but is also the case for the continuing smoker.²²

Evidence from surveys indicates that levels of physical activity are inversely related to smoking rates.²³ Smokers trying to quit are likely to be more receptive to an active life-style than smokers in general.^{24,25} Becoming more active has been positively associated with both confidence to maintain smoking abstinence²⁵ and success at stopping smoking.^{26,27} Other work shows a positive trend between avoiding relapse to smoking and physical health and fitness.²⁸ From this evidence one might hypothesize that an exercise intervention could act both to ameliorate nicotine withdrawal symptoms and to reduce the probability of relapses.

In practice, exercise is routinely recommended as an aid to smoking cessation by specialist smoking clinics,²⁹ by pharmaceutical companies³⁰ and in national guidelines.^{31,32} However, evidence from surveys would suggest that exercise is not routinely recommended by physicians.^{33,34} In the present review we consider the results of research trials which have examined the contribution of exercise to smoking cessation.

Methods

We reviewed studies published in refereed journals between 1980 and 1999. Studies written in any language were considered. Computerised searches were carried out using *Medline*, *Psych-Lit*, *Dissertation Abstracts* and *Sport Discus*. Key words included "smoking", "smoking cessation", "exercise", "physical activity" and "intervention". Further articles were identified

through manually reviewing reference lists, through carrying out additional searches on key authors, and through consultation with research colleagues. Searches were concluded in June 1999.

Each paper was read and assessed following established guidelines.³⁵ Only those trials which met the following criteria were considered to have adequately addressed the question of whether exercise aids smoking cessation, and provide the focus for the systematic review: trials in which (i) the specific effects of exercise on smoking abstinence were examined; (ii) smoking abstinence was the primary dependent variable; (iii) smokers who wished to quit were targeted; and (iv) subjects were assigned randomly to a treatment or control condition by a process of randomization. Other studies which had both exercise programming as an independent variable and smoking behaviour as a dependent variable, but did not satisfy the specific inclusion criteria, were not included but are discussed briefly.

Due to a combination of the small number of studies found, small sample sizes and differences in study design and intervention, a formal meta-analysis of the literature was not feasible. Instead, we present a systematic review of the literature. Each report identified was reviewed and categorized using a standard data extraction sheet according to design, subject characteristics, sample size, exercise programme, smoking cessation programme, control conditions, rates of exercise adherence, outcomes measures, length of follow-up and findings.

Results

The literature search identified eight studies which met the inclusion criteria (see Table 1). Findings from the studies are presented according to the following questions: (i) what is the evidence for exercise-based interventions aiding smoking cessation and (ii) how do variations in design and intervention affect the outcomes?

Evidence for exercise aiding smoking cessation

We defined the efficacy of the intervention in terms of the percentage of abstinent smokers at post-treatment and follow-up in the treatment group versus the controls. Two studies showed significant differences in abstinence between a

Table 1. Summary of results

Study	Participants	Experimental groups	Control groups	Follow-up (month post-treat.)	Abstinence criteria	Outcomes (% abstinence)
Hill 1985 ⁴⁰ Canada	26 women, 10 men, mean age 40, cig/day ≥ 10	(a) CV activity: various, group, facility, 30 min, [2, 5] + home activity + CP; [2, 5]	(b) CP as (a)	(i) 1, (ii) 3, (iii) 6	7 day PP, CO	ET (i) (ii) (iii) (a) 67 55 40 41 (b) 44 34 29 30 NS
Hill <i>et al.</i> 1993 ³⁸ USA	43 women, 39 men, mean age 59, mean cig/day 28, irregular walkers	(a) Walk: group/indiv, facility/home, 15-35 min, 60-70% HR reserve, [1-3, 12]; (b) as (a) + CP; [1-4, 12]; (c) CP as (b) + nicotine gum	(d) CP as (b)	(i) 1, (ii) 4, (iii) 9	5 day PP, CO < 10 p.p.m.	ET (i) (ii) (iii) (a) 25 10 20 10 (b) 33 33 22 28 (c) 45 41 50 37 (d) 45 32 27 32 NS
Marcus <i>et al.</i> , 1991 ⁴¹ USA	20 women, mean age 39, mean cig/day 28, exercise $\leq \times 1$ /week	(a) CV equipment: group, facility 30-45 min, 70-85% HR max, [3, 15] + CP; [2, 4]	(b) CP as (a)	(i) 1, (ii) 3, (iii) 12	7 day PP, SC < 10 ng/ml	ET (i) (ii) (iii) (a) 50 40 30 20 (b) 0 0 0 0 NS
Marcus <i>et al.</i> , 1995 ⁴² USA	20 women, mean age 38, mean cig/day 23, exercise $\leq \times 1$ week	(a) CV equipment: group, facility, 30-45 min, 70-85% HR max, [3, 15] + CP; [1, 12]	(b) CP as (a) + health education: [3, 15]	(i) 1, (ii) 3, (iii) 12	7 day PP, SC < 10 ng/ml	ET (i) (ii) (iii) (a) 30 30 30 30 (b) 10 10 10 10 NS
Marcus <i>et al.</i> , 1999 ³⁶ USA	281 women, mean age 40, mean cig/day 22, exercise < $\times 2$ week	(a) CV equipment: group, facility, 30-40 min, 60-85% HR reserve, [3, 12] + CP; [1, 12]	(b) CP as (a) + health education: [3, 12]	(i) 3, (ii) 12	Continuous abstinence, SC < 10 ng/ml CO < 8 p.p.m.	ET (i) (ii) (a) 19 16 12 (b) 10 8 5 (a) vs. (b) at ET & (i) ($p = 0.03$), at (ii) ($p = 0.05$)
Martin <i>et al.</i> , 1997 ⁶ USA	92 women, 113 men, problem drinkers, mean age 42, mean cig/day 27, exercise $\leq \times$ week	(a) CV activity: various, group/indiv, facility/home, 15-45 min, 60-75% HR max, [1, 4] + CP; [1, 12]; (b) CP as (a) + nicotine gum	(c) CP (different prog.) then for (a) & (b): [1, 8] + Nicotine Anon: [3, 4]	(i) 7 days, (ii) 6, (iii) 12	7 day PP (i), 24 hour PP (ii/iii), CO < 10 p.p.m.	(i) (ii) (iii) (a) 60 29 27 (b) 52 27 27 (c) 31 21 26 (a) vs. (c) at (i) ($p < 0.01$)
Russel <i>et al.</i> , 1988 ³⁹ USA	42 women, mean age 28, mean cig/day 23	(a) Walk/jog: group/indiv, facility/home, 20-30 min, 70-80% HRmax, [3, 9] + CP; [4, 1]	(b) CP as (a) + health education: [1, 9]; (c) CP as (a)	(i) 1, (ii) 4, (iii) 16	Self-report, CO	ET (i) (ii) (iii) (a + b + c) 83 73 49 34 NS
Taylor <i>et al.</i> , 1988 ⁴³ USA	58 men, post-acute myocardial infarction	(a) CV activity: various, group, facility, 30-40 min, 70-85% HRmax, [3, 23] (ii) [3, 8] + CP $\times$ 1 session; (b) (i, ii) as (a) home: 20 min, $\times$ 5/week	(c) Fit. test at ET; (d) Fit. test at baseline & ET	3.5	Self-report, Plasma thiocyanate < 100 μ mol/l.	ET (a) + (b) 78 (c) + (d) 76 NS

[x, y]: x = Frequency (per week); y = duration (weeks); CV: cardiovascular; CP: cessation programme; HR: heart rate; PP: point prevalence; SC: carbon monoxide; CO: saliva cotinine; ET: end of treatment.

physically active group and a control group at end of treatment.^{36,37} One of these studies also showed a positive effect for exercise on abstinence at both the 3-month and 12-month follow-up points.³⁶ The other studies showed no effect for exercise on abstinence.

In addition to comparing the exercise condition with a control group two of the studies examined the effectiveness of exercise versus nicotine gum.^{37,38} No significant differences were reported. One of the studies did not provide separate abstinence data for the experimental and control groups, although it was reported that no significant difference was found between the groups.³⁹

Effect of variations in design and intervention on the outcomes

General design considerations. Only two of the studies had a sufficiently large sample size to have adequate power to detect a difference of realistic dimensions between the treatment and control conditions.^{36,37} Several of the smaller studies showed a trend for higher rates of abstinence in the treatment condition compared with the controls.⁴⁰⁻⁴²

In one instance the effect of the treatment may have been compromised by the smoking cessation programme being limited to a single counselling session.⁴³ In the other studies a cognitive behavioural cessation programme was provided for both treatment and control conditions. In four of the studies the exercise condition received more staff contact time than the control,^{37,40,41,43} leading to the question of whether the outcomes for abstinence were due to exercise alone or due to additional professional support. The results of one of the studies showing a positive effect for exercise on smoking abstinence may have been confounded by the exercise group receiving a different cessation programme than the control group.³⁷

One of the trials compared the combined effect on smoking abstinence of four different exercise interventions with the combined effect of two different control interventions.⁴³ In this study it was not possible to relate outcomes for smoking cessation to specific interventions.

Although the study by Taylor and colleagues⁴³ satisfied all our inclusion criteria it differed from the others in that the interventions were not intended to initiate smoking abstinence but rather

to maintain abstinence in smokers following acute myocardial infarction (AMI). Thus, the results cannot be easily generalized beyond the context of abstaining post-AMI smokers.

It has been recommended that a smoking cessation programme should start before the quit date and continue into the period of abstinence.⁴⁴ However, only two of the trials did this.^{36,38} With the provision of more extensive cessation programmes the impact of the interventions may have been more pronounced. Furthermore, none of the studies described an intervention in which the smoking cessation and exercise components were integrated in such a way as to reinforce exercise as a coping strategy for smoking cessation.⁴⁵ For example, the potential for exercise to be used to reduce cigarette cravings and other withdrawal symptoms could have been made more explicit.

Characteristics of sample. Demographic factors, such as age, gender, weight, fitness level, socio-economic status and occupation could influence outcomes for both smoking cessation⁴⁶ and exercise behaviour.^{18,47} One study compared outcomes by gender, although no differences were reported.³⁸ A number of the trials reported an increase in fitness levels at the end of the treatment period within the active condition.^{36,41,42} Two studies showed an increase in fitness for the exercise conditions compared with the control at end of treatment,^{36,43} another showed no differences at end of treatment or at a 4-month follow-up.³⁹ Fitness measures are useful as a confirmation of exercise adherence. However, the significance of changes in fitness in the context of smoking cessation is debatable. Since exercise has been shown to benefit psychological and general health without increases in fitness,^{18,48} it is possible that exercise could aid smoking cessation independently of any changes in physical capacity.

One trial reported a significantly smaller weight gain for those in the exercise condition compared with the controls at the end of treatment;³⁶ however, those in the exercise condition by chance weighed more than the controls at baseline, which makes interpretation of the finding problematic.

None of the studies considered outcomes relative to occupation, socio-economic status or age. It is possible that the relationship between demographic variables and outcomes was not explored because of small sample sizes. All the studies were North American, with only two studies recording

ethnic status, and reporting a predominantly caucasian sample.^{36,37} Researchers must consider whether these results can be generalised to other national and ethnic populations.^{47,49,50}

Aspects of exercise programming. In most cases the exercise prescription was fitness-orientated,⁵¹ recommending at least 30 min of exercise 3 days a week at a vigorous intensity of between 70–85% of maximal heart-rate. However, if exercise is being used largely as a means of managing the affective state and body weight of abstaining smokers, rather than as a means of increasing fitness, then an alternative recommendation for short and frequent bouts of moderate intensity activity may be the preferred option for both psychological^{9,52,53} and physical wellbeing.^{54,55} This recommendation is consistent with the US Surgeon General's (1996) guidelines for health-benefiting exercise,⁵⁶ although these were issued after the publication of most of the papers discussed.

Where a quit date was set, the exercise programme began either before the quit date^{36,38,41,42} on the quit date^{37,40} or after the quit date.³⁹ For those beginning exercise either on or after the quit date success rates may have been hampered by the demand to cope simultaneously with two major changes in health behaviour.^{25,57} Furthermore, where the exercise programme started after a period of smoking abstinence the potential for exercise to moderate withdrawal symptoms during this period was lost.⁸

Two studies entailed exercise programmes lasting for less than 6 weeks.^{37,40} In these cases the intervention may have been of insufficient length to encourage long-term exercise adherence. Most of the trials employed supervised, group-based exercise supplemented by a home-based programme. Where home programmes were not provided,^{36,41,42} it is possible that the participants high level of dependence on supervised exercise may have reduced their level of post-intervention activity.

The fact that only one of the studies provided any post-intervention exercise programming³⁸ may also have reduced post-intervention exercise adherence.⁵⁸ However, it is not possible to draw any conclusions about whether various aspects of the intervention affected levels of exercise adherence after the formal supervised programme ended because none of the studies reported rates of adherence for this period.

Exercise adherence issues. During the treatment period a range of behavioural methods were employed to improve adherence to the exercise programme. Methods included self-monitoring,^{37,39,40,43} goal-setting,^{36–43} reinforcement,³⁷ group activities,^{36–43} telephone follow-up in the case of non-attendance,³⁸ remote monitoring of heart rate⁴³ and full supervision of facility-based exercise.^{36–43} All the studies reported activity levels for the treatment group during the treatment period and with the exception of one study compliance with the exercise programme was high.³⁸ Adherence rates may have been improved further through providing a greater choice of physical activities⁵⁹ and through encouraging moderate as well as vigorous exercise.⁶⁰

Although some of the studies reported fitness measures for the control group during the treatment period,^{36,39,40–43} only one of the investigations reported activity levels at this time.⁴⁰ Therefore the relative increase in physical activity in the treatment group versus any spontaneous increase in activity in the control group could not be accurately monitored.

During the follow-up period none of the studies used behavioural techniques to encourage regular exercise. Only one of the studies recorded fitness measures at this time³⁹ and none reported levels of activity, making it impossible to relate long-term abstinence rates with exercise behaviour.

Psychological indicators. Although the majority of the studies used psychological measures at baseline, only one of them reported an investigation of changes in affect.³⁹ This study found a significant increase in Profile of Mood States tension—anxiety scores for the active group compared with the control at 4 months follow-up.³⁹ These findings are inconsistent with the general consensus that exercise reduces mood disturbance and anxiety.^{9,61} Furthermore, no between-group differences on fitness measures were reported at this time, suggesting that the exercise group did not maintain the recommended levels of activity. The reported effect on psychological outcomes may have been caused by extraneous variables which could not be controlled for with such a small sample size.

Studies not satisfying inclusion criteria

The literature search revealed a number of trials

which did not satisfy the specific inclusion criteria, but had exercise as an independent variable and smoking cessation behaviour as a dependent variable. These studies fell into three broad categories.

Multiple independent and dependent variables. A number of studies were identified in which exercise was one element in a multiple risk factor intervention, with smoking cessation behaviour as one of a number of health-related outcomes.⁶²⁻⁷⁰ The specific effects of exercise on smoking cessation could not be determined due to possible interaction and confounding between levels of the independent variables. For example, it is not possible to separate the effects on smoking cessation due to a change in diet versus a change in exercise habits.

Multiple independent variables and a single dependent variable. Four studies were found which included multiple smoking cessation elements one of which was exercise.^{29,71-73} In these studies the specific effects of exercise on smoking abstinence were not addressed.

Single independent variable and multiple dependent variables. In some of the investigations the objective was to increase levels of regular exercise and examine changes in various health and behavioural indices including smoking cessation.⁷⁴⁻⁸⁰ A smoking cessation programme was not provided, nor were records made of the percentage of participants who were trying to stop smoking. None of these studies found a significant effect on smoking abstinence for the active condition. From this evidence, and evidence which shows a trend for lower rates of abstinence for an exercise only condition versus a combined exercise and cessation programme condition,³⁸ one could hypothesize that smoking abstinence is unlikely to occur spontaneously as a result of increasing levels of physical activity.

Discussion

A comparison of the studies was complicated by differences in study design and intervention, and by the relative paucity of research in this field. There were marked variations between the studies in the length, type and timing of the exercise intervention, in the design of the control condition and cessation programme and in the de-

mographic factors recorded. In addition, there was a general absence of data relating to the physical activity levels of the control groups, and of either group during the follow-up period. Together, these factors restricted meaningful comparison of results between studies.

The findings presented in this review have implications for future research in this field. One of the first requirements for future work must be to have trials with larger sample sizes. We have calculated that a sample of three hundred smokers would yield 80% power ($p < 0.05$, two-tailed) at post-treatment, to detect a difference in abstinence rates between treatment and control of 45% vs. 30%, which is broadly in line with the size of effect for NRT.⁵ For a 12-month follow-up an even larger sample size would be required.

It is possible that a greater integration between the smoking cessation and exercise programmes may have enhanced abstinence rates. In future research exercise could be presented more as a self-control strategy as well as a means of increasing fitness and general health and of managing body weight.⁴⁵ For example, in initiating abstinence, exercise could be presented as a strategy for managing withdrawal symptoms and overcoming physical dependency. With regard to relapse prevention, exercise could be presented as a strategy which increases self-esteem and pride in one's health in such a way that being a smoker is no longer an attractive option.⁸¹

At what point should the smoker who is trying to quit begin an exercise programme? In the studies reviewed there was wide variation in the timing of the exercise programme. Available evidence supports the recommendation for changes in exercise and smoking behaviour being sequential rather than simultaneous.^{25,57} It has been argued that a physical activity programme should begin prior to quitting, thereby allowing people to adjust to the demands of being more active before significantly changing their smoking behaviour.⁴² Elsewhere, it has been shown that abstaining smokers are more confident about adopting exercise than those preparing to quit,²⁵ which would support the notion of beginning an exercise programme when already abstinent, although delaying the start of the programme would reduce the potential for managing withdrawal symptoms.⁸ Clearly, further empirical work is required in order to ascertain the relative benefits of initiating exercise at different points in the cessation schedule.

Conclusions

Only one of the eight trials reviewed offered substantial evidence for exercise aiding smoking cessation.³⁶ However, the trials which did not show a significant effect of exercise on smoking abstinence lacked sensitivity because of numerous methodological limitations. Further trials are needed with larger sample sizes, equal contact control conditions, tailored and life-style exercise programmes and measures of exercise adherence across the sample.

Further work is needed to unravel the relationship between different levels and timings of exercise intervention, and the effect on smoking abstinence and on underlying processes such as cravings for cigarettes and mood disturbance.

References

1. DOLL, R., PETO, R., WHEATLEY K., GRAY, R. & SUTHERLAND, I. (1994) Mortality in relation to smoking: 40 years' observations on male British doctors, *British Medical Journal*, 309, 901-911.
2. US DEPARTMENT OF HEALTH AND HUMAN SERVICES (1990) *The Health Consequences of Smoking Cessation: a report of the Surgeon General* (Rockville, MD Public Health Service, Office on Smoking & Health).
3. WEST, R. (1997) *Getting Serious About Smoking Cessation: a review of products services and techniques* (London, No Smoking Day Report).
4. HUGHES, J. R., GULLIVER, S. B., FENWICK, J. W. *et al.* (1992) Smoking cessation among self-quitters, *Health Psychology*, 11, 331-334.
5. SILAGY, C., MANT, D., FOWLER, G. & LANCASTER, T. (1997) The effect of nicotine replacement therapy on smoking cessation, in: LANCASTER, T., SILAGY, C. & FULLERTON, D. (Eds) *Tobacco Addiction Module of the Cochrane Database of Systematic Reviews*, issue 3, 3rd June 1997 (Oxford, The Cochrane Collaboration, Update Software).
6. HILL, J. S. (1981) Health behaviour: the role of exercise in smoking cessation, *CAHPER Journal*, 28, 15-18.
7. HUGHES, J., HIGGINS, S. & BICKEL, W. (1994) Nicotine versus other withdrawal syndromes: similarities and dissimilarities, *Addiction*, 89, 1461-1470.
8. GROVE, J. R., WILKINSON, A. & DAWSON, B. T. (1993) Effects of exercise on selected correlates of smoking withdrawal, *International Journal of Sport Psychology*, 24, 217-236.
9. BYRNE, A. & BYRNE, D. G. (1993) The effect of exercise on depression, anxiety and other mood states: a review, *Journal of Psychosomatic Research*, 37, 565-574.
10. O'CONNOR, P. J. & YOUNGSTEDT, S. D. (1995) Influence of exercise on human sleep, *Exercise and Sport Science Reviews*, 23, 105-134.
11. DEVRIES, H. A. (1987) Tension reduction with exercise, in: MORGAN, W. P. & GOLDSTON, S. E. (Eds) *Exercise and Mental Health*, pp. 99-104 (Washington DC, Hemisphere).
12. KING, A. C., TAYLOR, C. B. & HASKELL, W. L. (1993) Effects of differing intensities and formats of 12 months of exercise training on psychological outcomes in older adults, *Health Psychology*, 12, 292-300.
13. KAWACHI, I., TROISI, R. J., ROTNITZKY, A. G., COAKLEY, E. H., COLDITZ, M. S. & COLDITZ, M. D. (1996) Can exercise minimise weight gain in women after smoking cessation, *American Journal of Public Health*, 86, 999-1004.
14. SORENSON, G., GOLDBERG, R., OCKENE, J., KLAR, J., TANNENBAUM, T. & LEMESHOW, S. (1992) Heavy smoking among a sample of employed women, *American Journal of Preventive Medicine*, 8, 207-214.
15. GRITZ, E. R., KLESGES, R. C. & MEYERS, A. W. (1989) The smoking and body weight relationship: implications for intervention and postcessation weight control, *Annals of Behavioral Medicine*, 11, 144-153.
16. STEPTOE, A., EDWARDS, S., MOSES, J. & MATTEWS, A. (1989) The effects of exercise training on mood and perceived coping ability in anxious adults from the general population, *Journal of Psychosomatic Research*, 33, 537-547.
17. MCAULEY, E., MIHALKO, S. L. & BANE, S. M. (1997) Exercise and self-esteem in middle-aged adults: multidimensional relationships and physical fitness and self-efficacy influences, *Journal of Behavioral Medicine*, 20, 67-83.
18. PATE, P. R., PRATT, M., STEVEN, S. N. *et al.* (1995) Exercise and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine, *Journal of the American Medical Association*, 273, 402-407.
19. ALBREHT, A. E., MARCUS, B. H., ROBERTS, M., FORMAN, D. E. & PARISI, A. F. (1998) Effect of smoking cessation on exercise performance in female smokers participating in exercise training, *American Journal of Cardiology*, 82, 950-955.
20. NIAURA, R., MARCUS, B., ALBRECHT, A., THOMPSON, P. & ABRAMS, D. (1998) Exercise, smoking cessation, and short-term changes in serum lipids in women: a preliminary investigation, *Medicine and Science in Sports and Exercise*, 30, 1414-1418.
21. SHINTON, R. (1997) Lifelong exposures and the potential for stroke prevention: the contribution of cigarettes smoking, exercise and body fat, *Journal of Epidemiology and Community Health*, 51, 138-143.
22. HEDBLAD, B., OGREN, M., ISACSSON, S. O. & JANZON, L. (1997) Reduced cardiovascular mortality risk in male smokers who are physically active, *Archives of Internal Medicine*, 157, 893-899.
23. WANKEL, L. M. & SEFTON, J. M. (1994) Exercise and other lifestyle behaviours, in: BOUCHARD, C., SHEPHARD, R. J. & STEPHENS, T. (Eds) *Exercise, Fitness and Health* (Champaign IL, Human Kinetics).

24. DOHERTY, S. C., STEPTOE, A., RINK, E., KENDRICK, T. & HILTON, S. (1998) Readiness to change health behaviours among patients at high risk of cardiovascular disease, *Journal of Cardiovascular Risk*, 5, 147-153.
25. KING, T. K., MARCUS, B. H., PINTO, B. M., EMMONS, K. M. & ABRAMS, D. B. (1996) Cognitive behavioural mediators of changing multiple behaviours: smoking and a sedentary lifestyle, *Preventive Medicine*, 25, 684-691.
26. DERBY, C. A., LASATER, T. M., VASS, K., GONZALEZ, S. & CARLETON, R. A. (1994) Characteristics of smokers who attempt to quit and of those who recently succeeded, *American Journal of Preventive Medicine*, 10, 327-334.
27. SEDGWICK, A. W., DAVIDSON, A. H., TAPLIN, R. E. & THOMAS, D. W. (1988) Effects of physical activity on risk factors for coronary heart disease in previously sedentary women: a five-year longitudinal study, *Australia and New Zealand Journal of Medicine*, 18, 600-605.
28. METHENY, K. B. & WEATHERMAN, K. E. (1998) Predictors of smoking cessation and maintenance, *Journal of Clinical Psychology*, 54, 223-235.
29. HURT, R. D., DALE, L. C., OFFORD, K. P., BRUCE, B. K., MCCLAIN F. L. & EBERMAN, K. M. (1992) Inpatient treatment of severe nicotine dependence, *Mayo Clinic Proceedings*, 67, 823-828.
30. BOOTS COMPANY PLC (1998) *Give up Smoking! Your guide to a brighter future without smoking* (Nottingham, UK, Boots Company plc).
31. QUIT (1994) *Helping Smokers to Quit: a handbook for the practice nurse, health visitor and midwife* (London, Department of Health).
32. WOODHOUSE, K. & RIGG, E. (1990). *Quit & Get Fit: a guide to running a six week course* (London, HEA).
33. BULL, F. C. L., SCHIPPER, E. C. C., JAMROZIK, K. & BLANKSBY, B. A. (1995) Beliefs and behaviour of general practitioners regarding promotion of physical activity, *Australian Journal of Public Health*, 19, 300-304.
34. WILLIFORD, H. N., BARFIELD, B., LAZENBY, R. B. & SCHARFF-OLSEN, M. A. (1992) A survey of physicians attitudes and practices related to exercise promotion, *Preventive Medicine*, 21, 630-636.
35. CHALMERS, I. & ALTMAN, D. G. (Eds) (1995) *Systematic Reviews* (London, BMJ Publishing Group).
36. MARCUS, B. H., ALBRECHT, A. E., KING, T. K. *et al.* (1999) The efficacy of exercise as an aid for smoking cessation in women: a randomised controlled trial, *Archives of Internal Medicine*, 159, 1229-1234.
37. MARTIN, J. E., KALFAS, K. J. & PATTEN, C. A. (1997) Prospective evaluation of three smoking interventions in 205 recovering alcoholics: one-year results of project SCRAP-Tobacco, *Journal of Consulting and Clinical Psychology*, 65, 190-194.
38. HILL, R. D., RIGDON, M. & JOHNSON, S. (1993) Behavioural smoking cessation treatment for older chronic smokers, *Behavior Therapy*, 24, 321-329.
39. RUSSELL, P. O., EPSTEIN, L. H., JOHNSON, J. J., BLOCK, D. R. & BLAIR, E. (1988) The effects of exercise as maintenance for smoking cessation, *Addictive Behaviors*, 13, 215-218.
40. HILL, J. S. (1985) Effect of a program of aerobic exercise on the smoking behaviour of a group of adult volunteers, *Canadian Journal of Public Health*, 76, 183-186.
41. MARCUS, B. H., ALBRECHT, A. E., NIAURA, R. S., ABRAMS, D. B. & THOMPSON, P. D. (1991) Usefulness of physical exercise for maintaining smoking cessation in women, *American Journal of Cardiology*, 68, 406-407.
42. MARCUS, B. H., ALBRECHT, A. E., NIAURA, R. S. *et al.* (1995) Exercise enhances the maintenance of smoking cessation in women, *Addictive Behaviors*, 20, 87-92.
43. TAYLOR, C. B., HOUSTON-MILLER, N., HASKELL, W. L. & DEBUSK, R. F. (1988) Smoking cessation after acute myocardial infarction: the effects of exercise training, *Addictive Behaviors*, 13, 331-334.
44. RAW, M., MCNEILL, A. & WEST, R. (1998) *Smoking Cessation Guidelines for Health Professionals: a guide to effective smoking cessation interventions for the health care system* (London, HEA).
45. MARLATT, G. A. & GORDON, J. R. (1985) *Relapse Prevention: maintenance strategies in the treatment of addictive behaviours* (New York, Guilford).
46. JARVIS, M. (1997) Patterns and predictors of smoking cessation in the general population, in: BOLLINGER, C. T. & FAGERSTROM, K. O. (Eds) *The tobacco epidemic, Progressive Respiratory Research*, 28, 151-164 (Basel).
47. CASPERSEN, C. J., MERRITT, R. K. & STEPHENS, T. (1994) International exercise patterns: a methodological perspective, in: DISHMAN, R. (Ed.) *Advances in Exercise Adherence*, pp. 73-110 (Champaign II, Human Kinetics).
48. MOSES, J., STEPTOE, A., MATTHEWS, A. & EDWARDS, S. (1989) The effects of exercise training on mental well-being in the normal population: a controlled trial, *Journal of Psychosomatic Medicine*, 33, 47-61.
49. KING, T. K., BORRELLI, B., BLACK, C., PINTO, B. M. & MARCUS, B. H. (1997) Minority women and tobacco: implications for smoking cessation interventions, *Annals of Behavioral Medicine*, 19, 301-313.
50. MACKEY, J. & CROFTON, J. (1996) Tobacco and the developing world, in: DOLL, R. & CROFTON, D. (Eds) *Tobacco and Health, British Medical Bulletin*, 52, 206-221.
51. WILLIAMS, P. & WILKINS, D. (1995) *American College of Sports Medicine Guidelines for Exercise Testing and Prescription*, 5th edn (Philadelphia, Lee & Febiger).
52. DYER, J. B. & CROUCH, G. J. (1987) Effects of running on moods: a time series study, *Perceptual and Motor Skills*, 64, 783-789.
53. STEPTOE, A. & BOLTON, J. (1988) The short-term influence of high and low intensity physical exercise on mood, *Psychology and Health*, 2, 91-106.
54. COLEMAN, K. J., RAYNOR, H. R., MUELLER, D.

- M., CERNY, F. J., DORN, J. M. & EPSTEIN, L. H. (1999) Providing sedentary adults with choices for meeting their walking goals, *Preventive Medicine*, 28, 510-519.
55. DUNN, A. L., MARCUS, B. H., KAMPERT, J. B., GARCIA, M. E., KOHL, H. W. & BLAIR, S. N. (1999) Comparison of lifestyle and structured interventions to increase physical activity and cardiovascular fitness: a randomised trial, *Journal of the American Medical Association*, 281, 327-334.
56. US DEPARTMENT OF HEALTH AND HUMAN SERVICES, CENTERS FOR DISEASE CONTROL AND PREVENTION, NATIONAL CENTER FOR CHRONIC DISEASE PREVENTION AND HEALTH PROMOTION (1996) *Physical Activity and Health: a report of the Surgeon General* (Atlanta, Georgia, Centers for Disease Control and Prevention).
57. EMMONS, K. M., MARCUS, B. H., LINNAN, L., ROSSI, J. S. & ABRAMS, D. B. (1994) Mechanisms in multiple risk factor interventions: smoking, exercise, and dietary fat intake among manufacturing workers, *Preventive Medicine*, 23, 481-489.
58. KING, A. C., FREY-HEWITT, B., DREON, D. & WOOD, P. (1989) Diet versus exercise in weight maintenance: the effects of minimal intervention strategies on long term outcomes in men, *Archives of Internal Medicine*, 149, 2741-2746.
59. THOMPSON, C. E. & WANKEL, L. M. (1980) The effects of perceived activity choice upon frequency of exercise behaviour, *Journal of Applied Social Psychology*, 10, 436-443.
60. SALLIS, J. F., HASKELL, W. L., FORTMANN, S. P., VRANIZAN, K. M., TAYLOR, C. B. & SOLOMON, D. S. (1986) Predictors of adoption and maintenance of physical activity in a community sample, *Preventive Medicine*, 15, 331-341.
61. TAYLOR, A. H. (in press) Physical activity, stress and anxiety: a review, in: BIDDLE, S. J. H., BOUTCHER, S. & FOX, K. (Eds) *Physical Activity and Mental Health: A consensus* (London, Routledge).
62. BURTON, L. C., PAGLIA, M. J., GERMAN, P. S., SHAPIRO, S. & DAMIANO, A. M. (1995) The effect among older persons of a general preventive visit on three health behaviours: smoking, excessive alcohol drinking, and a sedentary lifestyle, *Preventive Medicine*, 24, 492-497.
63. CARLSSON, R., LINDBERG, G., WESTIN, L. & ISRAELSSON, B. (1997) Influence of coronary nursing management follow up on lifestyle after acute myocardial infarction, *Heart*, 77, 256-259.
64. CUPPLES, M. E. & MCKNIGHT, A. (1994) Randomised controlled trial of health promotion in general practice for patients at high cardiovascular risk, *British Medical Journal*, 309, 993-996.
65. DEBUSK, R. F., MILLER, N. H., SUPERKO, H. R. *et al.* (1994) A case-management system for coronary risk modification after acute myocardial infarction, *Annals of Internal Medicine*, 120, 721-729.
66. GIBBENS, R. L., RILEY, M. & BRIMBLE, P. (1993) Effectiveness of programme for reducing cardiovascular risk for men in one general practice, *British Medical Journal*, 306, 1652-1656.
67. IMPERIAL CANCER RESEARCH FUND. OXCHECK STUDY GROUP (1995) Effectiveness of health checks conducted by nurses in primary care: final results of the OXCHECK study, *British Medical Journal*, 310, 1099-1104.
68. LEON, A. S., CONNETT, J., JACOBS, D. R. & RAURAMAA, R. (1987) Leisure time exercise levels and risk of coronary heart disease and death: the multiple risk factor intervention trial, *Journal of the American Medical Association*, 258, 2388-2395.
69. STRANDBERG T. M., SALOMAA, V. V., NAUKKARI-NEN, V. A., VANHANEN, H. T., SARNA, S. J. & MIETTINEN, T. A. (1991) Long-term mortality after 5 year multifactorial primary prevention of cardiovascular diseases in middle-aged men, *Journal of the American Medical Association*, 266, 1225-1229.
70. WORLD HEALTH ORGANIZATION EUROPEAN COLLABORATIVE GROUP (1982) Multifactorial trial in the prevention of coronary heart disease: 2. Risk factor changes at two and four years, *European Heart Journal*, 3, 184-190.
71. CINCIRIPINI P. M., CINCIRIPINI L. G., WALLFISCH A., WAHEEDUL H. & VAN VUNAKIS, H. (1996) Behaviour therapy and the transdermal nicotine patch: effects on cessation outcome, affect and coping, *Journal of Consulting and Clinical Psychology*, 64, 314-323.
72. FORTNAM S. P. & KILLEN J. D. (1995) Nicotine gum and self-help behavioural treatment for smoking relapse prevention: results from a trial using population-based recruitment, *Journal of Consulting and Clinical Psychology*, 63, 460-468.
73. HURT, R. D., EBERMAN, K. M., CROGHAN, I. T. *et al.* (1994) Nicotine dependence treatment during inpatient treatment for other addictions: a prospective intervention trial, *Alcoholism: Clinical and Experimental Research*, 18, 867-872.
74. HEIRICH, M. A., FOOTE, A., ERFURT, J. C. & KONOPKA, B. (1993) Worksite physical fitness programs: comparing the impact of different program designs on cardiovascular risks, *Journal of Occupational Medicine*, 35, 510-517.
75. KING, A. C., HASKELL, W. L., BARR TAYLOR, C., KRAEMER, H. C. & DEBUSK, R. F. (1991) Group vs home-based training in healthy older men and women, *Journal of the American Medical Association*, 266, 1535-1542.
76. MCMURDO, M. E. T. & BURNETT, L. (1992) Randomised controlled trial of exercise in the elderly, *Gerontology*, 38, 292-298.
77. ROSENFELD, O., TENENBAUM, G., RUSKIN, H. & HALFON, S. (1990) Behavioural modifications following a physical activity programme in the Israeli pharmaceutical industry, *Australian Journal of Science and Medicine in Sport*, 22, 93-96.
78. TAYLOR, A. H., DOUST, J. & WEBBORN, N. (1998) Randomised controlled trial to examine the effects of a GP exercise referral in Hailsham, East Sussex, on modifiable coronary heart disease risk factors, *Journal of Epidemiology and Community Health*, 52, 595-601.
79. WEISEMANN, A., METZ, J., NUESSEL, E., SCHEIDT,

- R. & SCHEUERMANN, W. (1997) Four years of practice-based and exercise-supported behavioural medicine in one community of the German CINDI area, *International Journal of Sports Medicine*, 18, 308-315.
80. WOOD, P. D., HASKELL, W. L., BLAIR, S. N. *et al.* (1983) Increased exercise level and plasma lipoprotein concentrations: a one-year, randomized controlled study in sedentary, middle-aged men, *Metabolism*, 32, 31-39.
81. FOX, K. R. (Ed.) (1998) *The Physical Self: from motivation to well being* (Champaign IL., Human Kinetics).

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