Are nutrition and physical activity primary prevention interventions in the primary care setting effective at reducing biochemical and physical risk factors?

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1 Introduction

1.1 Aims

The purpose of this review is to inform the effectiveness of primary prevention interventions in a primary care setting. With a focus on lifestyle, this review is interested in physical activity and nutrition interventions undertaken on individual adults. This review will be of use to primary care practitioners and those interested in primary prevention for physical activity and nutrition.

The purpose of this review was to answer the following research questions:

- What are the directional changes (positive, neutral, negative) of health endpoints (body mass index (BMI), waist circumference, blood pressure, lipids) from nutrition and activity primary prevention interventions in primary care settings?
- What are the recommendations for the sector regarding using lifestyle approaches for primary prevention?

A feature of this review is that studies were excluded if the outcome measured was not biochemical or physiological. Many studies measure individual outcomes such as change in behaviour (minutes of activity, servings of fruit) rather than change in a physiological endpoint (e.g. physical fitness, weight). We were interested in hard endpoints (physical and biochemical, such as weight, blood pressure, blood lipid levels, physical fitness and blood glucose levels) that are clinically relevant in the primary care setting beyond actual health behaviours.

1.2 What is primary care?

Primary care is the first level of contact with the health system where personal health services are delivered in the community, usually from a general practitioner or practice nurse (1, 2).

For the purposes of this review, the authors were particularly interested in primary care settings such as general practice services, mobile nursing services, community health services and pharmacies. This review excluded ‘participating in communities and working with community groups’, which is often included in broad definitions of primary care (1), but beyond the personal services/individual level the authors were interested in examining.

1.3 What is primary prevention?

Primary prevention is such a similar phrase to primary care that confusion is understandable. Primary prevention is the attempt to prevent people from developing diagnosed diseases – that is, preventing people from developing disease in the first place. For the purposes of this review, the authors focused on individuals who did not yet have diabetes, heart disease or another diagnosed disease, but had at least one risk factor such as high blood pressure, high lipids or elevated blood glucose. This compares with *secondary prevention*, where treatment of a diagnosed disease is undertaken in early stages before it causes significant illness. *Tertiary prevention* is where both the diagnosed disease and illness are present, and attempts are made to

restore function and stop this disease getting worse.

1.4 The primary care sector in New Zealand

Primary health organisations are the local structures for delivering and co-coordinating primary care services. Primary health organisations bring together doctors, nurses and other health professionals in the community to serve the needs of their enrolled patients. They are coordinated and funded by district health boards and, as at December 2011, there were 31 primary health organisations. All are not-for-profit organisations.

A primary health organisation provides services either directly or through its provider members. The aim of each primary health organisation is to ensure that general practice services are better linked with other primary care services (such as allied health services) to ensure a seamless continuum of care.

Funding of primary care services in New Zealand has a substantial private payment component (user charges) and a substantial government-funded component, depending on factors of the enrolled population, such as age, high-use, chronic condition, geographical area, etc.

Within the 2011/12 financial year, there were multiple government funding streams for primary health organisations and/or primary care providers in New Zealand[a]. Three are potential sources of funding for nutrition and activity primary prevention interventions. However, the first two do not explicitly focus on primary prevention nutrition or activity interventions for individuals, and while the third could do, it is signalled to end in the 2012/2013 financial year.

1. The first potential funding stream is *health promotion*, and this is targeted at communities and population groups (not the focus of this review) and is not targeted at individuals.
2. The second potential funding stream is *services to improve access*. This has the potential to be used to provide an innovative service to keep well individuals well. However, primary health organisations can only use this funding stream for services delivered to particular socioeconomic and ethnic groups. A typical use of the *services to improve access* funding stream is to transport individuals to their appointments and back.
3. The third potential funding stream is Healthy Eating Healthy Action, a flexible funding stream used for a number of nutrition and physical activity interventions, for example healthy lifestyle interventions that receive participants from GP referrals and may be delivered by primary health organisations.

a Future funding changes are likely to alter the potential options available.

2 Method

A full description of the method is found in Appendix 1. The topic was identified by the Scientific Committee in consultation with the Board and the Executive Director of Agencies for Nutrition Action. A precise and specific search of the literature was conducted on the following electronic databases and websites:

- OVID MEDLINE;
- OVID Nursing database;
- EMBASE;
- PsycInfo;
- EBM Reviews – ACP, Cochrane, DARE and NEED;
- NIHCE Evidence base website).

All databases and websites were searched from January 1996 to 24 February 2011. Full search terms, inclusion and exclusion criteria and an example strategy are provided in Appendix 1.

Of the 509 article abstracts, 198 were found to be potentially relevant by one member of the Scientific Committee, and these were reviewed by all three members. Forty-five papers were selected for further assessment. A further six papers were extracted from the reference lists of retrieved papers. Twenty-eight studies were included in the final report.

Data from the 45 papers were extracted into tabular form for ease of use, capturing such information as author, year, study sample and setting, intervention description, measured outcomes, duration and findings. Appendix 2 provides the description for the final set of 28 papers (after studies with less than six months' follow-up and those studies of populations with underlying conditions were excluded).

The Scientific Committee grouped the intervention studies into a logical framework that would be recognisable to the primary care sector delivering the individual interventions, and analysed the findings by these groupings:

- Physical activity-only interventions,
- Nutrition-only interventions,
- Joint nutrition and physical activity interventions.

Tables 1-3 summarise our findings. Appendix 2 provides a more extensive summary of these papers in annotated bibliography form.

Drafts of each section and subsequent amendments were circulated among all members, and written and verbal comments were incorporated into subsequent drafts. Wording in the final summary statements was informed by the World Cancer Research Fund's (2007) evidence judgement criteria (3).

All authors contributed to the review process and writing of the report and all members of the Scientific Committee have final responsibility for the report.

3 Results

3.1 Studies including physical activity-only interventions

A total of nine studies investigating individual-level physical activity interventions in a primary care setting were reviewed (Table 1). Three studies included a follow-up period of 6–12 months and two of these shorter studies provided the only 3 beneficial outcomes reported for physical activity-only interventions. One of these shorter studies reported no benefits in outcomes including blood pressure, BMI and body weight (4), while two studies reported benefits for outcomes including body weight (5), BMI (6) and waist circumference (6). No study reported harm.

Six studies included a follow-up period of at least 12 months. None of these studies showed any beneficial effects in any of the outcome measurements including fasting blood glucose (7, 8), HbA_{1c} (7, 8), blood lipids and lipoproteins (7–11), blood pressure (8–12), body weight (7–10, 12) and BMI (7-9, 11, 12).

Table 1. Physical activity-only interventions in a primary care setting

Outcome	**>6 months**			**>12 months**		
	Benefit	None	Harm	Benefit	None	Harm
Blood glucose					Fasting (7)* HbA_{1c} (7) Fasting (8) HbA_{1c} (8)	
Subtotal					4 outcomes	
Blood lipids					Total cholesterol (7) Lipids (8–11)	
Subtotal					5 outcomes	
Blood pressure		(4)			(8–12)	
Subtotal		1 outcome			5 outcomes	
Weight	–2.0 kg (5)	(4)			(7–10, 12)	
BMI	–0.7 (6)	(4)			(7–9, 11, 12)	
Waist circumference	–5 cm (6)					
Subtotal	3 outcomes	2 outcomes			10 outcomes	

* The numbers in parentheses in Tables 1–3 are references.

3.2 Studies including nutrition-only interventions

A total of four studies investigating individual-level nutrition interventions in a primary care setting were reviewed (Table 2). One study of six months' duration reported reductions in systolic and diastolic blood pressure (13). The other three studies included a follow-up period of at least 12 months, with five 'no effect' outcomes and three beneficial outcomes. Two of these longer studies reported no effect in blood lipids and lipoproteins (14, 15), body weight (14, 15) and BMI (15). The remaining longer study reported benefits in terms of the ratio of total cholesterol (TC) to high-density lipoprotein cholesterol (HDL-C), body weight and BMI (16). No study reported harm.

Table 2. Nutrition-only interventions in a primary care setting

Outcome	**>6 months**			**>12 months**		
	Benefit	None	Harm	Benefit	None	Harm
Blood glucose						
Subtotal						
Blood cholesterol				TC:HDL-C –0.2 (16)	TC (14) TC and triacylglycerol (TAG) (15)	
Subtotal				1 outcome	2 outcomes	
Blood pressure	Systolic blood pressure –4.0 mm/Hg (13) Diastolic blood pressure –1.4 mm/Hg (13)					
Subtotal	2 outcomes					
Weight				–2.3 kg (16)	(14, 15)	
BMI				–0.8 (16)	(15)	
Waist circumference						
Subtotal				2 outcomes	3 outcomes	

3.3 Studies including both physical activity and nutrition interventions

A total of 15 studies investigating both physical activity and nutrition interventions for individuals in a primary care setting were reviewed (Table 3). Six studies included a follow-up period of 6–12 months. Two of these studies reported no effects for outcomes including blood lipids (17, 18), blood pressure (17) and body weight (18). One study showed benefits in terms of blood glucose and body weight, but not for total cholesterol (19). A further three studies showed positive effects on outcomes including diastolic blood pressure (20) and body weight (20–22). No studies reported harm.

Nine studies involved a follow-up of at least 12 months. Five of these studies reported no effect for outcomes including blood glucose (23), blood lipids and lipoproteins (23–26), blood pressure (23–26) and body weight (23–27). One study showed benefit in terms of weight loss but not for TC or low density lipoprotein cholesterol (LDL-C). Four studies reported beneficial effects for outcomes including blood glucose (28), TC:HDL-C ratio (28), systolic and diastolic blood pressure (29, 30), and body weight (28–30).

Table 3. Joint physical activity and nutrition interventions in a primary care setting

Outcome	**6 months**			**>12 months**		
	Benefit	None	Harm	Benefit	None	Harm
Blood glucose	–0.4 mmol/L (19)			–2.0 mmol/L (28)	(23)	
Subtotal	1 outcome			1 outcome	1 outcome	
Blood cholesterol		TC (19) Lipids (17, 18)		TC:HDL-C –0.4 (28)	TC and LDL-C (31) TC (23, 25, 26) Lipids (24)	
Subtotal		3 outcomes		1 outcome	5 outcomes	
Blood pressure	Diastolic blood pressure –2 mm/Hg (20)	(17)		Diastolic blood pressure –2.6 mm/Hg (29) –0.9 mm/Hg (30) Systolic blood pressure –2.7 mm/Hg (29) –1.3 mm/Hg (30)	(23, 24, 26) Diastolic blood pressure (25)	
Subtotal	1 outcome	1 outcome		4 outcomes	4 outcomes	

Weight	–2.4 kg (19) –4.3 kg (21) –1.4 kg (22) –0.7 kg (20)	(18)		–2.6 kg (31) –1.3 kg (29) –4.5 kg (28) –2.0 kg (30)	(23–27)	
BMI	–0.8 (19) –0.21 (20)	(17)		–0.9 (31) –1.6 (28)	(23, 25, 26)	
Waist circumference	–5.2 cm (19)	(17, 18)		–1.4 cm (29) –4.4 cm (28)	(24)	
Subtotal	7 outcomes	4 outcomes		8 outcomes	9 outcomes	

4 Discussion

4.1 Physical activity-only interventions

Among nine intervention studies that employed a physical activity-only intervention at the individual-level, two were effective (5, 6) (both studies with follow up of less than 12 months), seven showed no effect (4, 7–12) (all studies with follow up greater than 12 months) and zero studies showed harm. Overall, there is *limited suggestive*[b] evidence that physical activity interventions have no effect at altering biochemical or physical endpoints in a primary care setting for individual adults requiring primary prevention.

The physical activity-only interventions with no effect had similar features to the effective interventions. For example, the seven studies with no effect had features such as: intensive home visits (8), ongoing support by experts (9), family support (8), tailored recommendations (10), telephone-based counselling (8), coordinated exercise opportunities (11) and being based on theory (8, 12). That is, they appeared to be both well constructed and conducted, yet were still ineffective at altering biological measures. Despite not achieving changes to individuals' biological endpoints, the studies often achieved changes in other measures, such as improved quality of life scores or increased time spent being active (New Zealand's Green Prescription intervention (9)).

For the two effective interventions in individual adults, Bolognesi *et al.* showed positive changes in BMI and waist circumference after 5–6 months in a small sample of Italian men and women (96 in total) (6). The intervention was modest, where the patient received the Patient-centred Assessment and Counselling for Exercise (PACE) protocol (a 2–5 minute meeting with a 2–3 week follow-up by phone or mail). Dutton *et al.* showed positive changes in body weight after six months in a sample of 139 women (92% African-American) (5). The intervention was moderately intensive, where patients received monthly 15-minute physician home visits for six months. Tailored intervention materials and recommendations were provided to each patient.

bGrading of evidence is presented in italics to signify carefully chosen words that reflect the World Cancer Research Fund (2007) evidence grading system.

4.2 Nutrition-only interventions

Few nutrition studies met the criteria for the review, with most studies either focusing on individuals previously diagnosed with a condition or not having outcome measures of interest to this review.

Among four intervention studies that employed a nutrition-only intervention in individual adults, two were effective (13, 16), two showed no effect (14, 15) and zero studies showed harm. Overall, there was *limited non-conclusive*[c] evidence that nutrition-only interventions are effective in altering biochemical or physical endpoints in a primary care setting for individual adults requiring primary prevention.

Ockene *et al.* (1999) showed positive changes in the TC:HDL-C ratio, weight and BMI after 12 months in a large sample men and women in the USA (930 in total) (16). The effective intervention was modest, where the patient received nutrition counselling from a physician (about 8–10 minutes). The physician had an office support programme to assist the physician undertaking the counselling. An intervention arm without the office support programme for the physician (but still with the 8–10 minute sessions) was ineffective, showing the importance of ongoing office support for this intervention.

John *et al.* showed positive changes in systolic and diastolic blood pressure after six months in a large sample of 690 English men and women (13). The intervention was of low to moderate intensity, where patients received a one-off 25-minute session with a research nurse on tailored practical ways to achieve five servings of fruit and vegetables per day, while also addressing barriers. A two-week follow-up phone call and three-month letter reinforced the tailored messages.

The nutrition-only interventions that were ineffective had features such as: intensive counselling by a physician and/or dietician every six months for five years (individually and in group settings) (15); and low intensity counselling in two sessions of two hours about the Mediterranean diet (14).

4.3 Joint nutrition and physical activity interventions

Fifteen intervention studies for individual adults used a joint nutrition and physical activity intervention. Eight were effective (19–22, 28-31), seven showed no effect (17, 18, 23–27) and no study showed harm. Overall, there was *limited suggestive*[d] evidence that nutrition and activity interventions are effective in altering biochemical or physical endpoints in a primary care setting for individual adults requiring primary prevention.

[c] Less than five studies and heterogeneity of effect.

d While there are a greater number of studies showing positive outcomes, there are also a similar number of studies showing no outcome, indicating an unexplained heterogeneity of effect. Therefore the evidence grading for this set of interventions is also *limited suggestive*.

Interventions showed positive changes at six months for:

- Blood glucose (19),
- Diastolic blood pressure (20),
- Weight (19-22),
- BMI (19).

Interventions showed positive changes at 12 months for:

- Blood glucose (28),
- Ratio of total cholesterol to HDL cholesterol (28),
- Systolic and diastolic blood pressure (29, 30),
- Weight (28–31),
- BMI (28, 31),
- Waist circumference (28, 29).

The key feature of these effective interventions for individual adults was a joint approach targeting multiple risk factors – both activity and nutrition. The interventions that were effective had the following features, but it is worth noting the interventions with no effect had similar features:

- Lifestyle change and advice on diet and activity, and supervised exercise programmes (19, 28, 31) delivered by health professionals (19), nutritionist and expert lecturers (28), and health promotion and exercise physiologists (31);
- Lifestyle change and advice on diet, activity and social support for two years (29) delivered by local public health nurses, and three years (30) delivered by dieticians and health educators;
- Telephone-based counselling delivered by Master's level counsellors covering seven food and activity sessions (21).
- Individual sessions delivered by support staff (22) or physical activity specialists and dieticians (20) covering diet, physical activity and setting appropriate tailored goals;
- Externally provided programmes but with the nature of primary care (9).

4.4 Across all interventions

Effect sizes were spread across all types of interventions. That is, effective nutrition and physical activity interventions had changes in outcomes (such as body weight) that were similar, or higher or lower than nutrition-only and activity-only interventions.

Nearly all of the studies we reviewed for inclusion had positive behavioural outcomes (e.g. increased time spent being active, increased servings of fruit and vegetables consumed), but these did not translate into similar changes in biological endpoints, hence the small number of studies reported as effective in this review.

Over half of all the primary prevention interventions in this primary care setting on this individual adult population, aiming to change particular endpoints, had no effect. Many of the studies with no effect were impressive in their design, theoretical underpinning and multi-risk factor approach. Any primary care practice wanting to develop and deliver an individual-level programme is strongly advised to include active research to ensure that any programme being implemented is actually

working. We also know primary prevention interventions undertaken in other settings (not the focus of this review) have produced encouraging results in the school setting in New Zealand (32, 33), internationally in the local government setting (34) and in the workplace setting (35).

Some of the studies we reviewed were particularly intensive and it could be argued they moved beyond the primary care setting. For example, both the Finnish Diabetes Prevention Study (28) and the UK Lifestyle Change Feasibility Study (19) had supervised exercise sessions as a component of the intervention, and home visiting was a component of the intervention in several other studies.

The majority of the interventions were not delivered by the general practitioner but instead by support staff. One intervention was well suited to a rural population by using a predominantly telephone-based intervention (21).

5 Conclusions

Many studies in the primary care setting with a focus on nutrition and/or physical activity are focused on treatment, not primary prevention. There is *limited suggestive* evidence that physical activity interventions have no effect in altering biochemical or physical endpoints in a primary care setting for individual adults requiring primary prevention. To paraphrase, for the physical activity-only studies, the typical finding was no change in the biochemical outcomes measured. There was *limited non-conclusive* evidence regarding nutrition-only interventions in altering biochemical or physical endpoints in a primary care setting for individual adults requiring primary prevention. There was *limited suggestive* evidence that combined nutrition and activity interventions are effective in altering biochemical or physical endpoints in a primary care setting for individual adults requiring primary prevention.

The studies showed substantial variation between behaviour change outcomes (which were effective) and hard endpoints such as blood lipid levels (*limited suggestive* and *limited non-conclusive* evidence).

The low grades of evidence (*limited suggestive* and *limited non-conclusive*) for the three intervention types reflect that over half of all the primary prevention interventions in this primary care setting, on this individual adult population group aiming to change hard biological endpoints, had no effect. The World Cancer Research Fund (2007) suggests that when such grades of evidence are used, no recommendation for policy or practice should be made (3).

The two largest interventions were effective; however, many of the ineffective interventions had similar features to the interventions that were effective, and were of substantial size themselves. Success does not appear to be directly related to the size of investment in the intervention.

The conclusion that the primary care sector (from predominantly overseas studies) is largely unsuccessful at individual-level primary prevention is important. We have not studied New Zealand alone, nor attempted to study the in-depth nature of success/lack of success within a New Zealand setting (which would require an

entirely different research approach). However, if primary care becomes a focus for primary prevention policy in New Zealand (beyond population level health promotion), then, based on the findings of this review, substantial understanding would be required of features such as the patient journey, the funding pathways, patient/sector expectations and other links within the health sector. It is these processes, we believe, offer substantial opportunities to learn about the potential barriers to successful primary prevention in a primary care setting in New Zealand.

6 Recommendations

Individual-level primary prevention interventions in the primary care sector for altering biochemical or physical endpoints via nutrition and physical activity interventions are not recommended. Population-level interventions and settings other than those in the health sector might offer more promise for primary prevention. Please note that this recommendation relates to primary prevention only, not to treatment within the primary care sector (not a focus of this review).

Any individual-level primary prevention programmes being undertaken in a primary care setting, or suggested to be undertaken, should include a strong active research component to assess whether the intervention is effective. Future research in the primary prevention area needs to focus on the assessment and improvement of delivery mechanisms to patients in this setting. Researchers should also look to include biochemical or physical end points and follow-up of sufficient length to determine long-term efficacy.

There were many studies that were not able to be included in this review because they had no data beyond a behavioural endpoint, and many of these studies showed significant changes in behavioural effect.

Before any further investment is undertaken in this area, further research on the barriers at the institutional level, health professional level and patient level must be known, along with the patient journey, the funding pathways, patient/sector expectations and other links within the health sector, all from a primary prevention perspective.

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Appendix 1: Methods

Goal of the Scientific Committee

The goal of the Scientific Committee is to provide New Zealand nutrition and physical activity community with practical evidence summaries about issues of interest to Agencies for Nutrition Action (ANA) member organisations.

Topic identification

This topic was identified by the Scientific Committee in consultation with the Board and the Executive Director of ANA. The proposed topic was considered to be relevant to ANA and its member organisations, to reflect the professional expertise of members of the Scientific Committee, to contain an adequate amount of relevant literature that had not been reviewed elsewhere and to be of interest to key agencies. Discussion was also held with the Ministry of Health and other agencies about suitable topics, and this topic was endorsed.

Literature identification

Initial discussions by the Scientific Committee and the Executive Director covered the potential questions and issues that should be incorporated into this report.

A precise and specific search of the literature was conducted. The search strategy was devised by the Scientific Committee and was conducted on the following electronic databases and websites:

- OVID MEDLINE;
- OVID Nursing database;
- EMBASE;
- PsycInfo;
- EBM Reviews – ACP, Cochrane, DARE and NEED;
- NIHCE Evidence base website).

All databases and websites were searched from January 1996 to 24 February 2011. The search terms and an example strategy are provided at the end of this methods section.

Data handling process

The following inclusion criteria were used:

- English language only;
- January 1996 to February 2011;
- Human studies;
- Randomised controlled trials (RCTs) and longitudinal studies;
- Adults;
- RCTs, where primary prevention used a physical activity and/or nutrition intervention to reach a health outcome endpoint (blood pressure, exercise capacity, physical fitness, blood lipids, blood glucose, weight, waist circumference). Follow-up had to be of six months duration or longer';
- Interventions directed at primary prevention and early detection only.

Exclusion criteria:

- Studies on populations in developing countries;
- Non-English language;
- Secondary and tertiary care, including that which seeks to arrest or retard existing disease and its effects, and the occurrence/establishment of chronic conditions;
- RCT interventions on infants, toddlers, children and youth;
- Alcohol-alone interventions;
- Eating disorder interventions.

Abstracts were rejected if the intervention included pharmacological components, as these interventions are not included within the remit of ANA. This ensured that the data handling process remained focused on its stated aims and objectives.

Assessment of abstracts and papers, writing the report

Of the 509 article abstracts, 198 were found to be potentially relevant by one member of the Scientific Committee, and these were reviewed by all three members and compared with the research questions to be answered. Forty-five papers were selected for further assessment. A further six papers were extracted from the reference lists of retrieved papers. Twenty-eight studies were included in the final report. There was no blinding of the authorship of retrieved papers. Where papers were found to be irrelevant, they were discarded.

Data from the 45 papers were extracted into tabular form for ease of use by one author (RB), capturing such information as author, year, study sample and setting, intervention description, measured outcomes, duration and findings. At this point, it was realised that some studies still included participants with diagnosed conditions, such as diabetes, and some studies were of very short duration (less than six months) and therefore 17 further papers were excluded. Appendix 2 provides the description for the final set of 28 papers.

One author (GS) used that information to create tables of findings that were relevant to nutrition-only; physical activity-only, and nutrition and physical activity interventions. One author (RQ) wrote up the findings for each topic area and the three authors wrote the remaining sections. Drafts of each section and subsequent amendments were circulated among all members, and written and verbal comments (at teleconferences) were incorporated into subsequent drafts. Wording in the final summary statements was informed by the World Cancer Research Fund's (2007) evidence judgement criteria and the members' judgement. The words (in order of significance) which have been chosen to reflect the consistency, strength and quality of evidence, and the number of studies are:

- Convincing,
- Probable,
- Limited – suggestive,
- Limited – no conclusion (World Cancer Research Fund, 2007).

The report was sent for external review.

All authors contributed to the review process and writing of the report, and all members of the Scientific Committee have final responsibility for the report.

The Scientific Committee acknowledges Jaikishan Desai and Rachel Blanch (Robinson) for the peer review of this report and for providing useful feedback. Finally, thanks to Nikki Chilcott for expertly managing the contract, for her good humour and for ensuring that the authors kept to their deadlines.

Research questions

What are the directional changes (positive, neutral, negative) of health endpoints (BMI, waist circumference, blood pressure, lipids) from nutrition and activity primary prevention interventions in primary care settings?

What are the recommendations for the sector regarding using lifestyle approaches for primary prevention?

Search strategy

The databases were searched using the keyphrases related to primary care (Group 1) and search terms from Group 2, Group 3 or Group 4.

Group 1: Medical subject heading (MeSH) terms related to primary care:

- “Primary health”
- “Primary care”
- “Primary healthcare”
- “Primary care nursing”
- “Community health services”
- “Community health care”
- “Community healthcare”
- “Community networks”
- “Community care networks”
- “Continuity of patient care”
- “Continuity of care”
- “Continuum of care”
- “Delivery of integrated health care”
- “Integrated health care systems”
- “Home nursing”
- “Patient-centred care”
- “Patient-focused care”
- “Primary prevention”

Group 2: Terms related to food lifestyle approaches with MeSH and non-MeSH headings:

- “Food habits”
- “Diet, fat-restricted”
- “Diet, carbohydrate-restricted”
- “Diet, macrobiotic”
- “Diet, protein-restricted”

- “Diet, sodium-restricted”
- “Diet, atherogenic”
- “Diet, vegetarian”
- “Diet therapy”
- “Diet, Mediterranean”
- “Diet”
- “Diet, cariogenic”
- “Diet fads”
- “Nutrition assessment”
- “Nutrition surveys”
- “Appetite”
- “Eat*” as keyword
- “Portion size” as keyword
- “Portion control” as keyword
- “Meal” as keyword
- “Serving size” as keyword
- “Feeding practices” as keyword

Group 3:. MeSH and non-MeSH headings related to (in)activity or exercise:

- “Video games” (MeSH)
- “Television” (MeSH)
- “Screen”
- “Sitting”
- “Sedentary” in title
- “Computer usage”
- “Computer games”
- “Exercise” (main subject heading)
- “Recreation” (secondary subject heading)
- “Physical activity”

Group 4: Other MeSH terms of interest:

- “Lifestyle” (secondary subject heading)

Appendix 2: Description of included studies

Abbreviations used in this table: BL, baseline; BMI, body mass index; BP, blood pressure; cal, calorie; CI, confidence interval; CHD, coronary heart disease; CVD, cardiovascular disease; d, day; DBP, diastolic blood pressure; diff = difference; FRS, Framingham risk score; GP, general practitioner; HbA_{1c}, glycosylated haemoglobin; HDL-C, high density lipoprotein cholesterol; h, hour; MET_{min}, Metabolic equivalent minutes ; MET_{max}, Metabolic equivalent maximum exercise capacity; min, minute; MUFA, monounsaturated fats; Na, sodium; OR, odds ratio; P:S ratio, polyunsaturated fat:saturated fat ratio; PUFA, polyunsaturated fatty acids; RCT, randomised controlled trial; REE, resting energy expenditure; SAFA, saturated fatty acids; SBP, systolic blood pressure; SF-36, Short Form 36; sig, significant(ly); TAG, triacylglycerol; TC, total cholesterol; TC:HDL-C ratio, total cholesterol to high density lipoprotein cholesterol ratio; TE, total energy; wk, week; W:H ratio, waist:hip ratio; y, year.

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
Bemelmans *et al.*, 2000 (14)	118 males and 148 females with hypercholesterolaemia and at least two other CVD risk factors. Participants were recruited from two counties in the Netherlands which were socioeconomically deprived.	*Intervention:* Intensive group education about the Mediterranean diet (involved two meetings of 2 h each). *Control*: Received usual care by GP.	• Dietary changes • TC • BMI	1 year (part of a continuing study lasting four years).	Compared to the control group, the intervention group reduced total fat and saturated fat more than the control by 1.8 % TE (95% CI: 0.2–3.4), and 1.2%TE (95% CI: 0.4–1.9) respectively. Sig diff ($p < 0.05$) in change between intervention and control for dietary intake as follows: Fruit intake: +39 g/d in intervention, –18g/d in control; Fish: +21 g/d in intervention, –11 g/d in control; Poultry: +4 g/d in intervention, 0 g/d in control; Bread: +6 g/d in intervention, –8 g/d in control; No sig diff in vegetables or red meat. Net diff in change in TC was not sig after 1 y. BMI increased at 1 y in both the groups, with no sig diff between the groups.
Bolognesi *et al.,* 2006 (6)	45 male and 51 female overweight	*Intervention:* Received the Patient-centred Assessment and	• BMI • Waist	5–6 months	Sig diff in change between the intervention and control groups for BMI and waist

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
	and obese patients. Patients were recruited from eight male GPs from the district of Cesena in Emilia Romagna, Italy	Counselling for Exercise (PACE) protocol. Intervention incorporated concepts from social cognitive theory and the transtheoretical model. PACE protocol involves an initial 2–5 min meeting with a 2- to 3-week follow-up conducted by phone or mail. *Control: R*eceived usual care.	circumference		circumference ($p < 0.05$). In females, BMI decreased by 0.45 in the intervention and increased by 0.30 in the control. For males, BMI decreased by 0.78 in the intervention group and increased by 0.83 in the control. In females, waist circumference decreased by 2.09 cm in the intervention and increased by 1.7 cm in the control. For males, waist circumference decreased by 6.07 cm in the intervention group and increased by 0.72 cm in the control.
Burtscher *et al.*, 2009 (31)	16 male and 20 female patients with impaired fasting glucose. The setting was primary care centres in Western Austria.	*Intervention:* Received counselling and were offered supervised progressive, individually tailored aerobic programmes for 1 h twice a week. The counselling involved information on the risk of developing Type 2 diabetes, lifestyle change, losing weight, and performing regular physical activity. They were advised to perform at least 30 min/d of exercise. They also received written information on physical activity and diet. *Control:* Received counselling and written information only.	• Levels of exercise capacity • Body weight • Fasting blood glucose • TC • HDL-C • BP	12 months	Exercise capacity ($METs_{max}$) increased by 0.3 in the intervention and decreased in the control by 0.5 ($p = 0.01$). Body weight reduced in the intervention by 2.6 kg and increased in the control by 1.08 kg ($p = 0.03$). BMI decreased in the intervention by 0.9 and increased in the control by 0.3. No sig diff in change between the groups for fasting plasma glucose, TC and HDL-C levels.
Dutton *et al.*, 2007 (5)	139 women (92% African-American).	*Intervention:* Received six 15-minute (one per month) physician visits. Examples of	• Changes in physical activity	6 months	The intervention group lost a mean of 2 kg whereas the control group gained 2 kg. No diff in weekly physical activity ($p = 0.22$) or

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
	The setting was 2 family medicine clinics in Baton Rouge, LA, USA.	advice included incorporating lifestyle activity into daily routines, recommendations to begin an exercise programme to achieve 150 min/wk of at least moderate intensity exercise. Intervention materials were individually prepared and tailored to each patient. It included components from social cognitive theory. *Control:* Received standard care which included usual obesity management conducted in a typical office visit.	• Physical fitness • Body weight		physical fitness (p = 0.65) between the groups. More people in the intervention group (90.1%) achieved at least 150 min of weekly physical activity compared to 76.5% in the control (p < 0.03).
Dyson *et al*., 1997 (7)	201 participants thought to be at risk of developing Type 2 diabetes were recruited from three English and two French centres.	*Intervention:* Received reinforced healthy living advice which was a dietary and exercise package. Participants were seen by a dietician every three months and advised to change their diet in line with the nutritional recommendations of the British Diabetic Association. Those with a BMI over 22 were advised to lose weight. Participants were encouraged to increase physical activity gradually to 5–6 times per week by the end of the year. Participants met with a fitness instructor every three months.	• Dietary intake • Weight • W:H ratio • BP • Physical fitness • Fasting plasma glucose • HbA_{1c} • TC • LDL-C • HDL-C • TAG	1 year	Sig increase in physical fitness in the intervention group compared to the control, net diff = 0.20 (L/min). The only sig diff in diet between the groups was a 3.5% reduction in percent contribution of fat to TE in the intervention compared to a 1.4% reduction in the control. No diff in changes body weight, W:H ratio, fasting plasma glucose, HBA_{1c} or plasma lipids and lipoproteins between the groups.

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
		Control: Received basic healthy living advice. They received written dietary information and were seen by a physician who advised weight loss and increased physical activity. They were seen every three months for assessment of glycaemia, but healthy living advice was not reiterated.			
Edelman *et al.*, 2006 (17)	31 male and 123 female outpatients aged ≥45 y, with 1 or more known CVD risk factors were recruited from primary care practices near an academic medical centre. The actual trial was carried out at the Centre for Integrative Medicine at Duke University Medical Centre, USA	*Intervention:* Personalised Health Planning (PHP) delivered predominantly by a health coach trained in activating techniques to assist patients in setting and achieving health goals. The PHP consisted of personal risk education and a personalised health plan. Techniques included small group sessions (e.g. mind–body approaches, stress management) and individual coaching sessions involving 20–30 min biweekly phone sessions (e.g. clarifying priorities, enhancing motivation). Participants learned about the integrative model of health. *Control:* Received a mailed report including their health risk assessment and BL blood test results, then returned to usual care.	• FRS • BMI • Waist circumference • BP • Fasting lipid profile • BP • Exercise frequency • Readiness to increase exercise and to lose weight	10 months	Intervention group had greater readiness to increase physical activity than the control (p = 0.02). Days of exercise were significantly increased in the intervention compared to the control (3.7 vs 2.4 days, p = 0.002).

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
Elley *et al.*, 2003 (9)	168 male and 582 female sedentary patients aged 40–79 y visiting their GP during the study's recruitment period. Participants were recruited from 42 rural and urban general practices in Waikato, New Zealand.	*Intervention:* GPs or practice nurses were prompted by the patient to give oral and written advice on physical activity during usual consultations. Exercise specialists continued support by phone and post (Green Prescription). *Control:* Received usual care.	• Change in total energy expenditure and leisure time energy expenditure • CVD risk assessed by BP and CHD risk • Quality of life • Potential harm e.g. falls	12 months	Change in total energy expenditure in intervention greater than controls (adjusted diff: 9.38 kcal/kg/wk; $p = 0.001$). Change in leisure time energy expenditure greater in intervention (adjusted diff: 2.67 kcal/wk; $p = 0.02$). Change in leisure time activity greater in intervention (adjusted diff: 33.6 min/wk; $p = 0.04$). The proportion of patients who achieved 2.5 h of moderate or vigorous leisure time activity increased by 14.6% in the intervention compared to 4.9% in the control ($p = 0.003$) with the number needed to treat of 10.3. Changes in quality of life scores for physical (adjusted diff: 7.24; $p = 0.045$), bodily pain (adjusted diff: 4.01; $p = 0.020$), general health (adjusted diff: 4.51, $p < 0.001$) and vitality (adjusted diff: 2.3, $p = 0.047$) were sig greater in the intervention group. No sig changes in other health outcomes or potential harm.
Ellingsen *et al.*, 2006 (15)	This was a follow-up of diet and CVD risk factors 20 y after the end of the Oslo Diet and Anti-smoking Study intervention. 563 males aged	*Intervention:* Participants were counselled by the physician and dietician at visits every six months for five years. Dietary advice was given individually and during group sessions. They were advised to reduce dietary SAFA and cholesterol and	• Fat quality score • Body weight • BMI • TC • TAG	Five-year intervention. Results reported here are 20 y after the cessation of the intervention	The fat score was sig higher in the intervention (mean diff = 1.7 (11.5% of the BL intervention score). Higher score = more protective. Both groups gained weight and increased BMI but no diff was seen between groups. TC and TAG decreased in both groups but no diff was seen between groups.

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
	40–49 y when first recruited and who has elevated serum TC of a high coronary risk score.	increase PUFA. They were asked to consume fibre-rich bread, skimmed milk, lean meat and fish, and not more than 1 egg per wk. Those with high TAG were advised to reduce total energy (mainly by reducing sugar, sweet drinks, alcohol, chocolate and fat intake). *Control:* Participants were seen at 12-month intervals and were not given dietary or anti-smoking advice.			Reported intakes of total fat ($p = 0.01$), SAFA ($p = 0.001$), cholesterol ($p = 0.02$), and Ω6:Ω3 ratio ($p = 0.04$) were lower in the intervention compared to the control. Reported intakes of protein ($p = 0.01$), beta-carotene ($p = 0.01$) and some long chain PUFA ($p = 0.01$), and the P:S ratio were high in the intervention compared with the control. The intervention group reported higher intakes of fish ($p < 0.05$), vegetable cooking oil ($p < 0.001$), and skimmed milk ($p < 0.01$), and a lower intake of eggs ($p < 0.01$), whole milk ($p < 0.05$), low fat milk ($p < 0.05$), total margarine and butter ($p < 0.05$), and hard margarine and butter ($p < 0.05$) than the control group.
Ely *et al.*, 2008 (21)	76 males and 78 females aged >18y were recruited from three primary care practices in rural counties in Kansas, USA.	*Intervention:* Received a telephone-based counselling regimen. Counselling was biweekly during first three months and every month thereafter. Counselling used motivational interviewing principles, and framework from the Social Cognitive Theory, the transtheoretical model, the Theory of Reasoned Action and the Health Belief Model. Topics included relationship with food; increasing fruit, vegetables and fibre intake; decreasing fat and calorie intake; past weight loss attempts; body image and	• Weight • Fruit and vegetable intake • Physical activity	180 days	At day 180, the mean (standard deviation) decrease in body weight was greater in the intervention (–4.3 (4.7) kg) compared to the control group (–0.9 (4.9) kg); $p = 0.01$.

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
		weight loss goals. *Control:* Received usual care.			
Greaves *et al.*, 2008 (22)	51 male and 90 female patients aged ≥18 y were identified by their GP as having a BMI ≥28. The setting was two GP surgeries in a semirural town in the UK.	*Intervention:* Received up to 11 individual sessions over a six-month period. A combination of one-to-one contacts and telephone contacts was received with a mean 34 min per contact. Dietary recommendations were based on reducing energy intake, portion size, fat and SAFA intake, and increasing fibre intake, wholegrain products, vegetables, fruit, low-fat milk, low-fat meat, soft margarines and vegetable oils rich in MUFA. Physical activity recommendations focused on increasing overall physical activity within the context of the individual's existing life. Health counsellors were trained in motivational interviewing. *Control:* Received a standardised pack promoting similar diet and physical activity recommendations to the intervention.	• Proportion of patients achieving 5% body weight reduction. • Proportion meeting the target of 150 min moderate activity per wk. • Weight • Waist circumference • Physical activity levels	6 months	A significantly higher proportion of the intervention group achieved 5% weight loss (24% vs 7%, OR = 4.0 95% CI: 1.4–-11.4). Number needed to treat to achieve 5% weight loss was 6.1 (95% CI: 3.6–20.8). Mean change in weight was higher in the intervention group (mean diff = 1.3 kg) (1.4% of BL for intervention).
Halbert *et al.*, 2000 (10)	299 sedentary males and females aged ≥60 were recruited from two	Both groups had a 20-min session with an exercise specialist.	• Self-reported physical activity • BP	12 months	At 12 months, the median (25^{th}–75^{th} percentile) for sessions per wk of walking increased sig from BL in the intervention group (0 sessions (0–1) to 3 sessions (1–4))

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
	general practices in Adelaide, Australia.	*Intervention:* Received individualised advice about the benefits of physical activity and a pamphlet with a plan for physical activity over the next three months. This involved moderate intensity aerobic activities for a minimum of three sessions per wk, for at least 20 min per session. Heart rate was self-monitored. The exercise plan and potential barriers to exercise were discussed. *Control*: Received a pamphlet promoting good nutrition for older adults, which was discussed for 20 min.	• Weight • Serum lipids • Quality of life scores		compared to the control group (0 sessions (0–2) to 2 sessions (1–3). At 12 months, the median (25^{th}–75^{th} percentile) for frequency of vigorous exercise sessions per wk of increased sig from BL in the intervention group (0 sessions (0–0) to two sessions (0–3)) compared to the control group (0 sessions (0–0) to 0 sessions (0–1). At 12 months, the median (25^{th}–75^{th} percentile) for min per session of vigorous exercise increased sig from BL in the intervention group (0 min (0–0) to 20 min (0–35)) compared to the control group (0 min (0–0) to 0 min (0–15). At 12 months, more intervention than control participants increased their intention to exercise ($p < 0.001$). Quality of life scores decreased over the 12 months. The decrease was sig greater among intervention than control women (but not men) for emotional wellbeing ($p = 0.02$), physical wellbeing ($p = 0.04$) and social functioning ($p = 0.04$). No sig changes in body weight, BP or serum lipids between the control and intervention groups.
Hardcastle *et al.*, 2008 (20)	334 males and females aged 18–65 y with at least one CVD risk factor were recruited from a patient electronic database at a local	*Intervention:* Received standard exercise and nutrition information plus up to five face-to-face counselling sessions with a physical activity specialist and a registered dietician. The counselling intervention	• BP • Blood lipid profile • Physical activity • BMI	6 months	The intervention group sig increased their walking (198 vs –145 MET_{min}/wk; $p = 0.01$) and combined physical activity (245 vs –122 MET_{min}/wk; $p = 0.05$) compared to the control group. Sig diff in the change in the percent inactive between the intervention group (42% at BL vs

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
	health centre in the UK.	incorporated the principles and strategies from psychotherapy and behaviour change theory and included motivational interviewing. *Control:* Received the standard information only.	• Body weight		25% at follow-up) compared to the control (31% vs 27%); $p = 0.005$. The control group sig reduced their fat intake (–2.92% TE from fat) compared to the intervention group (–3.9% TE from fat); $p = 0.01$. The reduction in BMI was greater in the intervention group compared to the control (–0.21 vs 0.15; $p = 0.01$). The reduction in weight was greater in the intervention group compared to the control (–0.7 kg vs 0.12 kg; $p < 0.04$). The reduction in DBP was greater in the intervention group compared to the control (–1.98 mmHg vs 0.49 mmHg, $p = 0.01$).
Hillsdon *et al.*, 2002 (12)	817 males and 841 females aged 45–65 y from two medical centres in Wellingborough, UK.	Participants were randomised into one of three arms: *Direct advice:* Intervention of 30 min where participants received advice about the importance of a physically active lifestyle. This considered usual care and was based on the Health Belief Model. They were advised to work towards 30 min of brisk walking at least 5 d/wk. Participants were telephoned at 2, 6, 10, 18, 26 and 34 weeks, each lasting <3 min. *Brief negotiation:* Based on motivational interviewing. Intervention of 30 min and	• Self-reported physical activity (logbook) • Weight • BMI • BP	12 months	No sig diff in physical activity, BP or body weight/BMI between intervention groups and control.

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
		follow-up phone calls (same times as above) where participants were asked to report on positive and negative outcomes of attempts to become more active. *Control:* Were invited to a health check 11 months later for follow-up.			
John *et al.*, 2002 (13)	338 healthy males and 352 healthy females aged 25–64 y were recruited from two primary-care health centres in Thame, Oxfordshire, UK.	*Intervention:* Included a brief 25-min session with a research nurse on the benefits of eating more fruit and vegetables in order to increase fruit and vegetable intake to at least five daily portions. The brief negotiation method was used to encourage practical ways consistent with their habits and preferences of eating more fruit and vegetables. Participants were encouraged to discuss possible barriers. Two weeks after the initial intervention, a research nurse phoned participants to reinforce the message and discuss any problems. At three months, a letter was sent reinforcing the five-a-day message, a booklet of seasonal recipes and a strategy check list suggesting ways of incorporating additional portions	Plasma concentrations of: • α-carotene • β-carotene • lycopene • β-cryptoxanthin • lutein • retinol • Plasma γ-tocopherol • Plasma β-tocopherol • Ascorbic acid • Self-reported fruit and vegetable intake • Weight • BP	6 months	At six months, the intervention group showed greater increases than the control in plasma concentrations of α-carotene (adjusted diff 7% of BL in the intervention group, $p = 0.027$), β-carotene (7%, $p = 0.005$), lutein (4%, $p = 0.032$), β-cryptoxanthin (25%, $p = 0.0002$) and ascorbic acid (7%, $p = 0.023$). At six months, the intervention group showed reported a greater increase in fruit and vegetable intake (3.4– 4.9 daily portions compared to the control (3.–3.5 daily portions). The adjusted diff in the change between groups was 1.4 (41%) daily portions ($p < 0.0001$). SBP fell more in the intervention (diff in change: 4.0 mmHg (3%); $p < 0.0001$). DBP fell more in the intervention (diff in change: 1.5 mmHg (2%): $p = 0.02$).

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
		of fruit and vegetables into the diet. *Control:* Received usual care.			
Kastarinen *et al.*, 2002 (29)	336 males and 379 females aged 25–74 y with raised BP were recruited from 10 municipal primary health care centres in eastern Finland.	*Intervention:* Four visits to local public health nurses at 1, 3, 6 and 9 months. Participants were instructed to change their health behaviour to meet the following goals: normal body weight; daily sodium intake of <5 g; alcohol consumption <2 drinks/d; exercise at moderate intensity at least 3 times/wk for 30 min; stop smoking. At each visit, BP and weight were measured and lifestyle factors to be obtained by next visit were written down. Written feedback on four-day diet record given. A 2-h group session was organised at 6 and 18 months. *Control:* Received usual care.	• BP • Blood lipids • Lifestyle	2 years	At one year, there were sig diff in mean change between the groups (intervention – control) for DBP (–1.6 mmHg, 95% CI:–2.7,–0.6), body weight (–1.3kg, 95%CI: –1.7,–0.9), waist circumference (–1.4 cm, 95% CI: –2.0,–0.8), hip circumference (–0.9 cm, 95% CI: –1.4; 0.4), % with BMI < 25 (3.9%, 95% CI: 0.1–7.7), % with a 5% reduction in BMI (9.5%, 95% CI: 3.8–15), % with 10% reduction in 24-h urine Na excretion (7.9% (95% CI: 0.2–15.8) and % meeting recommended physical activity (10.7%, 95% CI:1.2–20.3). At two years, there was a sig diff in mean change between the groups (intervention – control) for body weight (–1.2kg, 95% CI: –1.7,–0.7), waist circumference (–1.4 cm, 95% CI: –2.0,–0.8); hip circumference (–0.9 cm, 95% CI: –1.5,–0.4), TC (–0.11 mmol/L, 95% CI: –0.2,–0.01), LDL-C (–0.15, 95% CI: –0.23,–0.05); % with BMI < 25 (4.6% (95% CI: 1.0, 8.4), % with 5% reduction in BMI (11.7%, 95% CI: 5.8,17.7); % with a 10% reduction in 24-h urine Na excretion (7.9% (95% CI: 0.2, 15.8) and % meeting recommended physical activity (11.3%, 95% CI: 1.8, 20.8). In subgroup analysis, among those not taking hypertensive drug treatment, there were sig diff in mean change between groups (intervention-control) at 1 y for SBP (–2.6

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
					mmHg (95% CI: –4.7, –0.5) and DBP (–2.7 mmHg (95% CI:–4.0, –1.4). Similar results were seen at 2 y for SBP (–2.4 mmHg (95% CI: –4.7, 0.0) and DBP (–2.0 mmHg (95% CI: –3.4,–0.6) In participants on antihypertension drugs treatment, there was no sig diff in BP reduction between the groups.
Ketola *et al.*, 2001 (23)	150 males and females aged 18–65 y with CVD or multiple risk factors were recruited from a health care centre in northern Helsinki, serviced by five GPs.	*Intervention:* Participants were seen by a doctor and nurse at BL, 6, 12 and 24 months. The intervention consisted of an individual multifactorial tailored programme, e.g. booklets on healthy lifestyle habits, individual dietary counselling (when BMI ≥ 35), joining a weight reduction group, group or individual physiotherapy programme. *Control:* Received usual care and a booklet on healthy lifestyle habits.	• BP • Blood glucose • TC • Weight • BMI	2 years	Changes were not statistically sig diff between groups.
Kinmonth *et al.*, 2008 (8)	365 sedentary males and females with a parental history of Type 2 diabetes were recruited at 20 GP practice clinics in the UK.	There were two intervention groups. *Intervention 1:* Received a behavioural change programme over the phone. *Intervention 2:* Programme was delivered face-to-face in the home.	• Energy expenditure on daytime physical activity expressed as a ratio to measured REE • Maximal cardiovascular	1 year	No sig diff in change in any outcomes (apart from some SF-36 outcomes) between groups. The intervention groups scored sig better on self-reported health status on six of the eight SF-36 scales, on change in health over the year, and on anxiety than the control. Effect sizes were: physical function (0.20), general health (0.21), anxiety (0.29), social function (0.41), energy levels (0.38), change in

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
		The interventions focused on eight self-regulatory strategies for behavioural change: goal-setting, action planning, self-monitoring, using rewards, goal review, using prompts, building support from family and friends, and prevention of relapses. The telephone intervention included four 45-min calls and two 15-min support calls during the five-month intensive phase, followed by monthly postal contact for the remaining seven months. The home-based intervention included four one-h home visits and two 15-min phone calls during the five-month intensive phase, followed by monthly phone calls for the rest of the year. *Control:* Participants were posted a leaflet with brief motivational advice on the benefits of increased activity.	fitness • Self-reported physical activity • Weight • Body fat • BP • HbA_{1c} • Fasting plasma glucose • Plasma lipids • Plasma insulin • Self-reported measures for psychosocial outcomes by the SF-36 survey		health (0.43), mental health (0.51) and impact on daily activities (0.48).
Lamb *et al.*, 2002 (11)	127 males and 133 females aged 40–70 y taking less than 120 min of moderate intensity per wk were	All participants received standardised advice in a primary care setting led by a physiotherapist. Sessions were conducted in groups of 10–20 and topics included health	• Physical activity (questionnaire) • BMI • Cholesterol	1 year follow-up	No sig diff between groups in intention-to-treat analysis.

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
	recruited from a general practice in Reading, UK.	benefits of exercise, recommended levels of exercise, tips on getting started and adhering to a physical activity programme. The key message was to take at least 120 min/wk of exercise. The seminar lasted 30 min and was supplemented by written guidance. *Intervention:* Received the above and were given verbal and written information about the local health walks programme and encouraged to consider this as an option for increasing physical activity. A local walk coordinator telephoned each participant to explain the programme. There were accompanied walks or packs to encourage independent walking. *Control:* Received the initial advice only.	• Aerobic capacity • BP		
Logue *et al.*, 2005 (24)	207 males and 458 females aged 40-69 y with elevated BMI (>27) or elevated W:H ratio (>0.95 for males and >0.80 for females) were recruited from 15	*Intervention:* A transtheoretical model for chronic disease. Participants received dietary and exercise advice, and three 24-h recalls, plus stages of change assessments for five target behaviours, matched workbooks, and monthly phone	• Weight • Waist circumference • Blood lipids • BP • Physical activity	2 years	No diff in change in weight between the intervention and control. Sig increase in self-reported physical activity in the intervention compared to the control (mean diff = 31.5 min/wk, p = 0.008).

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
	primary care practices in northeastern Ohio, USA.	calls (15 min) from a weight loss advisor. Target behaviours included increased exercise, increased usual activity, increased dietary portion control, decreased dietary fat, and increased fruits and vegetables. *Control:* Received augmented usual care. These participants received dietary and exercise advice, prescriptions, and three 24-h recalls every six months.			
Martin *et al.*, 2008 (27)	144 overweight and obese low-income African-American women, aged 18–65 y were recruited from two primary care clinics in Louisiana, USA.	*Intervention:* Received a tailored programme based on information during an initial assessment. Participants received five physician-counselled office visits on a monthly basis. Topics included weight loss, decreasing dietary fat, increasing physical activity, barriers to weight loss, healthy alternatives when eating out. Participants also received one maintenance session at six months. Physicians received training on stages of behaviour change, motivational interviewing and techniques for behavioural treatment of obesity. *Control:* Received usual care.	• Weight	6-month intervention, follow-up at 9 months, 12 months and 18 months	At nine months, mean (standard deviation) weight change in the intervention group (–1.52 (3.72) kg) differed sig from the control (0.61 (3.37) kg); $p = 0.01$. No sig diff between groups at 12 and 18 months.

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
Ockene *et al.*, 1999 (16)	412 males and 518 females aged 20–65 y with high TC were recruited from a health maintenance organisation in Massachusetts, USA.	There were two. *Intervention 1:* Received physician nutrition counselling (8-10 min). *Intervention 2:* Received physician nutrition counselling (8–10 min) plus an office support programme. The office support was designed to assist the physician in carrying out the counselling sequence. *Control:* Received usual care.	• % TE for SAFA • Weight • LDL-C	1-year follow-up	Compared to the control group there was a sig decrease in TAG in Intervention 2 (diff = –0.13, $p = 0.03$; a sig decrease in TC:HDL-C (diff = –0.2, $p = 0.004$); a sig reduction in % TE SAFA (diff = –1.1% TE, $p = 0.01$), a relative diff of -10.3%TE SAFA; a sig reduction on body weight (diff = –2.3 kg, $p < 0.001$.); and a sig reduction in BMI (diff = –0.81, $p < 0.001$).
Steptoe *et al.*, 1999 (25)	406 males and 477 females with one or more cardiovascular risk factor were recruited from 20 GPs in the UK.	*Intervention:* Included brief behavioural counselling using the stage of change model, carried out by a practice nurse in order to reduce dietary fat and smoking, and increase regular physical activity. *Control:* Received counselling by practice nurses on smoking cessation, reduction in dietary fat and increasing physical exercise by usual methods involving information provision and exhortation.	• Diet • Exercise • Smoking habits • BP • TC • Weight • BMI • Smoking cessation	12 months (interim measures taken at four months)	At four months, there were sig greater reductions in the intervention compared to the control for number of cigarettes per day (diff = 4.5 per day); fat score (diff = 4.8); and SBP (diff = 2.4 mmHg). The change in physical activity was greater for the intervention (diff = 3.7 episodes of moderate or vigorous physical activity in past four week). At 12 months, there were sig greater reductions in the intervention compared to the control for number of cigarettes per day (diff = 5.2 per day) and fat score (diff = 2.8). The change in physical activity was greater for the intervention (diff = 3.9 episodes of moderate or vigorous physical activity in past four weeks). No diff between groups in changes in TC, weight, BMI, DBP or smoking cessation.

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
Stevens *et al.*, 2001 (30)	782 males and 409 females aged 30–54 y who were ~110–165% ideal weight with non-medicated DBP 83–89 mmHg were recruited in USA.	*Intervention:* Weight loss intervention group sought to lose as least 4.5 kg during the first six months of intervention and maintain weight loss for remainder of trial. There was an individual counselling session followed by 14 weekly group meeting lead by dieticians or health educators. This was followed by six biweekly group meetings, The intervention focused on self-directed behaviour change, health education, information on physical activity and social support for maintaining behaviour changes. Focused on decreasing excess fat, sugar and alcohol. Physical activity goal to increase activity to 30–45 min/d, 4–5 times/wk. *Control:* Received usual care.	• Weight • BP	3 years	Mean (95% CI) change in weight at three years was –0.2kg (–0.7 to 0.3) in the intervention and 1.8kg (1.3–2.2) in the control. Mean (95% CI) diff between groups was –2.0 (–2.6 to –1.3); $p < 0.001$. Mean (95% CI) diff between groups for DBP at three years was –0.9 mmHg (–1.7 to –0.0); $p < 0.05$. Mean (95% CI) diff between groups for SBP at three years was –1.3 mmHg (–2.4 to –0.3); $p < 0.01$.
Taylor *et al.*, 1998 (4)	53 males and 89 females who were smokers, hypertensive or overweight, were recruited from two community health centres and one leisure centre in Sussex, UK.	Both the intervention and control group received Health Education Authority leaflets on preventing CHD but were not given specific advice to change their lifestyle. *Intervention*: Received 20 half-price exercise sessions at a leisure centre over 10 wk. The introductory session involved a	• Physical activity (7-day recall) • BP • BMI • Sum of skinfolds	10-week intervention with measurements at 8, 16, 26 and 37 weeks	At 26 and 37 weeks, there were no sig diff in the change of any outcomes between the intervention and control groups. At week 8, moderate physical activity was greater in the intervention (247 vs 145 min/wk; p = 0.02). Energy expended was also sig higher in the intervention (34.6 kcal/kg/d vs 33.7 kcal/kg/d; p = 0.01).

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
		lifestyle assessment, and a brief discussion regarding exercise perceptions and goals.			At 16 weeks, vigorous physical activity was greater in the intervention (59 vs 21 min/wk; p = 0.03). Sum of skinfolds were sig lower in the intervention group (70.3 vs 75.7; p < 0.01).
van Weel *et al.*, 2006 (26)	The study was a longitudinal cohort analysis of cardiovascular outcome of a RCT of cardiovascular prevention after 18 y. The RCT involved 2092 males and females recruited from family practices in Nijmegen, The Netherlands. 2335 participants took part in the remeasurement.	*Intervention:* Received practice nurse support for the follow-up of those at elevated risk of CVD. *Control:* Received usual care.	• Smoking • BMI • BP • TC • Physical activity	Initial intervention was 1 year; this is the 18-year follow-up.	No sig diff in changes in CVD risk factors between the intervention and control groups.
Whittemore *et al.*, 2009 (18)	56 males and 52 females at risk of Type 2 diabetes were recruited from four nurse practitioner sites in New England, USA.	*Intervention:* A lifestyle change program based on the Diabetes Prevention Program. The intervention was based on behavioural science and provided culturally relevant education on nutrition, exercise, and Type 2 diabetes prevention; behavioural support identifying lifestyle change goals and problem-solving barriers to change; and motivational	• % weight loss • Glucose tolerance • Insulin resistance • TC • LDL-C • HDL-C • TAG • Waist circumference • Physical	6 months	No sig diff in changes in outcomes between the intervention and control groups

Author, year (reference)	Study sample and setting	Intervention(s)	Measured outcome(s)	Duration	Findings/effect size
		interviewing. There were six in-person sessions and five phone sessions with nurse practitioners over six months. *Control:* Received advanced standard care where all participants received written information about diabetes prevention, a 20- to 30-min individual session with their nurse practitioner on the importance of a healthy lifestyle and a 45-min individual session with a nutritionist.	activity • Nutrition		