The cost-effectiveness of exercise training for the primary and secondary prevention of cardiovascular disease
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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
Exercise training to improve cardiovascular disease (CVD) risk factors was investigated. Exercise training was defined as aerobic exercise performed at least 3 times per week for 30 minutes per session, within 65 to 85% of an individual's maximum heart rate.

Type of intervention
Primary and secondary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised Canadians aged 35 to 74 years with and without symptomatic CVD, as found in the 1992 Canadian Heart Health Survey.

Setting
The setting was the community and primary care. The economic study was carried out in Canada.

Dates to which data relate
The risk factor data represented the Canadian population as from 1992. The effectiveness data were derived from studies published during the period 1982 to 1998. The cost data related to 1996.

Source of effectiveness data
The effectiveness data were derived from a review and synthesis of completed studies, and from the authors' assumptions.

Modelling
The Cardiovascular Disease Life Expectancy Model (see Other Publications of Related Interest) was used to estimate the benefits and the costs arising with and without exercise training. The model used regression equations to forecast the long-term risk of death as well as developing myocardial infarction, congestive heart failure, transient ischaemic attacks, arrhythmias, stroke. It also forecasted the need for surgical procedures (coronary artery bypass graft, surgery, catheterisation, angioplasty, and pacemaker insertion). The model was a state transition model using a cohort of 1,000 patients. The risk factors were death due to CVD, death due to other causes, survival with a CVD event, or survival without a CVD event. The duration of each cycle was one year.
Outcomes assessed in the review
The outcomes assessed were the effects (percentage change) of exercise training on cardiovascular risk factors. The cardiovascular risk factors were low-density and high-density lipoprotein (LDL and HDL, respectively) cholesterol, and systolic and diastolic blood pressure. Additional outcomes were the adherence with exercise training at 1 year and in the long term, and the cardiovascular risk profile of the Canadian population.

Study designs and other criteria for inclusion in the review
The benefits of exercise training on LDL and HDL-cholesterol were obtained from randomised controlled trials lasting between 3 and 12 months, which were published in English between 1980 and 1999. The evidence for the decrease in the systolic and diastolic blood pressure were derived from a published, critical review of 22 articles evaluating physical activity as a means of reducing blood pressure. The cardiovascular risk profile was obtained using the 1992 Canadian Heart Health Survey, combining information from 10 provincial surveys conducted between 1986 and 1992.

Sources searched to identify primary studies
Not reported.

Criteria used to ensure the validity of primary studies
Not reported.

Methods used to judge relevance and validity, and for extracting data
Not reported.

Number of primary studies included
Seventeen studies provided evidence for the effect of exercise training on the LDL and HDL cholesterol levels. One review, including 22 primary studies, provided evidence for the effect of exercise training on the systolic and diastolic blood pressure. Four studies provided evidence for adherence with exercise training. One primary publication provided data for the cardiovascular risk profile of the Canadian population.

Methods of combining primary studies
The results on the impact of exercise training on the LDL and HDL cholesterol were combined using a meta-analytic approach (weighted averages).

Investigation of differences between primary studies
Not reported.

Results of the review
The weighted changes due to exercise training were a 4% decrease in LDL cholesterol and a 5% increase in HDL cholesterol.

The average reduction in blood pressure was 6 mmHg in both systolic and diastolic blood pressure.

The adherence with exercise training was approximately 50% one year after the initiation of a supervised programme, and 30 to 40% at 5 years.

Methods used to derive estimates of effectiveness
The authors made some assumptions about the effectiveness.
Estimates of effectiveness and key assumptions
The authors assumed that participants who stopped exercise training would revert to the pre-exercise risk level. They also assumed that the benefits would stop at age 75.

Measure of benefits used in the economic analysis
The measure of benefit used in the economic analysis was the life-years gained (years of life saved, YOLS) due to long-term exercise training. These were estimated using the Cardiovascular Disease Life Expectancy Model. The life-years gained in future years were discounted at an annual rate of 3%.

Direct costs
The direct costs analysed were the treatment costs due to acute, non-surgical manifestations of coronary disease. The costs for each CVD medical event were for hospitalisation, the physician, outpatient and emergency fees. These were determined from a published study. The costs were in 1996 Canadian dollars and were converted to US dollars at the 1996 exchange rate. First year costs prior to exercise training included a physician visit with a blood test and an exercise stress test. These costs were an average of Ontario and Quebec health insurance plan fees from 1996. The costs of two different types of exercise programmes were evaluated, a group supervised exercise class and an unsupervised walking programme. Both included the costs of proper clothing and footwear, but the supervised programme included the cost of the programme as well.

The costs were discounted at an annual rate of 3%. All the unit costs were reported. The resource quantities were not reported and some were derived from the model.

Indirect Costs
No indirect costs additional to the cost of exercise training (if borne by the patients) were evaluated.

Currency
US dollars ($). The 1996 exchange rate was US $1=Canadian $1.364.

Sensitivity analysis
Sensitivity analyses were conducted on the cost per YOLS. These investigated the effect of 100% and 20% adherence rates, a 5% discount rate, double and half the yearly cost of the supervised exercise programme, and the assumption that the impact of exercise training on the risk of CVD would continue until death.

Estimated benefits used in the economic analysis
Assuming a 100% lifetime adherence, the benefit of exercise training for men without CVD aged between 35 and 54 years was 0.7 YOLS. The YOLS were less for older men and all women without CVD. However, the YOLS were greater for those with CVD, compared with their age- and gender-matched counterparts without CVD. The YOLS were greatest for younger men with CVD, 1.18 YOLS for men aged 35 to 54 years.

Cost results
The costs were only given separately for the use of an unsupervised exercise programme in a 35- to 54-year-old man without CVD. The incremental discounted total cost amounted to cost-savings of $182.70. These costs varied depending on the age group, gender, disease status, and type of exercise programme.

Synthesis of costs and benefits
The unsupervised exercise gave an incremental cost-effectiveness ratio of less than $12,000/YOLS for all individuals.
with and without CVD under the base-case assumptions. The assumptions were an adherence of 50% in the first year and 30% for all remaining years, benefits stopped at age 75 years, and the cost of the exercise programme continued until death.

Supervised exercise gave a cost-effectiveness ratio of less than $20,000/YOLS for all men with CVD, and for women with CVD who were between 55 and 64 years of age. The cost-effectiveness ratio was $20,000 to $40,000/YOLS for younger men (35 to 64 years) without CVD and older women (65 to 74 years) with CVD, and was borderline (greater than $40,000/YOLS) for all others.

The cost-effectiveness improved when the benefits were assumed to accrue until death, when 100% adherence with the exercise programme was assumed, and when the costs of the exercise programme were halved. The cost-effectiveness worsened under the other assumptions in the sensitivity analyses.

Authors’ conclusions
Unsupervised exercise training was an efficient use for resources as it was highly cost-effective across all age groups and for both genders, even with a long-term compliance rate of 30%. Supervised exercise was highly cost-effective for both men and women with CVD who were aged between 55 and 64 years. It was relatively cost-effective for men without CVD and older women with CVD. It was borderline or expensive for women without CVD and younger women with CVD.

CRD COMMENTARY - Selection of comparators
The authors did not provide an explicit justification for their choice of the comparator (no exercise training).

Validity of estimate of measure of effectiveness
The measure of effectiveness was derived from a systematic review of the literature, as reported by the authors. The effectiveness estimates were combined through averages weighted by the sample size of the exercise group, which was an appropriate approach. The methods used to derive the estimates of effectiveness were generally clearly reported. Details of the sources searched and the search strategy used were not provided. In addition, the methods used to assess the validity of the studies and to extract the data were not provided. The authors made some assumptions about the effectiveness, and these were tested in the sensitivity analysis.

Validity of estimate of measure of benefit
The estimates of benefits were derived from a Markov model. The instrument used to derive a measure of health benefit, the Cardiovascular Disease Life Expectancy Model (developed from the Lipid Research Clinics Program Prevalence and Follow-up studies), appears to have been appropriate for the objective of the study. References were given.

Validity of estimate of costs
The authors did not explicitly state the perspective adopted. All costs for the exercise programme and future CVD events were considered in the analysis. The unit costs were reported but without the resource quantities. The uncertainty relating to the effectiveness estimates and the Cardiovascular Disease Life Expectancy Model was not explored. The sensitivity of the results to the cost of the exercise programme, the adherence to the intervention and the duration of the benefit, was analysed.

Other issues
The authors made appropriate comparisons of their findings with those from other studies. The authors did not present their results selectively, except that the resource quantities were not reported in full. The authors used Canadian costs and the CVD risk profile for the Canadian population, and thus the study is relevant to the Canadian setting. The issue of generalisability was discussed and explored through the sensitivity analysis. The authors reported a number of
conservative assumptions adopted that may be regarded as limitations. First, the exclusion of benefits from managing and preventing non-insulin dependent diabetes mellitus, reducing body fat or coronary mortality. Secondly, the assumption that the benefits stopped at the age of 75 years. Finally, the exclusion of quality of life benefits or benefits due to preventing non-CVD events.

**Implications of the study**
The authors recommend that, given the relatively few risks and the many benefits, some form of exercise training (either supervised or unsupervised) can be cost-effective for everyone. In addition, if long-term compliance is improved, lives and money can be saved.

**Source of funding**
Supported in part by the Fonds de la Recherche en Sante du Quebec, Montreal.

**Bibliographic details**

**PubMedID**
10860196

**Other publications of related interest**

**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Adult; Aged; Canada /epidemiology; Cardiovascular Diseases /economics /epidemiology /etiology /prevention & control; Cost-Benefit Analysis; Exercise; Female; Humans; Life Expectancy; Male; Middle Aged; Models, Cardiovascular; Primary Prevention /economics; Risk Factors

**AccessionNumber**
22000007672

**Date bibliographic record published**
30/11/2002

**Date abstract record published**
30/11/2002