Cost-effectiveness of aerobic and resistance exercise in seniors with knee osteoarthritis

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
The use of aerobic versus resistance exercise training for patients with knee osteoarthritis.

Type of intervention
Secondary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The population comprised individuals aged 60 years or older, with knee osteoarthritis. Individuals were eligible for inclusion in the study if they met the following criteria:

- age 60 years or over;
- pain on most days of the month in one or both knees;
- difficulties with walking quarter of a mile, climbing stairs, getting in and out of a car, rising from a chair, lifting and carrying groceries, getting out of bed or the bathtub, or performing shopping, cleaning or self-care activities, due to knee pain;
- radiographic evidence of knee osteoarthritis in the tibial-femoral compartments on the painful knee(s), as judged by a radiologist.

Individuals were excluded from participation if they were seriously ill, they were unable to walk 420 feet in 6 minutes without an assistive device, or they resided in or were planning to move to an extended care facility. They were also excluded if they currently exercised on a regular basis, or were participating in another research study.

Setting
The setting was the community. The economic study was conducted in the USA.

Dates to which data relate
The effectiveness and resource use evidence related to a 15-month period from May 1992 to July 1994. The price year was 1994.

Source of effectiveness data
The effectiveness data were derived from a single study.
Link between effectiveness and cost data
The costing was carried out retrospectively on the same patient sample as that used in the effectiveness analysis.

Study sample
A total of 4,575 individuals were screened by telephone during the study period. Of these, 439 were eligible and agreed to participate in the study. Overall, 144 patients were randomised to the aerobic exercise group, 146 to the resistance exercise group, and 149 to the health education group. The mean age in the aerobic exercise group was 69 (+/-6) years and 31% were men. The mean age in the resistance exercise group was 68 (+/-6) years and 27% were men. The mean age in the health education group was 69 (+/-6) years and 31% were men. No power calculations to determine sample size were reported.

Study design
The study was a single-blind randomised clinical trial carried out in two centres (the University of Tennessee in Memphis and the Wake Forest University at Winston Salem). The duration of follow-up was 18 months. The blinding seems to have referred to the assessment of the outcomes (predominantly self-completed questionnaires). The method of blinding was not reported.

A total of 365 participants (83%) completed the study. The retention was not statistically different among the intervention groups (aerobic group 81%, resistance group 84%, and health education group 83%). The participants who did and did not complete the study were not significantly different in terms of their age, gender, race, number of chronic conditions, initial X-ray score, knee pain or disability score.

Analysis of effectiveness
The basis for the analysis of the clinical study was not stated. It would appear that all the patients included in the study were accounted for in the analysis, thus implying an intention to treat basis. The outcome measures considered in the analysis were self-reported disability, measures of physical performance, and measures of pain frequency and pain intensity on ambulation and transfer.

Self-reported physical disability was measured using an investigator-developed questionnaire of 23 questions, which addressed the amount of difficulty the respondent had with daily activities. Physical performance was determined from the distance walked in 6 minutes, a timed stair climb and descent, a lift and carry task, and the time required to get into and out of a car. The frequency and intensity of knee pain was measured using the Knee Pain Scale (KPS), which was a scale developed in the study and specific to patients with knee osteoarthritis. The four dimensions assessed were transfer pain frequency, ambulatory pain frequency, transfer pain intensity, and ambulatory pain intensity. The groups were comparable in terms of their sociodemographic variables, co-morbid status, and other health variables.

Effectiveness results
The outcome measures at 18 months were reported for the three groups as follows.

Self-reported physical disability: education 1.90 points, aerobic exercise 1.72 points, and resistance exercise 1.74 points.

Six-minute walking distance: education 1,349 feet, aerobic exercise 1,507 feet, and resistance exercise 1,406 feet.

Stair climb: education 13.9 seconds, aerobic exercise 12.7 seconds, and resistance exercise 13.2 seconds.

Lifting and carrying task: education 10.0 seconds, aerobic exercise 9.1 seconds, and resistance exercise 9.3 seconds.

Car task: education 10.6 seconds, aerobic exercise 8.7 seconds, and resistance exercise 9.0 seconds.

Transfer pain frequency: education 3.18 points, aerobic exercise 2.89 points, and resistance exercise 2.99 points.
Ambulatory pain frequency: education 3.46 points, aerobic exercise 3.12 points, and resistance exercise 3.06 points.

Transfer pain intensity: education 2.28 points, aerobic exercise 2.10 points, and resistance exercise 2.11 points.

Ambulatory pain intensity: education 2.45 points, aerobic exercise 2.27 points, and resistance exercise 2.34 points.

Compared with the health education control group, the aerobic exercise group participants had better scores on the self-reported physical disability, (p<0.001), knee pain, (p=0.001), 6-minute walking distance, (p<0.001), stair climb, (p=0.05), lifting and carrying task, (p<0.001), and car task, (p<0.001).

Compared with the health education control group, the resistance exercise group participants had better scores on the self-reported physical disability, (p=0.003), knee pain, (p=0.02), 6-minute walking distance, (p=0.02), lifting and carrying task, (p=0.001), and car task, (p=0.003).

**Clinical conclusions**
The magnitude of the differences in efficiency between the aerobic and resistance exercise programmes, compared with the health education programme, was small when self-reported disability and various measures of physical functions had been analysed.

**Measure of benefits used in the economic analysis**
No single measure of benefit was used in the economic analysis. However, an incremental cost-effectiveness analysis was carried out for each of the nine outcome measures assessed.

**Direct costs**
The cost/resource boundary adopted was not explicitly stated. The analysis of the direct costs included:

- physician office visits for check-up and consultation on the exercise interventions (1994 Medicare Physician Fee Schedule);
- in-centre activities, derived from a survey of local health clubs);
- four home visits of the exercise instructor to the exercise participants (based on authors' assumptions);
- telephone follow-up (18 follow-up phone calls of 15-minutes each, made by the exercise instructor for the exercise participants and by a nurse for the education participants);
- additional medical referrals, due to the detection of physical problems that would otherwise have gone unnoticed (1994 Medicare Physician Fee Schedule), and
- the costs associated with adverse events (ICD9 charges).

The unit costs and the quantities of resources were only reported separately for a few items. Discounting was irrelevant since all the costs were incurred over less than two years. The price year appears to have been 1994.

**Statistical analysis of costs**
No statistical analysis of the costs was carried out.

**Indirect Costs**
No indirect costs were analysed.
Currency
US dollars ($).

Sensitivity analysis
A sensitivity analysis was performed. This assumed a zero probability of adverse events for both exercise groups.

Estimated benefits used in the economic analysis
See the 'Effectiveness Results' section.

Cost results
The education programme cost $343.98 per participant. This comprised $171 in in-centre activities, $171 in telephone follow-up, and $1.98 in medical referrals. The aerobic exercise intervention cost $323.55 per participant. This comprised $32.71 in medical consultation, $135 in in-centre activities, $93.25 in home visits, $51.98 in telephone follow-up, $7.95 in medical referrals, and $2.66 in adverse events. The resistance training intervention cost $325.20 per participant. This comprised $32.71 in medical consultation, $135 in in-centre activities, $93.25 in home visits, $51.98 in telephone follow-up, $8.28 in medical referrals, and $3.98 in adverse events.

Both the aerobic and the resistance exercise were cheaper than the education intervention. Compared with the education intervention, the incremental cost of the aerobic intervention resulted in a cost-saving of $20.43 per person and the incremental cost of the resistance intervention in a cost-saving of $18.78 per person. The costing was programme-based for the intervention programme and follow-up.

Synthesis of costs and benefits
An incremental cost-effectiveness analysis was carried out, comparing both exercise programmes with the education intervention.

Compared with the education intervention, the incremental costs per incremental unit of improvement with the aerobic intervention were -$114 per self-reported disability score, -$0.13 per 6-minute walking distance, -$17 per stair climb, -$23 per lifting and carrying task, -$11 per car task, -$70 per transfer pain frequency, -$60 per ambulatory pain frequency, -$114 per transfer pain intensity, and -$114 per ambulatory pain intensity.

The corresponding values for the resistance intervention were -$117 per self-reported disability score, -$0.33 per 6-minute walking distance, -$27 per stair climb, -$27 per lifting and carrying task, -$12 per car task, -$99 per transfer pain frequency, -$47 per ambulatory pain frequency, -$110 per transfer pain intensity, and -$171 per ambulatory pain intensity.

The sensitivity analysis, which assumed zero probability of adverse events, had minimal influence on the incremental cost and did not change the conclusions.

Authors' conclusions
Both exercise programmes were cheaper and more effective than a simple education intervention. However, the resistance training for seniors with knee osteoarthritis was slightly more economically efficient than aerobic exercise in improving physical function.

CRD COMMENTARY - Selection of comparators
The authors justified their choice of the education intervention as a comparator on the grounds that is was a means of minimising attention and social interaction biases. You should decide whether the comparator represents current practice in your own setting. The authors acknowledged that other sources of exercise training were available.
Validity of estimate of measure of effectiveness
The analysis used a randomised controlled trial, which was appropriate for the study question. The study sample was representative of the study population, and the patient groups were shown to be comparable at analysis. The analysis of the clinical study appears to have been conducted on an intention to treat basis, although this was not explicitly stated. The authors stated that the drop-outs were not significantly different from those who remained in the study. Power calculations were not performed.

Validity of estimate of measure of benefit
No summary measure of health benefit was used in the analysis. A number of effectiveness measures were used to derive the cost per unit of effectiveness. The comparisons of the aerobic training and the education programmes, and the resistance exercise and the education programmes, appear to have been inappropriate since both exercise programmes were dominant over the education programme (both more costly and less effective). It would have been more interesting to have compared the two exercise programmes, although the aerobic exercise programme was dominant over the resistance exercise programme in terms of almost all outcomes, with the exception of ambulatory pain frequency.

Validity of estimate of costs
The cost/resource boundary adopted in the analysis was unclear. The major costs and categories were reported. The price year was not reported for the adverse events. Statistical analyses on the quantities were not reported. A sensitivity analysis was only performed for zero probabilities of adverse events for both exercise programmes, and no effect on the final results was observed. The costs and the quantities were reported separately for the occasions where the programme was costed (initial medical visit, in-centre sessions, and follow-up activities). Charges were generally used to proxy prices.

Other issues
The authors made few appropriate comparisons of their findings with those from other studies, and did not address the issue of generalisability to other settings. Thus, the external validity was quite limited. The discussion of the results was limited. The overall authors' conclusion is not justified by the results reported, as the aerobic exercise programme proved to be the most cost-effective intervention, rather than the resistance exercise programme.

Implications of the study
The authors acknowledge that further research is needed to examine the impact of the exercise interventions on the long-term cost and utilisation of health care services, and on the patients' quality of life in terms of general utility.

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