Effectiveness and economic evaluation of a nurse delivered home exercise programme to prevent falls. 2: Controlled trial in multiple centres

M Clare Robertson, Melinda M Gardner, Nancy Devlin, Rob McGee, A John Campbell

Abstract

Objectives To assess the effectiveness of trained nurses based in general practices individually prescribing a home exercise programme to reduce falls and injuries in elderly people and to estimate the cost effectiveness of the programme.
Design Controlled trial with one year's follow up.
Setting 32 general practices in seven southern New Zealand centres.
Participants 450 women and men aged 80 years and older.
Intervention 330 participants received the exercise programme (exercise centres) and 120 received usual care (control centres); 87% (371 of 426) completed the trial.
Main outcome measures Number of falls, number of injuries resulting from falls, costs of implementing the programme, and hospital costs as a result of falls.
Results Falls were reduced by 30% in the exercise centres (incidence rate ratio 0.70, 95% confidence interval 0.59 to 0.84). The programme was equally effective in men and women. The programme cost $NZ418 (£121) (at 1998 prices) per person to deliver for one year or $NZ1519 (£441) per fall prevented. Fewer participants had falls resulting in injuries, but there was no difference in the number who had serious injuries and no difference in hospital costs resulting from falls in exercise centres compared with control centres.
Conclusions An individually tailored exercise programme, delivered by trained nurses from within general practices, was effective in reducing falls in three different centres. This strategy should be combined with other successful interventions to form part of home programmes to prevent falls in elderly people.

Introduction

Three questions need to be addressed in the development and evaluation of a public health intervention: "can it work?", "does it work in practice?", and "is it worth it?"[1] Our research group considered the efficacy, effectiveness, and efficiency of a home based, individually tailored, muscle strengthening and balance retraining programme, designed to prevent falls in elderly people living in the community.

We tested the exercise programme in a group of women aged 80 years and older and showed it could work.[2] The numbers of falls and falls resulting in moderate injuries were reduced when the exercise programme was delivered by a physiotherapist from the research group. The reduction in falls continued during a second year of follow up.[3]

In this paper we report the results from the second of two pragmatic trials designed to test the effectiveness and efficiency of the same exercise programme in routine clinical practice. In this trial the programme was delivered from general practices by trained practice nurses to men and women aged 80 years and older. We initiated the trial as a health promotion exercise to evaluate the processes involved and to determine whether the exercise programme would be as effective in reducing falls in the wider community as it had been for women in the initial trial in a research setting.

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BMJ 2001;322:1–5

Participants and methods

Participant recruitment

We identified potential participants aged 80 years and older from computerised registers at 32 general practices (56 doctors) in seven southern New Zealand centres. These patients received a letter from their doctor inviting them to take part in the study. The criteria for exclusion were inability to walk around own residence, receiving physiotherapy at the time of recruitment, or not able to understand the requirements of the trial. Recruiting took place over a six month period in 1998.

Trial design

This was a controlled trial, with one year's follow up. The sample size calculation was based on the proportion of elderly people who fell once or more in a 12 month prospective study in the community,[4] an expected reduction from 0.50 to 0.30, and allowance for the multicentre design, the Poisson type distribution of falls, and a 20% dropout rate. Our study was approved by the ethics committees of the Southern Regional Health Authority Otago and Southland.

Table 1 Characteristics of participants at entry to trial. Values are numbers (percentages) unless stated otherwise

Characteristic	Control centres (n=120)	Exercise programme centres 1 (n=115)	2 (n=120)	3 (n=95)
Mean (SD) age (years)	84.2 (3.1)	82.7 (2.5)	83.6 (2.8)	84.1 (3.0)
Men	35 (29)	32 (28)	37 (31)	32 (34)
Living arrangements:				
Two or more participants in one home	20 (17)	26 (23)	24 (20)	12 (13)
Living alone	74 (62)	64 (56)	76 (63)	56 (59)
Living in nursing home	—	1 (1)	2 (2)	—
Fallen in previous year	55 (46)	47 (41)	54 (45)	53 (56)
Medical conditions:				
Parkinson's disease	3 (3)	2 (2)	1 (1)	1 (1)
Stroke	16 (13)	15 (13)	18 (15)	12 (13)
Hip fracture	3 (3)	2 (2)	8 (7)	3 (3)
Knee or hip pain, or both	34 (28)	34 (30)	39 (33)	25 (26)
Mean (SD) scores on SF-12*:				
Physical component	42.0 (10.2)	43.1 (10.0)	40.1 (11.0)	42.4 (11.6)
Mental component	56.4 (4.5)	55.6 (5.0)	55.1 (5.7)	54.1 (6.6)
Mean (SD) No of current prescribed drugs	3.0 (2.1)	2.7 (2.0)	3.8 (2.1)	2.6 (1.8)
Taking psychotropic drugs	16 (13)	4 (4)	13 (11)	17 (18)
Home assistance:				
Cleaning	47 (39)	47 (41)	49 (41)	34 (36)
Showering	9 (8)	3 (3)	4 (3)	10 (11)
Meals on wheels	16 (13)	7 (6)	16 (13)	10 (11)

*Score ranges 0–100, lower scores indicate poorer health.

We chose three centres as exercise centres and a similar mix of four towns to act as control centres. The 120 participants in the control centres were required to indicate that they would be willing to receive the exercise programme if it was offered. After written informed consent was obtained and baseline assessments (personal characteristics, health, and function) completed at home by an independent assessor, the 330 participants in the exercise centres received the muscle strengthening and balance retraining programme.

Intervention

The three nurses from the exercise centres received the same training and implemented the same exercise programme as in the accompanying article.[5] For the delivery of the programme the nurses were employed part time on research funding. In addition to supervision by the physiotherapist the nurses attended team meetings at the supervising centre on four occasions to discuss progress and any problems and to compare experiences.

Measurement of falls and injuries and health status

Fall events were defined and monitored for one year and the severity of injury categorised as described in the accompanying article.[5] The nurse or independent assessor in each centre telephoned participants to record the circumstances of the falls and any injuries or resource use as a result of the falls. The SF-12 questionnaire was used to estimate self perceived health status at entry to the trial.[6]

Methods used in economic evaluation

The methods used in the economic evaluation are detailed in the accompanying paper.[5] We report costs in 1998 New Zealand dollars, exclusive of government goods and services tax.

Assuming that participants keep exercising, the benefits of the exercise programme would extend past the time individuals participated in the trial, but the extent of this benefit and longer term compliance rates are uncertain. We calculated cost effectiveness ratios for the duration of the trial only.

Statistical analysis

We analysed data with the same methods as in the accompanying article.[5] Four participants in the exercise centres completed the baseline assessments but did not receive any visits (one died, a spouse died, and two were no longer interested). The mean (SD) time between the baseline assessment and the first home visit for the exercise programme was 17.0 (14.0) days. We analysed data on an intention to treat basis with Stata Release 6 and SPSS 6.1.1.

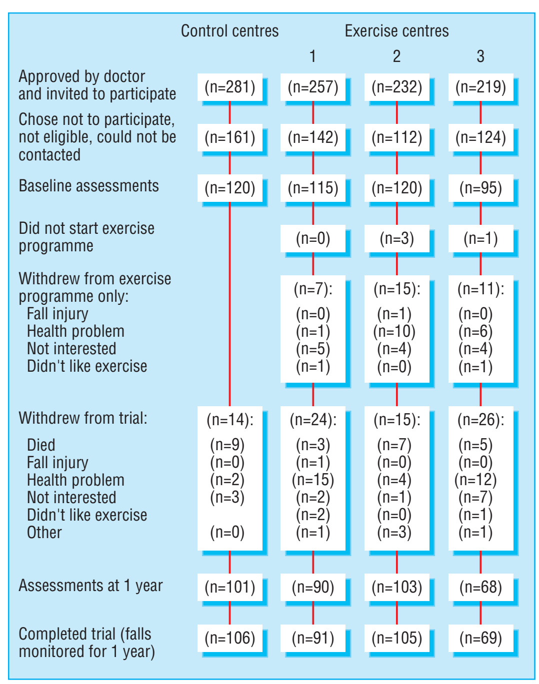
We compared the number of falls and the number of falls resulting in injuries (moderate or serious) in the exercise and control centres using negative binomial regression models, adjusting standard errors for clustering on centre.[7] These models estimate the number of occurrences of an event when the event has Poisson variation with overdispersion, and they allow for variable follow up times for participants and investigation of the treatment and interaction effects.

We present unadjusted results for the remainder of the outcome variables because the numbers of events were low and the within centre correlation is likely to have little effect. We used Student's *t* test to compare means and Fisher's exact test or c^2 test to compare proportions between groups.

Results

Trial participants and follow up

The mean (SD) age of participants was 83.7 (2.9) years, and ages ranged from 79 to 94 years. The participants in both groups were well matched on characteristics at entry to the trial (table 1).



Flow of participants through trial

The figure shows the flow of participants through the trial. The results of assessments repeated at one year will be reported separately. More participants from the control centres than the exercise centres completed the trial (88% *v* 80%, P = 0.066).

Overall, 43% (114 of 265) of participants who completed the trial carried out their prescribed exercise programme three or more times a week, 62% (n = 164) completed their exercise programme at least twice a week, and 63% (n = 167) walked at least twice a week during the one year.

Three adverse events were reported. One person stopped exercising and visited her doctor with pain due to the exercises, and two people fell while exercising, one pulling a muscle. One person walked backwards into a stool, and one collapsed while walking sideways.

Falls and fall related injuries

Table 2 shows the actual and standardised numbers of falls and the numbers of falls resulting in injuries during the trial. A significant reduction was found in the numbers of falls during the trial for the exercise centres compared with the control centres (incidence rate ratio from negative binomial regression model 0.70, 95% confidence interval 0.59 to 0.84). This 30% reduction in falls was similar for both men and women.

Fewer falls in the exercise centres resulted in an injury (moderate or serious) than the control centres (incidence rate ratio 0.72, 95% confidence interval 0.62 to 0.82). No difference was found between the numbers of participants with serious injuries (15 of 330 in exercise centres versus 2 of 120 in control centres, P = 0.261). Eight falls resulted in fractures and three in lacerations requiring sutures.

Economic evaluation

Costs of implementing the exercise programme—The exercise programme cost $NZ137 878 or $NZ418 per person to deliver to the 330 participants in the exercise centres for one year.

Resource use and costs resulting from falls—Overall, 71 of 303 (23%) falls resulted in the use of healthcare services (table 2). No significant difference was found in the numbers of hospital admissions as a result of a fall injury (12 in total) between the exercise and control centres. The difference between the actual cost of these hospital admissions for participants from the exercise ($NZ50 470) and control centre ($NZ10 993) as a result of a fall was not significant (P = 0.584).

Cost effectiveness measures—The incremental cost per fall prevented was $NZ1519 (table 3). Estimates for the cost per fall with an injury prevented ranged from $NZ2553 to $NZ4255 for the different cost scenarios. Table 4 shows the incremental costs of implementing the exercise programme.

We did not include costs from hospital admissions as a result of a fall in the calculation of cost effectiveness ratios as there was no significant difference in these costs, or the number of hospital admissions for exercise and control centres.

Discussion

Falls can be reduced in men and women aged 80 years and older receiving an exercise programme from trained nurses based in general practices, and this is achievable in usual clinical practice.[2 5] It was more difficult to gauge whether the exercise programme gave value for money. The programme cost a similar amount per person to deliver as the first pragmatic trial involving a district nurse prescribing the programme, and there were similar estimates for cost effectiveness ratios when the costs of implementing the programme only were considered. Hospital costs were not reduced, however, and therefore the programme was not as cost effective as the first trial. This may be due to the sample sizes used, which were based on falls and not on injury rates, and the fact that the data for hospital costs have a

Table 2 Incidence of fall events and follow up times in control and exercise programme centres

	Control centres (n=120)	Exercise programme centres		
		1 (n=115)	2 (n=120)	3 (n=95)
No of falls*	105	57	87	54
Falls per 100 person years	93.9	57.4	78.4	66.4
No of injurious falls†:	46	27	37	22
Serious	2	3	9	4
Moderate	44	24	28	18
Injurious falls per 100 person years	41.1	27.2	33.3	27.1
No (%) of falls for which medical care sought	24 (23)	14 (25)	24 (28)	9 (17)
Mean (SD) follow up time (months)	11.2 (2.6)	10.4 (3.4)	11.1 (2.8)	10.3 (3.3)
Total follow up time (person years)	111.83	99.38	111.03	81.29

*Incidence rate ratio 0.70 (95% confidence interval 0.59 to 0.84), P=0.001.
†Incidence rate ratio 0.72 (0.62 to 0.82), P=0.001.

Table 3 Cost effectiveness ratios and sensitivity analysis: incremental cost of exercise programme per fall event prevented in exercise centres compared with control centres

Cost scenario	$NZ
Cost per fall prevented:	
Total cost of programme	1519
125th centile total cost of programme	1899
75th centile total cost of programme	1139
Training, supervision in same centre	1426
125th centile cost of home visits	1757
× 4 ankle cuff weights	1856
No extra overhead costs	1247
Adjusted cost per fall prevented*:	
Total cost of programme	1734
125th centile total cost of programme	2167
75th centile total cost of programme	1300
Training, supervision in same centre	1627
125th centile cost of home visits	2005
× 4 ankle cuff weights	2117
No extra overhead costs	1423
Cost per injurious fall prevented:	
Total cost of programme	3404
125th centile total cost of programme	4255
75th centile total cost of programme	2553
Training, supervision in same centre	3196
125th centile cost of home visits	3937
× 4 ankle cuff weights	4158
No extra overhead costs	2794
Adjusted cost per injurious fall prevented*:	
Total cost of programme	3846
125th centile total cost of programme	4808
75th centile total cost of programme	2885
Training, supervision in same centre	3611
125th centile cost of home visits	4448
× 4 ankle cuff weights	4698
No extra overhead costs	3157

Average exchange rate in 1998, $NZ1.00=32p.
*Calculated using fall events per 100 person years to adjust for variable follow up times for individuals in trial.

Table 4 Incremental costs of implementing exercise programme

Cost item	Resource use	Unit cost ($NZ)	Total cost ($NZ)
Training course*			
Physiotherapist (hours)	37.5	19.17	539
Three exercise nurses			
Time (hours)	37.5 each	16.46 per hour	1852
Travel to Dunedin (km)	2220	0.62	1110
Accommodation (nights)†	5	110	650
Materials	Folders	28.21	85
Transport in Dunedin	Visits to 15 clients	0.62 per km	84
Recruitment, programme prescription and follow up			
Time for 3 nurses	0.5 equivalent full time, 1 nurse 18 months, 2 nurses 19 months	Average 16.58 per hour	67 963
Transport for 3 nurses (km)	4609	0.62	2858
Doctors' time‡	46 doctors, 0.25 hours each	40.39	1858
General practice staff time	26 practices, 0.75 hours each	13.11	341
Typing lists and letters (hours)	78	18.88	1473
Postage (stamps)	768	0.40	307
Stationery and photocopying	Paper, envelopes	0.10	373
Telephone	Local calls, 1 "call minder," 2 mobiles		2676
Ankle cuff weights	480	Average 17.40	8352
Instruction booklets	330 folders, paper	7.50	2475
Supervision of programme			
Physiotherapist:			
Time (hours)	703	19.17	13 484
Travel to centres (km)	2808	0.62	1741
Accommodation†	4 visits to each centre	Average 102.50	410
Telephone calls	108	Average 6.77	731
Three exercise nurses:			
Time	4 meetings, telephone calls	Average 16.58 per hour	1607
Telephone calls	82	Average 7.11	583
Travel to Dunedin (km)	2586	0.62	1603
Overhead costs§		21.85% of resource use	24 724
Total cost			137 878
Average cost per participant for 1 year programme			418

Average exchange rate in 1998, $NZ1.00=32p.
*Costs for training course were divided equally among the four nurses at course (one nurse was from trial reported in accompanying paper).
†Includes food allowance.
‡Time spent by doctors was valued using weighted average price in 1998 for consultation "person over 65 without card"; item used in calculation of consumers price index.
§Includes office accommodation, financial and administration services, depreciation on equipment.

skewed distribution. The participants from the exercise centres had fewer moderate injuries as a result of a fall, but no differences were found in the numbers of serious injuries between the two groups.

For the trial of the exercise programme in a research setting, the programme was delivered by a physiotherapist.[2] We conclude that trained nurses from general practices can also implement the programme successfully. The implementation of the programme worked well from a general practice setting, and because it took up only half the nurses' time it fitted in with other work. Nurses should be trained and supervised by a suitably qualified physiotherapist.

The earlier a health problem can be identified the better. In both our pragmatic trials the nurses acted as patient advocates on several occasions and were able to identify health concerns during the home visits and to deal with them before they became a major problem. It was reassuring that death rates were lower, although not significantly so, in the exercise groups than in the control groups in both trials.

Methodological issues

As this was a trial of implementing a programme in the community, we used control and exercise centres rather than a randomised controlled design. The pragmatic design ensured that the delivery of the intervention matched as closely as possible what might occur in normal practice using practice nurses. This also avoided contamination as increased public awareness may lead to sharing of information. It is possible that the variable success of the programme in the different centres was influenced by the expertise of the instructor.

Different conditions in different centres may result in different rates of falls. Bias in the findings may have occurred as blinding was not possible except for classifying fall events. It is possible participants in the exercise centres did not want to report falls and disappoint their instructor. However the nurses all developed considerable rapport with the participants, and we believe the effect of this on outcome was minimal.

We investigated only the immediate health related costs and benefits in the economic evaluation, and this resulted in a conservative estimate of cost effectiveness. The benefits of exercising may continue longer than the one year of follow up. In a previous trial we found that reduction of falls continued for two years and involved very little extra use of resources.[3] In this trial 53% (139 of 261) of participants completing the exercise programme said they intended to keep exercising, and 41% chose to keep the ankle cuff weights (from 1 to 8 kg). Healthcare costs after a fall may well continue to accrue for the remainder of an individual's life.

Conclusions

Exercise programmes can prevent falls in elderly people living in the community.[8] We have also shown that withdrawing psychotropic drugs can prevent falls in people taking these drugs.[9] Another intervention delivered at home by a health professional—assessment and modification of environmental hazards—has been shown to reduce falls in elderly people who were at increased risk of falling.[10] A home based programme that was individually targeted and multifactorial also reduced falls in elderly people.[11]

We recommend a home based exercise programme delivered by trained nurses. Other components such as awareness of falls, home safety advice, and referral to doctors for reassessment of psychotropic drugs could be included to maximise effectiveness. A programme to prevent falls within general practice is practical, can reduce trauma and help maintain independence, and has the potential to reduce costs due to injury.

We thank the participants; the doctors and their receptionists; Jo Halkett, Rachel Hall, and Jan Muir, exercise instructors; Lenore Armstrong, independent assessor; Graham Arnold, decision support coordinator, HealthCare Otago; Shona Ellis, clinical costing, Southern Health; Irene Henderson, manager, Gore Hospital; Peter Herbison, statistician; Professor Murray Tilyard and the General Practice Research Unit; and Sheila Williams, statistician.

All authors contributed to the study or protocol design, or both, interpreted the data, and wrote the paper. AJC directed the project. MCR managed the project and the data gathering, analysed and interpreted the data, and wrote the paper. MMG trained and supervised the exercise instructor. ND and Dr Paul

What is already known on this topic

One half of those aged 80 years and older will fall in any one year, often with serious health and social consequences

An exercise programme delivered by a physiotherapist or trained district nurse was successful in reducing falls and moderate injuries in elderly people

What this study adds

An exercise programme to prevent falls in elderly people can be delivered safely and effectively by trained nurses in general practices

The nurses obtained results that were consistent with the physiotherapist in the research setting and the district nurse in the accompanying paper

Scuffham advised on the economic evaluation. RM advised on health promotion aspects. AJC and MCR will act as guarantors for the paper.

Funding: This project was funded by Accident Rehabilitation and Compensation Insurance Corporation of New Zealand, the Health Research Council, and Lottery Grants Board, New Zealand. MMG was part funded by a Trustbank Otago Community Trust medical research fellowship.

Competing interests: None declared.

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(Accepted 19 December 2000)