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ORIGINAL ARTICLE

Cost-effectiveness in fall prevention for older women

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Abstract

Aims: The aim of this study was to estimate the cost-effectiveness of implementing an exercise-based fall prevention programme for home-dwelling women in the ≥80-year age group in Norway. *Methods:* The impact of the home-based individual exercise programme on the number of falls is based on a New Zealand study. On the basis of the cost estimates and the estimated reduction in the number of falls obtained with the chosen programme, we calculated the incremental costs and the incremental effect of the exercise programme as compared with no prevention. The calculation of the average healthcare cost of falling was based on assumptions regarding the distribution of fall injuries reported in the literature, four constructed representative case histories, assumptions regarding healthcare provision associated with the treatment of the specified cases, and estimated unit costs from Norwegian cost data. We calculated the average healthcare costs per fall for the first year. *Results:* We found that the reduction in healthcare costs per individual for treating fall-related injuries was 1.85 times higher than the cost of implementing a fall prevention programme. ***Conclusions:*** **The reduction in healthcare costs more than offset the cost of the prevention programme for women aged ≥80 years living at home, which indicates that health authorities should increase their focus on prevention. The main intention of this article is to stipulate costs connected to falls among the elderly in a transparent way and visualize the whole cost picture. Cost-effectiveness analysis is a health policy tool that makes politicians and other makers of health policy conscious of this complexity.**

Key Words: *Cost-effectiveness analysis, elderly, fall prevention, public health*

Background

Falls among the elderly are a major public health concern. The yearly incidence of falls by people aged ≥80 years living in their own home is about 50%, and half of them fall more than once [1,2]. Half of the Norwegian women aged between 75 and 93 years have between two and 11 falls per year [3]. Reports indicate that between 40% and 60% of the falls in the elderly population result in injuries that require medical attention, and hospital admissions increase with advancing age [3–6]. The cost of falling is high, both to the individual in terms of physical and psychosocial costs, and to society in terms of healthcare utilization in the treatment of injuries connected with falls. The evidence for the effectiveness of fall prevention in the elderly is growing, and various intervention programmes have been deemed to be cost-effective [7–12]. However, nationwide implementation of programmes for fall prevention among the elderly is lacking.

Limited healthcare resources combined with continuous innovation in healthcare technology force decision-makers to establish healthcare priorities. To arrive at the best alternative, an economic evaluation of healthcare costs and health benefits can be undertaken. Hence, economic evaluation is a tool with which to achieve optimal allocation of resources [13–15]. Three different methods, differing only with regard to the quantification of health benefits, can be applied. In cost–benefit analysis, the health benefit is measured in a monetary unit; for instance, based on surveys of willingness-to-pay. On the basis

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of results from a cost–benefit analysis, the health authorities will implement an intervention when the willingness-to-pay exceeds the cost. In cost-effectiveness and cost-utility analyses, on the other hand, the health benefit is measured in non-monetary units; for instance, life years gained or quality-adjusted life years (QALYs) or reduced occurrence of an incident that negatively influences health. The cost-effectiveness and the cost-utility are then displayed as cost per life year gained or cost per QALY. Whether the health authorities will implement a certain intervention on the basis of these two methods will depend on the threshold specified for a life year gained or a QALY. In the current analysis, the cost-effectiveness method is employed, and we display cost per fall-related injury.

Aims

The aim of this study was to explore the cost-effectiveness of implementing an exercise-based fall prevention programme for females aged ≥80 years from a societal perspective. We show that a cost-effectiveness analysis is important for making the total healthcare cost of falling among the elderly visible. The impact of the home-based exercise programme (also called Otago) on the number of falls is based on a New Zealand study [7,8]. The calculation of the average healthcare cost of falling is based on assumptions regarding the distribution of fall injuries reported in the literature, four constructed representative case histories, assumptions regarding healthcare provision associated with the treatment of the specified cases, and Norwegian unit costs. The analysis illustrates the possible gains for society provided by the implementation of a fall prevention programme instead of treating fall-related injuries.

Material and methods

The intervention: effectiveness and cost

We searched Medline, PubMed, Cochrane, NHSEED and Cinahl to find interventions that quantify costs and describe the content and delivery of effective programmes that have been proven to reduce falls and injuries in the elderly [16]. The number of studies was scarce, and we ended up with a strength and balance re-training programme tested in a randomized controlled trial in New Zealand [11,17]. We have chosen to target this single intervention for people at high risk of falling due to muscle weakness and impaired balance, because it has a large impact on the number of falls. The programme has been evaluated through research, and has been shown through meta-analysis to be effective [17,18]. In Norway, students in physical therapy are trained to use the Otago programme.

In the New Zealand study, 233 females aged ≥80 years living in their own home were included; 116 received an exercise programme (the intervention group), and 117 were randomized to the control group. During the first 2 months, the intervention group received four home visits (1 hour per visit) by a physiotherapist who gave instruction in home-based training. For the next 10 months, the physiotherapist made telephone calls (20 minutes per call) to the participants every second month. The exercise programme lasted for 30 minutes and was completed three times a week for 1 year. In addition, the intervention group received a walking plan. The participants registered their falls in a calendar and reported them monthly. In the intervention group, 88 falls were reported, while the number of falls in the control group was 152. The data were analysed on the basis of the intention-to-treat methods and a negative binomial regression analysis, and showed a statistically significant reduction in falls of 40%. The study in New Zealand was concluded to be cost-effective for women ≥80 years.

The cost of the home-based training programme is based on the number of units from Robertson et al. [11] and Norwegian unit costs. The programme cost per participant is shown in Table I.

The cost of falling

The calculation of the cost of falling rests on several assumptions (Table II) [16]. We based these assumptions on both clinical experience and the description of fall-related injuries in the literature. In the first step, we used the literature to classify the distribution of falls according to the type of injury: moderate, serious, severe, and very severe. Reports indicate that between 40% and 60% of the falls among the elderly population result in injuries that require medical attention [3,4,6], and in a Norwegian study 53% of women aged ≥75 years suffered an injury after a fall [19]. On the basis of these findings, we assume that 50% of falls result in an injury. In the literature, it is

Table I. Programme cost per participant if the Otago exercise programme were to be implemented in Norway [13,20].

Service provision	Unit cost (#) in NOK	Total cost in NOK
Recruiting participants	60 (1)	60
Instruction in exercise programme	520 (4)	2080
Equipment	80 (1)	80
Follow-up by telephone	174 (5)	870
Cost per participant		3160

reported that between 30% and 50% of falls cause mild and moderate injuries such as sprains and simple fractures, while between 5% and 15% cause serious fractures, of which hip fractures constitute between 0.2% and 2% [20–22]. Norway has the highest incidence of hip fractures ever reported [23,24]; the incidence of hip fractures increases with age, and the incidences are higher in females [24]. Bergland et al. [3] found that 13% of the falls among females result in fractures, of which 3% are hip fractures (mean age 80.8 years). This study shows that the incidence of fractures may be higher in Norway than in many other countries. We have chosen to employ conservative estimates. Hence, we ended up with the following distribution of seriousness of injuries: moderate, 37%; serious, 11%; severe, 1%; and very severe, 0.5%. In the second step of the calculation, we defined a representative case history for each of the different injuries, and made assumptions regarding the service provisions in primary healthcare, hospitals, and long-term care connected with treatment of the different cases. The chosen service provision level is based on the assumption that the amount of treatment and rehabilitation should bring the patient back to the functional status that he or she had before the fall, i.e. able to live at home.

The third step in the calculation concerns the assumptions regarding cost per unit of healthcare and long-term-care services and the number delivered by each unit. These unit costs and numbers are based on public information, both from different hospitals and municipalities and from official numbers reported by the Norwegian Labour and Welfare Administration, Statistics Norway, and the Norwegian Medical Association. We calculate the average healthcare costs per fall for treatment in hospitals and

Table II. The cost of falling: assumptions.

Degree of injury	Proportion of all falls	Description of the injury	Service provision (resource use) connected with treatment	Cost per unit (#) in NOK	Healthcare cost (NOK)
No	~0.50				
Mild and moderate injury	0.37	Bruising, sprains, cuts, abrasions and simple fractures	Radiological examinations	522 (1)	2924
		Unaltered care needs	General practitioner visits	300 (1.55)	
			Physical therapy	520 (1.8)	
			Materials	200 (1)	
			Transport (patient)	300 (2.55)	
				20 (1.8)	
Serious injury	0.11	Complex fractures of	Inpatient cost	8033 (3)	40,259
		the forearm, upper	Outpatient cost	1440 (1)	
		arm/shoulder,	General practitoner visits	300 (1)	
		femur or leg requiring	Physical therapy	520 (13)	
		fixation and hospitalization	Home care	370 (12)	
		Altered care needs	Transport (patient)	300 (4) + 20 (13)	
			Ambulance	1400 (1)	
			Transport (staff)	30 (12)	
Severe injury	0.01	Hip fracture	Inpatient cost (DRG 209A)	32,490 (3.62)	236,984
Hip fracture type 1		Primary hemiprosthesis	Rehabilitation	1650 (21)	
		Uncomplicated	Outpatient cost	1440 (1)	
		Institutional rehabilitation	General practitioner Visit	300 (1)	
		in 3 weeks	Physical therapy	520 (24)	
		Altered care needs	Occupational therapy	520 (3)	
			Home equipment	3640 (1)	
			Transport (patient)	300 (2) + 600 (1)	
			Ambulance	1400 (1)	
			Community nursing	520 (35)	
			Home care	380 (104)	
			Transport (staff)	30 (166)	
Very severe injury	0.005	Hip fracture with complications	Inpatient cost (DRG210)	32,490 (2.25)	674,772
Hip fracture type 2		Primary nail operation	Re-operation (DRG209B)	32,490 (4.51)	
		Re-operation with prosthesis	Outpatient cost	1440 (1)	
		Discharged nursing home	Nursing home	450,000 (1)	
			Transport (patient)	300 (3)	
			Ambulance	1400 (2)	
Average healthcare cost per fall	$(0.50 \times 0\,\text{NOK}) + (0.37 \times 2924\,\text{NOK}) + (0.11 \times 40{,}259\,\text{NOK}) + (0.01 \times 236{,}984\,\text{NOK}) + (0.005 \times 674{,}772\,\text{NOK}) =$				11,254

rehabilitation centres for the first year, i.e. the average variable and fixed costs, including capital costs [16].

Results

Based on the cost estimates from Tables I and II and the estimated reduction in the number of falls from Robertson et al. [11], we estimate the cost-effectiveness of a home-based prevention programme for females aged $\geq$80 years. The healthcare costs of treating a fall are based on the calculations shown in Table II (11,254 NOK per fall). The difference between the control group (no prevention programme) and the intervention group (home-based exercise programme) is based on assumptions made concerning the percentages of falls in the two groups and the programme costs connected with the fall prevention programme. Table III shows the differences between introducing the home-based exercise programme and no prevention programme with regard to both total healthcare costs and mean number of falls. From the column on incremental effect (reduction in falls) and the column on incremental costs (differences in cost), we see that the prevention programme has a positive effect (0.52) and that the reduced healthcare costs due to falling in the intervention case (8778 – 14,630 = –5852) more than offset the cost of the prevention programme (3160 in Table I). Hence, the home-based exercise programme is cost-saving (11,938 – 14,630 = –2692).

Discussion

The assumptions made in the analysis

The results from the cost-effectiveness analysis show that the reduction in healthcare costs connected with a reduction in the number of falls among the elderly more than offset the cost of the prevention programme. However, this conclusion rests on several assumptions. The first assumption is that the effect of the home-based exercise programme in New Zealand can be applied to Norway. Second, it is assumed that the number of falls per year among the elderly living at home is 1.3, based on the incidence of fall events in New Zealand, and that about 50% of the falls result in injuries [7,19,25]. The third important assumption is connected with the distribution of the seriousness of fall-related injuries and the constructed representative case histories for the four different injuries [21,26]. Because costs due to hospitalization represent the most important component of total healthcare costs, the assumption that hip fractures constitute 1.5% of all falls is the most important one [16]. If we were even more conservative, and assumed that the proportion of falls that result in injury was 0.3375 rather than 0.5, and that the distribution according to injuries was 0.27, 0.06, 0.005, and 0.0025 (in contrast to 0.37, 0.11, 0.01, and 0.005), respectively, the cost per fall would decline from 11,254 to 6077 NOK. Given this distribution of injuries, the reduction in healthcare costs for treating fall-related injuries will equal the cost of implementing the exercise programme $((1.3 \times 6077) - (0.78 \times 3160))$; that is, the intervention breaks even. The fourth critical assumption in the calculation is the effect on the number of falls of the strength and balance intervention. The results from various randomized controlled trials on fall prevention show that the effect varies between 15% and 50% [4]. In our study, we assume that, by reducing falls by 40%, we reduce the extent of injuries by 40%, evenly distributed among the different degrees of injury reported [7]. We do not know the exact effect of the Otago exercise programme on the elderly in Norway, but from Table III we see that the intervention breaks even when the number of falls in the control group is 1.02 per person ((14,630 – 3160)/11,254 = 1.02), in contrast to the 1.30 per person reported from New Zealand.

In the analysis, we use no intervention, here defined as doing nothing, as comparator. Hence, we estimate the incremental effect and cost of the strength and balance programme as compared with no intervention. In the literature, other measures have been shown to have an effect on the number of falls and the consequences of falls; for instance, other types of exercise programmes, nutrition, adjustments

Table III. Cost-effectiveness of a home-based prevention programme for the elderly (all costs are in NOK).

Patient group	Mean number of falls	Incremental effect	Healthcare cost per individual[a]	Cost of fall prevention	Total healthcare costs	Incremental costs
Control	1.30		14,630	0	14,630	
Prevention	0.78	0.52	8778	3160	11,938	–2692

[a]Healthcare costs per individual for the control group ($11,254 \times 1.3$) and for the fall prevention group ($11,254 \times 0.78$).

at home [27], and medication such as Alendronat [28] and hip protectors [29]. Because we disregard these kinds of efforts, we could have overestimated the effect of the exercise programme on the number of falls. If the effect of all of these different measures were available and could be included in the analysis, we would have information on the proportion of falls and the total healthcare costs for each specific measure. It would then be possible to rank the measures in ascending order according to total healthcare cost. In the next round, we could have estimated the incremental effect and incremental cost of adding the strength and balance intervention to an existing programme for modification of environmental hazards [9]. We would then have been able to give information on the prioritizing of different measures for preventing falls among the elderly. Such a complete list of measures does not exist, but future research should aim at complementing this information.

Even though we may overestimate the effect of the Otago programme in this analysis, we know that, even if the reduction in falls is as low as 22%, the programme will break even. If the health authorities are willing to pay for a reduction in falls among the elderly, they may also accept a smaller result. In the calculation, several factors are not quantified. First, we did not try to quantify psychosocial costs connected with falls among the elderly. It follows that inclusion of these costs will increase the positive effects of the prevention programme. In Robertson et al. [11], health status was registered with the questionnaire SF36. Second, health-related quality of life (QALYs) is not included in the analysis. Including QALYs in the analysis would make the analysis more general and, with regard to prioritization, the home-based prevention programme could be compared with other healthcare interventions. Third, both the programme costs and the treatment costs are calculated for 1 year. It is important to note that, in order to obtain the positive effect of the reduction in the number of falls over time, the strength and balance programme must be continued. However, as documented in Robertson et al. [11], the programme costs of completing the training programme for a certain group will be reduced in subsequent years, and hence the effect of the prevention programme will be further strengthened.

Prevention or cure: the everlasting dilemma

In the literature, several trials and experiments have documented the positive effects of fall prevention programmes, but these interventions have still not been given priority in healthcare policy. One explanation for the lack of emphasis on prevention is most likely the way in which the healthcare system is organized and financed. For instance, in Norway, two governmental levels with different health and long-term-care enterprises are responsible for organizing and financing healthcare and long-term care. In the case of fall prevention, the intervention most likely will be organized by primary healthcare in the municipalities, while the reduced costs related to a reduction in fall-related injuries will go to the state, either to the National Insurance Company or the Regional Health Enterprises, or to the long-term-care institutions in the municipalities. Even if all of the resources are public, it is challenging to organize a well-documented prevention programme when the positive gains of the intervention do not necessarily go to the provider who finances it. Another barrier impeding the implementation of such interventions is linked to the fact that the effect of prevention programmes is not necessarily measurable within a budget year [30]. The last challenge to implementing a prevention programme for the elderly is associated with the financing of hospitals' inpatient activity, which is partly based on prospective payments that depend on the number and case mix of patients. With activity-based financing, every new admission contributes to the hospital's earnings, because it will increase revenues. Hence, in the short term, hospitals have incentives to increase the number of patients treated, and have no incentives to avoid fall-related injuries. Therefore, economic incentives designed to increase efficiency in hospitals might conflict with the health policy goal of efficient use of the total healthcare resources and the goal of overall proper and reasonable treatment of the elderly.

Conclusion

Cost-effectiveness analysis visualizes the total cost of an intervention and the total cost connected with the treatment of a certain injury. This might be a health policy tool that should be employed to make politicians conscious of the complexity in the cost picture, both across healthcare levels and enterprises and over time. The reason why fall prevention is not prioritized is probably not the lack of randomized controlled trials documenting the effectiveness of such programmes; it is more likely the fact that the overall cost picture is lacking when politicians allocate resources. The calculations presented in this article can be criticized because they rest on experience and assumptions connected with representative cases, and not a specific trial or intervention. However, our intention is to stipulate costs connected with falls among the elderly in a transparent way and visualize the whole cost picture. The effect of the exercise programme during the first year was a 0.52 reduction, which implies a reduction in the healthcare cost per individual of 5852 NOK ($0.52 \times 11{,}254$). The cost of the prevention programme is 3160 NOK per individual. Hence, we find that even with rather conservative estimates, the reduction in healthcare cost per individual for treating fall-related injuries is 1.85 times higher than the cost of implementing a fall prevention programme for women aged $\geq$80 years living at home. On the basis of this calculation, our policy advice to the health authorities is to increase their focus on prevention.

Conflict of interest statement

There are no conflicts of interest regarding financial or personal connections to this work.

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