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ORIGINAL INVESTIGATION

Predictors of uptake and adherence to the use of hip protectors among nursing-home residents

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Abstract The aim of the present study was to identify predictors for initial uptake and adherence with the use of hip protectors when offering hip protectors free of charge to nursing-home residents. An 18 months prospective follow up study was carried out in 18 Norwegian nursing homes. One thousand two hundred and thirty-six residents were included in the study of which 604 started to use a hip protector. A multivariate logistic regression model was used to identify predictors for the initial uptake. A Cox proportional hazard model was used to identify predictors for adherence. A stepwise backward strategy was used in both the logistic and in the Cox regression. The effect of nursing homes as clusters was adjusted for in the analysis. The uptake rate among all residents was 46% and the adherence was approximately 75% after 3 months, and approximately 60% after 18 months. Female gender [odds ratio (OR): 1.54, 95% CI: 1.06–2.24, $P = 0.022$], previous fractures (OR: 1.67, 95% CI: 1.02–2.75, $P = 0.043$), previous falls (OR: 2.08, 95% CI: 1.35–3.19, $P < 0.001$) and memory (not able to memorise: OR: 3.71, 95% CI: 2.09–6.59, $P < 0.001$, large problems with memorising: OR: 2.85, 95% CI: 1.81–4.49, $P < 0.001$, medium problems with memorising: OR: 2.45, 95% CI: 1.39–4.33, $P = 0.002$, some problems with memorising: OR: 1.99, 95% CI: 1.14–3.48, $P = 0.016$) seemed to be important predictors for uptake. Among those who took up the offer male gender (HR: 1.71, 95% CI: 1.00–2.91, $P = 0.049$), memory (not able to memorise: HR: 0.26, 95% CI: 0.14–0.50, $P < 0.001$, large problems with memorising: HR: 0.32, 95% CI: 0.22–0.45, $P < 0.001$, medium problems with memorising: HR: 0.46, 95% CI: 0.30–0.73, $P < 0.001$, some problems with memorising: HR: 0.49, 95% CI: 0.32–0.73, $P = 0.001$) and bowel incontinence (HR: 0.41, 95% CI: 0.25–0.66, $P < 0.001$) were predictors for a lower probability of ending hip protector use. Factors related to a high risk of falling were important predictors for both uptake and adherence. The fact that neither memory impairments nor incontinence (bowel) seemed to be barriers to hip protector use is important since these characteristics are common among nursing-home residents and tertiary prevention such as the use of hip protectors is probably the most feasible intervention to prevent hip fractures in this group.

Keywords Hip protectors · Nursing homes · Uptake · Adherence · Predictors

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Introduction

Hip protectors are a non-pharmaceutical device intended to prevent hip fractures. Hip protectors have the potential to reduce the risk of a hip fracture in falls by more than 50% (Bentzen et al. 2008a, b; Cameron et al. 2003; Forsén et al. 2004; Harada et al. 2001; Kannus et al. 2000; Lauritzen 1993) and their use in nursing homes has been recommended (Parker et al. 2006; Sawka et al. 2007). However, getting high-risk individuals to take up the offer and keep wearing the device seems to be a challenge, and might explain why the effectiveness, i.e. hip fracture incidence reduction, of offering hip protectors to groups of individuals is uncertain (Parker et al. 2006; Sawka et al. 2007). The uptake has been reported to vary from 37 to 72% and

the adherence from 20 to 92% (van Schoor et al. 2002). So far, hip protectors are probably not an appropriate intervention for all elderly nursing-home residents. Making a profile of residents who show high uptake and adherence may possibly help in selecting residents who will use hip protectors (van Schoor et al. 2002).

Studies examining factors associated with the initial uptake and adherence show conflicting results. Some investigators have found incontinence to be a barrier to compliance (Butler et al. 1998; Cameron and Quine 1994), while others have found incontinence to be associated with higher compliance (van Schoor et al. 2003; Warnke et al. 2004). In some studies, residents suffering from dementia and confusion have been more compliant than residents without these characteristics (O'Halloran et al. 2005; Thompson et al. 2005). Others have not found any association between cognitive status and adherence (Kurrle et al. 2004). A high number of risk factors for falls, previous falls, high degree of disability, and female sex have also been shown to influence adherence positively (Hubacher and Wettstein 2001; O'Halloran et al. 2005; Thompson et al. 2005; van Schoor et al. 2003; Warnke et al. 2004). Other researchers have not found independent associations with mobility problems or a history of falls and fractures (Cryer et al. 2006; Kurrle et al. 2004). Type of hip protector does not seem to be important in some studies (Bentzen et al. 2008b; O'Halloran et al. 2005), while others have found higher compliance with soft hip protectors compared to hard ones (Suzuki et al. 1999; Yasumura et al. 1999). Meyer et al. (2003) state that training of the nursing staff, and provision of hip protectors free of charge can increase the use of hip protectors.

Since most earlier studies are relatively small, with different designs and short follow up time, the aim of the present study was to identify predictors for uptake and adherence within a large study population and a long follow up period when offering hip protectors free of charge to nursing-home residents.

Material and methods

Intervention

The present study is prospective, conducted within the framework of a cluster randomized trial in 18 Norwegian nursing homes in which the potential differences in uptake and adherence between soft-shelled and hard-shelled hip protectors were studied. The intervention was carried out between May 2005 and November 2006. The design of the study and the flow of clusters and participants through each stage of the trial have been presented elsewhere (Bentzen et al. 2008b). In short, hip protectors were accessible to all participants, but participants who were assessed by staff judgement to be at a high risk of falling were especially encouraged to take up the offer. Staff judgement of fall risk is a non formal risk assessment where staff simply uses clinical experience and knowledge when classifying a resident's risk of falling. Staff judgement of fall risk has been shown to be as good as formal risk assessment tools in discriminating between fallers and non fallers (Lundin-Olsson et al. 2003; Myers and Nikoletti 2003). When a resident passed away or was transferred from the nursing home, that person's place was filled. Thus new permanent residents were included continuously during the intervention period.

The study was approved by the Regional Committee for Ethics in Medical Research. All the participants received written or oral information about the study. Written consent was obtained directly from residents who were considered cognitively competent. For cognitively impaired residents a member of the staff gave consent on behalf of the resident. This was in accordance with recommendations from the Regional Committee for Ethics in Medical Research. Competency to provide informed consent was ascertained from the nursing staff.

We have previously shown that the type of hip protector (soft or hard) did not influence uptake rate or the probability of ending hip protector use substantially (Bentzen et al. 2008b). Consequently, in the present study the two types of hip protectors are not treated separately.

Participant's baseline characteristics were registered by the staff in each nursing home. The study protocol recommended that the staff member most familiar with a resident should perform the registration. The baseline characteristics included among others the Barthel ADL Index which is an assessment of functional ability with a sum score ranging from 0 to 20, where 20 is the highest functional ability (Mahoney and Barthel 1965). In addition St. Thomas Risk Assessment Tool (STRATIFY) was used, modified for use in the nursing and residential homes (Guidelines for the prevention and management of falls in the elderly, http://www.laterlifetraining.co.uk/documents/DorsetHealthCare.pdf). STRATIFY consists of five risk factors for falls; previous falls within the last 3 months, visual impairment, frequent toileting, agitation and mobility and transfer score. The sum score for STRATIFY ranges from 0 to 5 where five represents the highest risk of falling. A score of 2 or more is identified as the appropriate cut-off score for increased risk of falling (Oliver et al. 1997). The STRATIFY sum score was calculated by the project manager in retrospect and was not the basis for selecting residents in need of hip protectors in our study. In the main analysis we used each individual item in the Barthel ADL Index and each individual item in STRATIFY. In a sub-analysis we used Barthel sum score categorised as follows; 0–4: very low functional ability;

5–8: low functional ability; 9–11: moderate functional ability; 12–20: high functional ability and STRATIFY categorised according to a cut-off value of 2 or higher. Memory and communication were assessed using a five-point scale; not able to, large problems, medium problems, some problems, none problems (IPLOS, Norwegian Directorate for Health, http://www.shdir.no).

Uptake was defined as "the percentage of residents who initially agreed to wear the hip protector" and was registered on the baseline registration form. Those who agreed to us a hip protector were defined as a "user". Adherence was defined as the probability of ending hip protector use and was registered monthly by the staff where they were asked to state whether the user was still a "user" or had "ended hip protector use". A "user" was defined as a participant who had used the hip protector within the last month. This might have been daily or intermittent. However, the study protocol recommended hip protector use at all times when the resident had a risk of falling. "Ending hip protector use" was defined as the time a decision not to use a hip protector at all was taken. This decision was either taken by the staff on behalf of the resident or by the resident. The reason for ending hip protector use was stated on the registration form. Deceased, transferred, bedridden/in need of great assistance, different kinds of discomfort, issues of the impracticability of the device in the individual's circumstances and unwanted side effects (soreness, swelling, itchiness, pain) were the categories that could be recorded. Cognitively impaired residents were assessed for signs of discomfort, such as agitated behaviour, trying to remove the hip protector, refusing to co-operate when putting the hip protector on and unwanted side effects. If such signs were observed as a consequence of hip protector use, a decision to end hip protector use was taken.

Number of beds in each nursing home ranged between 18 and 96. In each nursing home one or two study coordinators were chosen from the staff members. The coordinator's function was to be the main contact between the project manager and the nursing home, to ensure that the registration forms concerning baseline registration and the use of hip protectors were completed, and that new residents were enrolled in the study. Prior to intervention each nursing home was offered a session of 60 min training. The main purpose of the session was to give information about the aim and implementation of the study. In addition the section covered some information about risk factors for falls and fractures. The number of staff attending each session varied between 3 and 35 in the various nursing homes and the rate of participants related to number of beds in each nursing home varied from 0.08 to 0.35.

Statistics

The statistical analysis was conducted using SPSS version 14.0 and STATA version 9.0. Differences in baseline characteristics between groups were tested by the chi-squared test and by the independent sample t test for means. To identify potential predictors for uptake we used a multivariate logistic regression model. A Cox proportional hazard model allowing multiple censorings and multiple failures per resident was applied to investigate potential predictors for ending hip protector use. Events including death, moving from the institution, no longer in need of hip protectors and the end of the observation time were censorings, while ending hip protector use because of some kind of discomfort, impracticality or unwanted side effects was defined as a failure. We first identified baseline characteristics that in a bivariate analysis were significantly associated with the outcome variable ($P < 0.05$). Since many of these variables were correlated, we checked each of them for confounding. A confounding factor was defined as a factor associated with the outcome and associated with the exposure but not an effect of the exposure (Rothman 2002). Final models for both the logistic regression and the Cox regression model were derived using a stepwise backward strategy. In both the logistic regression and in the Cox regression we adjusted for nursing home by using the option cluster (nursing home) which is possible in STATA.

Results

One thousand, two hundred and thirty-six participants were included in the study. Of those 38% were assessed by staff judgement to have a high risk of falling, while 62% were assessed to be at no (8%) or low (54%) risk. Initially, 569 out of the 1,236 residents (46%) took up the offer of using a hip protector. Eleven of the 1,236 residents agreed to wear the hip protectors but subsequently never wore them. These 11 were included in the numerator of the uptake rate. Three participants had missing information about initial uptake. The uptake among those assessed by the staff judgement to have a high risk of falling was 78%, and it was 30% among residents assessed to have a low fall risk.

The baseline characteristics of those taking up the offer and of those not are shown in Table 1. The Barthel ADL index and STRATIFY are presented with both their individual items and categorised as described in "Materials and methods". Those taking up the offer were on average older, had a higher proportion of women, a higher proportion taking calcium supplements, and some kind of osteoporosis medication. Furthermore, those taking up the offer had a higher proportion that had a fracture within the last 6 months, a fall within the last 3 months, were in need of

Table 1 Baseline characteristics of residents taking up the offer and of residents not taking up the offer ($N = 1,233$)

Variables		Participants taking up the offer $N = 569$	Participants not taking up the offer $N = 664$	P value
Age (mean, SD)		85.4 (7.70)	83.6 (9.1)	<0.001
Gender (%)	Female	75.7	69.3	0.011
Weight[a] (%)	Underweight	18.9	17.6	0.607
	Normal weight	60.1	59.1	0.766
	Overweight	21.0	23.2	0.392
Feeding[b] (%)	Unable	6.5	18.3	<0.001
	Needs help	42.2	32.5	0.001
	Independent	51.3	49.2	0.498
Bathing[b] (%)	Dependent	98.6	94.4	<0.001
	Independent	1.4	5.6	
Grooming[b] (%)	Needs help	74.3	71.6	0.274
	Independent	25.7	28.4	
Dressing[b] (%)	Dependent	52.0	58.1	0.037
	Needs some help	33.2	18.0	<0.001
	Independent	14.8	23.9	<0.001
Bowels[b] (%)	Incontinent	25.4	31.8	<0.001
	Occasional accident	46.1	36.3	0.001
	Continent	28.5	31.9	0.221
Bladder[b] (%)	Incontinent	26.7	39.0	<0.001
	Occasional accident	52.2	33.2	<0.001
	Continent	21.1	27.7	0.009
Toilet use[b] (%)	Dependent	9.3	33.3	<0.001
	Needs some help	52.4	31.7	<0.001
	Independent	38.3	35.2	0.287
Transfers[b] (%)	Unable	6.0	30.8	<0.001
	Major help	18.9	17.1	0.457
	Minor help	32.7	13.9	<0.001
	Independent	42.4	38.2	0.151
Mobility[b] (%)	Immobile	9.2	35.6	<0.001
	Wheelchair independent	6.7	11.1	0.010
	Walks with help of one person	51.8	21.9	<0.001
	Independent	32.3	31.5	0.812
Stairs[b] (%)	Unable	52.1	61.3	0.001
	Needs help	36.9	21.8	<0.001
	Independent	11.0	16.9	0.004
Memory[c] (%)	Not able to	23.5	20.1	0.171
	Large problems	33.0	24.2	0.001
	Medium problems	15.9	17.6	0.474
	Some problems	19.6	20.4	0.782
	None problems	8.1	17.8	<0.001
Communication[c] (%)	Not able to	9.5	11.2	0.380
	Large problems	21.3	17.9	0.154
	Medium problems	16.0	17.3	0.595
	Some problems	25.0	20.4	0.064
	None problems	28.2	33.1	0.073
Vitamin D supplementation (%)	Yes	14.9	12.2	0.162
Calcium supplementation (%)	Yes	10.1	5.3	0.002

Table 1 continued

Variables		Participants taking up the offer $N = 569$	Participants not taking up the offer $N = 664$	P value
Osteoporosis medication (%)	Yes	5.9	3.4	0.037
Fractures within last 6 months (%)	Yes	16.5	5.2	<0.001
Use of walking aids (%)	Yes	79.9	74.7	0.032
Falls within last 3 months[d,e] (%)	Yes	52.0	15.0	<0.001
Visual impairment[d,f] (%)	Yes	23.5	20.3	0.173
Frequent toileting[d,g] (%)	Yes	23.0	13.2	<0.001
Agitated[d,h] (%)	Yes	34.2	19.4	<0.001
Transfer and mobility score of 3 or 4[d,i] (%)	Yes	35.8	15.2	<0.001
Staff judgement of fall risk (%)	No risk	0.5	14.5	<0.001
	Low risk	35.6	70.2	<0.001
	High risk	63.8	15.3	<0.001
STRATIFY score ≥2 (%)	Yes	52.1	19.6	<0.001
Barthel ADL index total score	0–4 (Very low)	11.4	35.9	<0.001
	5–8 (Low)	24.1	14.9	<0.001
	9–11 (Moderate)	22.9	9.6	<0.001
	12–20 (High)	41.6	39.6	0.517

[a] Weight categorised according to BMI (BMI < 18.5 = under weight, 18.6–24.9 = normal weight, <25.0 = over weight) or by staff

[b] Barthel ADL Index

[c] None problems: independent, some problems: the resident can perform the activity, but with a different standard. Not in need of assistance, but might be in need in very soon, moderate problems: can perform some of the activity themselves, but in need of some assistance, large problems: can perform some of the activity themselves, but need a great deal of assistance, not able to: totally dependent

[d] STRATIFY Risk Assessment Tool

[e] Has the resident had a fall within the last 3 months?

[f] Do you think the resident is visually impaired to the extent that everyday function is affected?

[g] Do you think the resident is in need of especially frequent toileting?

[h] Do you think the resident is agitated?

[i] A summarised transfer and mobility score in Barthel of 3 or 4

frequent toileting, were agitated, had a summarised transfer-and mobility score in Barthel of three or four and had been assessed by staff judgement to have a high risk of falling. The two groups also differed on several items in the Barthel ADL Index and in memory scores (Table 1). A significant higher proportion of the user had a summarised STRATIFY score of two or higher. More users had a summarised Barthel score of 5–8 and 9–11, and fewer had a score from 0 to 4.

The items in the Barthel ADL Index were highly correlated with a gamma ranging from 0.54 to 0.98.

Factors associated with uptake

In Table 2 logistic regression shows baseline characteristics significantly associated with the initial uptake, in an unadjusted and adjusted model. The adjusted model shows that significantly more female than male residents took up the offer. Having one or more falls within the last 3 months and having a fracture within the last 6 months were associated with a higher uptake. Memory impairments influenced uptake with the highest uptake being among residents with the greatest memory loss. Those who needed some help in dressing had a significantly higher uptake than those that were either independent or dependent. Those who were dependent in toileting had a significantly lower uptake than those who needed some help or were independent. Those who were unable to transfer had a significantly lower uptake than those who were in need of major or minor help or were independent in transferring. "Staff judgement" of fall risk influenced uptake, with a higher uptake among those assessed to have a high risk of falling.

In the sub-analysis using the Barthel sum score categorised as described in "Materials and methods" and using a STRATIFY score of 2 or more as a cut-off value the result was approximately the same for the variables gender, fracture within the last 6 months, memory and staff

Table 2 Logistic regression for baseline characteristics significantly associated with initial uptake; in an unadjusted and adjusted model

Variables		Odds ratio (95% CI) unadjusted	*P* value	Odds ratio (95% CI) adjusted***	*P* value
Gender[a]		1.39 (1.08–1.78)*	0.012	1.54 (1.06–2.24)	0.022
Age		1.03 (1.01–1.04)*	<0.001		
Calcium supplementation[b]		1.99 (1.29–3.09)*	0.002		
Osteoporosis medication[b]		1.79 (1.03–3.11)†	0.039		
Walking aids[b]		1.34 (1.03–1.76)†	0.032		
Fracture 6 months[b]		3.65 (2.42–5.50)*	<0.001	1.67 (1.02–2.75)	0.043
Falls within the last 3 months[b]		6.14 (4.67–8.07)*	<0.001	2.08 (1.35–3.19)	0.001
Agitated[b]		2.15 (1.66–2.79)*	<0.001		
In need of frequent toileting[b]		1.96 (1.46–2.64)*	<0.001		
Transfer and mobility score ≥ 2[b]		3.10 (2.36–4.08)*	<0.001		
Memory[c]	Not able to	2.56 (1.69–3.89)*	<0.001	3.71 (2.09–6.59)	<0.001
	Large problems	2.99 (2.00–4.47)	<0.001	2.85 (1.81–4.49)	<0.001
	Medium problems	1.97 (1.27–3.06)	0.002	2.45 (1.39–4.33)	0.002
	Some problems	2.11 (1.38–3.22)	0.001	1.99 (1.14–3.48)	0.016
Communication[c]	Not able to	0.99 (0.66–1.49)†	0.978		
	Large problems	1.40 (1.01–1.94)	0.044		
	Medium problems	1.09 (0.77–1.52)	0.631		
	Some problems	1.44 (1.06–1.97)	0.021		
Feeding:[d,e]	Unable	0.34 (0.23–0.51)*	<0.001		
	Needs help	1.24 (0.98–1.58)	0.079		
Bathing:[d,e]	Dependent	4.16 (1.92–9.00)†	<0.001		
Dressing[d,f]	Needs help	1.45 (1.07–1.97)*	0.017	1.56 (1.08–2.26)	0.043
	Can do about half unaided	2.99 (2.11–4.24)	<0.001		
Bowels[d,e]	Incontinent occasional	0.89 (0.66–1.20)†	0.451		
	Accident	1.42 (1.08–1.86)	0.011		
Bladder[d,e]	Incontinent occasional	0.90 (0.66–1.22)*	0.502		
	Accident	2.07 (1.55–2.76)	<0.001		
Toilet use[d,e]	Dependent	0.26 (0.18–0.37)*	<0.001	0.53 (0.36–0.80)	0.002
	Needs some help	1,52 (1.18–1.96)	0.001		
Transfers:[d,e]	Unable	0.18 (0.12–0.26)*	<0.001	0.38 (0.19–0.74)	0.005
	Major help minor help	0.99 (0.72–1.37)	0.972		
		2.11 (1.55–2.87)	<0.001		
Mobility:[d,e]	Immobile	0.25 (0.18–0.36)*	<0.001	1.66 (1.15–2.39)	0.007
	Wheelchair independent	0.59 (0.38–0.91)	0.018		
	Walks with help	2.30 (1.74–3.05)	<0.001		
Stairs:[d,e]	Unable	1.31 (0.93–1.85)†	0.125		
	Needs help	2.62 (1.80–3.81)	<0.001		
Staff judgement of fall risk[f]	No risk	0.09 (0.00–0.13)*	<0.001	0.03 (0.01–0.12)	<0.001
	Low risk	0.12 (0.09–0.16)	<0.001	0.26 (0.17–0.39)	<0.001
STRATIFY score**	≥ 2	4.23 (3.28–5.45)	<0.001		
Barthel ADL index total score**	0–4 (Very low)	0.30 (0.22–0.42)	<0.001		
	5 –8 (Low)	1.54 (1.12–2.10)	0.008		
	9–11(Moderate)	2.28 (1.60– 3.24)	<0.001		

* Variables included in the backward, stepwise regression, †variables confounded by other registered variables and not included in the stepwise regression, **variables only included in the backward stepwise subanalysis (results in text), ***adjusted for cluster (nursing home)

[a] Reference category: male

[b] Reference category: no

[c] Reference category: no problems

[d] Reference category: highest score

[e] Barthel item

[f] Reference category: high fall risk

[g] Reference category: high functional ability (11–20)

judgement of fall risk. Those having a STRATIFY score of 2 or more had a significantly higher uptake compared to those with a score of 0 or 1 (odds ratio (OR): 1.63, $P = 0.005$, 95% CI: 1.16–2.28). Those having a very low functional ability according to the Barthel ADL Index had a significantly lower uptake compared to those with higher functional ability (OR: 0.30, 95% CI: 0.19–0.47, $P < 0.001$).

Factors associated with the probability of continued use

The 11 residents who never started to use a hip protector were excluded from the Cox regression analysis. Forty-six not willing to use a hip protector at the time of inclusion changed their minds and started to use a hip protector at a later date. These 46 were included in this analysis. Thus, the Cox proportional hazard model was based on 604 residents who started to use a hip protector. During the intervention 114 of the users stopped using the hip protector because of death, 20 because they were transferred and 78 because they were assessed not to be in need any longer. Fifteen stopped without giving any reason. One hundred and seventy-one failures (for some kind of discomfort, impracticality and unwanted side effects) among 168 participants were registered during the intervention period. That means that three participants had two failures.

Figure 1 shows a Kaplan–Meier estimate of the probability of ending hip protector use during the 18 months intervention. Approximately, 75% of the users were adherent after 3 months, but the adherence decreased to approximately 60% after 18 months.

In Table 3 Cox regression shows the association between the baseline characteristics and the probability of ending hip protector use; in an unadjusted and adjusted model. In the unadjusted model we found that male residents, those with a fracture within the last 6 months and a fall within the last 3 months, those having an agitated behaviour and those with memory- and communication impairments had a lower probability of ending hip protector use. Those assessed to be independent according to most items in Barthel had the highest probability of ending hip protector use. The adjusted model shows that being a male, having memory impairments and being incontinent (bowel) were significantly associated with a lower probability of ending hip protector use.

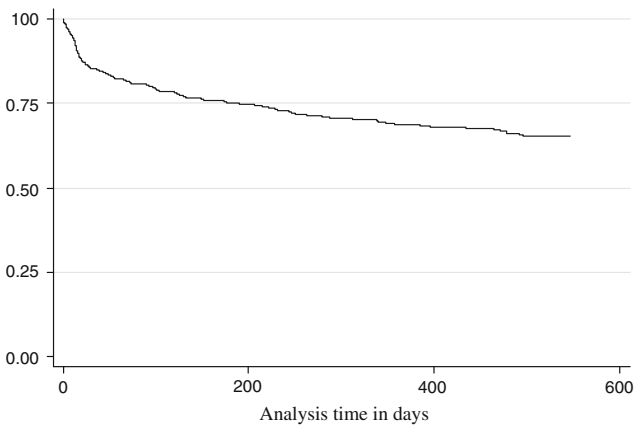

Fig. 1 Kaplan–Meier estimate of the probability of ending hip protector use

The adjusted sub-analysis using Barthel sum score and STRATIFY categorised as described under "Materials and methods" shows the same result for memory. However, gender was not a significant predictor in this model. Having a STRATIFY score of 2 or more was not significantly associated with the probability of ending hip protector use, but those having a low functional ability according to Barthel (sum score: 5–8) showed a lower probability of ending hip protector use than those with very low, moderate and high functional ability (HR: 0.57, 95% CI:0.39–0.85, $P = 0.005$).

When excluding from the analysis those who ended hip protector use due to some kind of discomfort within the first month (80 excluded), only memory and incontinence (bowel) stayed significant (not able to memorise: HR: 0.56, 95% CI: 0.42–0.77, $P < 0.001$, incontinence bowel: HR: 0.30, 95% CI: 0.16–0.58, $P < 0.001$)). The difference between male and female users turned insignificant. Figure 2a and b shows Kaplan–Meier estimates for gender when all users are included (a) and when excluding those who ended hip protector use within the first month (b). The difference in adherence between male and female residents seems to arise within the first month.

Discussion

In this prospective study among residents in nursing homes nearly half of all the residents took up the offer to use a hip protector, and the uptake was even higher (78%) among those assessed by staff judgement to be at high risk of falling. The adherence among those who took up the offer decreased to approximately 75% after 3 months and to approximately 60% after 18 months. A higher uptake was significantly associated with female gender and factors related to a high risk of falls and fractures. Male gender, memory impairments and incontinence (bowel) were predictors for higher adherence.

Previous studies investigating predictors for uptake and adherence used different methods of identifying residents with a high risk of falls and fractures and different definitions of adherence were used. This makes a direct comparison with other studies difficult. However, even though we used a non formal risk assessment method, an

Table 3 Cox regression for baseline characteristics significantly associated with the probability of ending hip protector use; in an unadjusted and adjusted model

Variables		Hazard ratio (95% CI)		Hazard ratio (95% CI)	
		Unadjusted	*P* value	Adjusted***	*P* value
Gender[a]		1.72 (1.13–2.61)*	0.011	1.71 (1.00–2.91)	0.049
Fracture within last 6 month[b]		0.54 (0.32– 0.91)*	0.019		
Falls within the last 3 months[b]		0.67 (0.49–0.92)†	0.012		
Agitated[b]		0.57 (0.40–0.81)†	0.002		
Memory[c]	Not able to	0.19 (0.11–0.33)*	<0.001	0.26 (0.14–0.50)	<0.001
	Large problems	0.28 (0.17–0.44)	<0.001	0.32 (0.22–0.45)	<0.001
	Medium problems	0.40 (0.17–0.44)	<0.001	0.46 (0.30–0.73)	0.001
	Some problems	0.46 (0.29–0.74)	0.001	0.49 (0.32–0.73)	0.001
Communication[c]	Not able to	0.39 (0.20–0.75)†	0.005		
	Large problems	0.56 (0.36–0.86)	0.008		
	Medium problems	0.48 (0.30–0.78)	0.003		
	Some problems	0.68 (0.46–0.99)	0.044		
Feeding[d,e]	Unable	0.38 (0.15–0.93)†	0.034		
	Needs help	0.65 (0.47–0.89)	0.008		
Bathing:[d,f]	Dependent	0.32 (0.14–0.71)†	0.006		
Grooming[d,f]	Needs help	0.57 (0.42–0.78)†	<0.001		
Dressing[d,f]	Needs help	0.42 (0.28–0.61)†	<0.001		
	About half unaided	0.66 (0.45–0.98)	0.040		
Bowels[d,f]	Incontinent	0.24 (0.14–0.40)*	<0.001	0.41 (0.25–0.66)	<0.001
	Occasional accident	0.68 (0.49–0.93)	0.016		
Bladder[d,f]	Incontinent	0.36 (0.23–0.56)†	<0.001		
	Occasional accident	0.53 (0.38–0.74)	<0.001		
Toilet use[d,f]	Dependent	0.55 (0.30–1.00)†	0.050		
	Needs some help	0.49 (0.35–0.67)	<0.001		
Transfers[d,f]	Unable	0.70 (0.34–1.44)†	0.336		
	Major help	0.52 (0.32–0.83)	0.006		
	Minor help	0.64 (0.45–0.91)	0.012		
Stairs[d,f]	Unable	0.63 (0.40–0.97)†	0.038		
	Needs help	0.85 (0.55–1.31)	0.461		
Staff judgement of fall risk[e]	No risk	2.04 (0.50–8.28)†	0.320		
	Low risk	1.45 (1.07–1.96)	0.016		
STRATIFY score	≥2	0.63 (0.47–0.86)**	0.004		
Barthel ADL index total score	0–4 (Very low)	0.41 (0.21–0.78)**	0.007		
	5–8 (Low)	0.44 (0.29–0.69)	<0.001		
	9–11(Moderate)	0.69 (0.47–1.02)	0.064		

* Variables included in the backward stepwise regression, †variables confounded by other registered variables and not included in the stepwise regression, **variables only included in the backward stepwise subanalysis (results in text), ***adjusted for cluster (nursing home)

[a] Reference category: male

[b] Reference category: no

[c] Reference category: no problems

[d] Barthel item

[e] Reference category: high fall risk

[f] Reference category: highest score (independent)

uptake rate of 46% among all residents and 78% among high risk individuals must be regarded as relatively high. Compared to other studies an adherence of approximately 75% after three months and 60% after 18 months is also relatively high, but in accordance with the results in the study of Thompson et al. (2005).

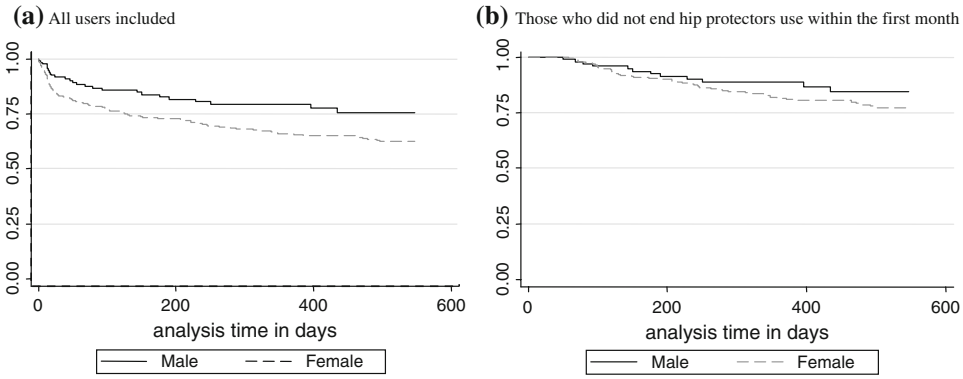

Fig. 2 Kaplan–Meier estimates of the probability of ending hip protector use, by gender

Our study supports the findings of a higher uptake among female residents found in the study of Hubacher and Wettstein (2001). Cryer et al. (2006) did also find a higher uptake among female residents however, the difference was not significant. Even though female residents were more prone to take up the offer than male residents, once they had started male residents had a lower probability of ending hip protector use than female residents. This is contrary to the findings of O'Halloran et al. (2005) who found that female residents had a higher adherence than male residents. However, their study was small with a much shorter follow up time. The main difference in adherence between men and women in our study seemed to arise within the first month (Fig. 2a, b). One explanation why female residents had a higher uptake than male residents might be our pragmatic design using staff judgment to identify high risk individuals. Staff members might have encouraged female residents more than male residents to take up the offer because of a presumed higher risk of hip fractures among females. A different explanation might be that men are more difficult to convince, but once agreeing to wear hip protectors they might be more likely to stick to their initial decision. Esthetical concerns might be more important for women that for men and might be an explanation why female residents to a higher degree ended hip protector use at an early stage.

Memory impairment is an important criterion for dementia (Breitner 2006) and dementia is a risk factor for falls (Rubenstein et al. 1994; van Doorn et al. 2003). In that respect it is reassuring that residents with a high degree of memory loss showed a higher uptake and a lower probability of ending hip protector use than those with no memory impairment. Our result showed a linear trend; the greater the memory loss the higher the uptake and the lower the probability of ending hip protector use. Our result supports the results from the studies of O'Halloran et al. (2005) and Thompson et al. (2005). The interpretation might, on the one hand, be that residents with memory loss are more easily persuaded to use a hip protector compared to those without any memory impairment and that the perception of discomfort more or less is a question of attitude and cosmetic concerns (e.g. making the hips appear larger) rather than pad related discomfort. On the other hand, it might be an ethical challenge that residents with less ability to make decisions and to express themselves were those with a lower probability of ending use. However, cognitively impaired residents were assessed for signs of discomfort, and a decision to end hip protector use was taken if such signs were observed as a consequence of hip protector use.

We found a higher adherence among residents with incontinence (bowel). Since bowel and bladder incontinence was highly correlated, our result can probably be regarded to be in accordance with the results in some other studies (Thompson et al. 2005; van Schoor et al. 2003; Warnke et al. 2004). Warnke et al. explain their positive correlation between adherence and incontinence with their training course concerning the problem of hip protector use in persons with urinary incontinence (Warnke et al. 2004). This focus was not a part of the initial training in our study and is probably not an explanation for our result. Van Shoor et al. explain a high adherence among residents with incontinence in that persons wearing incontinence products are used to special underpants (van Schoor et al. 2003). There is no documentary evidence, but staff members in our study reported that the hip protector is useful in fixing the incontinence pad. Since all the individual items in Barthel was highly correlated a different explanation might be that incontinence (bowel) is a marker for frail nursing-home residents dependent on nursing. Dependency of nursing has in another study been a predictor for high adherence (van Schoor et al. 2003). The adjusted sub analysis using Barthel total score categorised in four categories showed that functional ability influenced adherence, but not in a linear trend. The bivariate analysis using all the individual items in Barthel showed that those being most independent were those having the lowest adherence (Table 3). Consequently, there seems to be a challenge related to adherence among those most independent of nursing. One interpretation of the lower

adherence in this group might be a more negative attitude towards hip protectors. Another interpretation could be that use of hip protectors in more independent nursing home residents increases dressing and toileting difficulties resulting in a higher risk of falling and an increased need of assistance. It has been reported that hip protectors are tight and difficult to remove and that some people need more help with dressing or when going to the toilet than they did before starting with hip protectors (van Schoor et al. 2002). The hip protector is then seen as a nuisance rather than a benefit.

Our study is subject to some limitations that should be considered. First, our registration of baseline characteristics is crude and based on staff assessment which is more subjective than measurements. Second, measuring the probability of ending hip protector use does not capture to what extent or for how many hours the participant actually wore the hip protector. A daily diary would be more appropriate for this purpose (van Schoor et al. 2002), but beyond the scope of the present study. Third, one important premise for our findings is that hip protectors were offered free of charge. Since hip-protector users, and especially those experiencing incontinence, will need several pairs, cost might be a barrier to uptake and adherence. Consequently, the result might have been different if the resident or the nursing home had been charged for the hip protectors. Using a non formal risk assessment for identifying residents at high risk of falling might be regarded as a limitation by making it more difficult to compare the findings to other studies. However, this method of identifying high risk individuals is probably close to "real world" practice in most nursing homes. How fall risk is estimated using "staff judgement" is unknown. It is a subjective measurement where probably clinical experience and knowledge of risk factors are important. The logistic regression performed in the present study showed that uptake was significantly associated with known risk factors for falls and fractures. This indicates that these factors probably were important in staff judgment of fall risk. We cannot exclude the probability that our training sessions prior to the intervention influenced some of the staff's knowledge about risk factors for falls and fractures. However, our training sessions was not a main part of the intervention. The sessions were offered to the staff. The intention was to give information about the study and was not intended as an adherence improving strategy. This, in addition to the low rate of staff participating in these sessions, gives a low probability of an influence of the training sessions on the results. The fact that the staff encouraged residents at high risk of falls is probably a normal proceeding in nursing homes either high risk individuals has been identified by a formal risk assessment tool or by staff judgement.

The strengths of our study are the large number of participants and a long follow up time, which give the study enough power to detect significant associations. The fact that we adjusted for nursing homes clustering strengthens our results as well. The study population was similar in its age and gender distribution for Norwegian nursing-home residents in general (Kirkevold and Engedal 2004, Kirkevold and Engedal 2006). However, general conclusions must be drawn with caution and no conclusion should be drawn outside a nursing-home setting.

Conclusion

This large prospective study showed that several risk factors for falls and fractures, such as female gender, previous falls, previous fracture and memory impairment were predictors for a higher uptake with the use of hip protectors among nursing home residents. Memory impairments and incontinence (bowel) were strong predictors for higher adherence among those who took up the offer. The fact that neither memory impairments nor incontinence seemed to be barriers to hip protector use is important since these characteristics are common among nursing-home residents. Tertiary prevention, such as the use of hip protectors is probably one of the best feasible interventions in nursing homes and should be advocated to prevent hip fractures.

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