

# Predictors of Adherence to the Use of Hip Protectors in Nursing Home Residents

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See editorial comments by Dr. Elizabeth Capezuti on pp 461–462.

**OBJECTIVES:** To assess predictors of hip-protector use in nursing home residents under usual-care conditions and after intervention consisting of structured education of nurses and nursing home residents and provision of free hip protectors.

**DESIGN:** Nested cohort analyses within a cluster randomized, controlled trial with 18 months follow-up.

**SETTING:** Forty-nine nursing home clusters in Hamburg, Germany.

**PARTICIPANTS:** Residents with at least one fall during the study period (intervention group,  $n = 237$ ; usual-care group,  $n = 274$ ).

**MEASUREMENTS:** Use of hip protector while falling. Regression analyses were performed for each of the two cohorts of fallers using the time to the first fall without hip protector as the dependent variable. Predefined nursing home cluster-related parameters (center, staffing ratio, proportion of registered nurses in nursing staff, hip-protector use before study period) and resident-related parameters (sex, history of falls and fractures, fear of falling, urinary incontinence, use of walking aid, degree of disablement) were considered as explanatory variables.

**RESULTS:** Under usual care, 97% of fallers ( $n = 266$ ), compared with 62% ( $n = 148$ ) in the intervention group, experienced at least one fall without hip protection. Using Cox proportional hazards models with and without frailty parameter (random cluster effect), the following predictors were identified: intervention group: use of walking aid,

hazard ratio (HR) = 1.53 (95% confidence interval (CI): 0.98–2.39) and no urinary incontinence, HR = 1.47 (95% CI: 1.03–2.09); usual care: nursing staff per 10 residents, HR = 0.78 (95% CI = 0.63–0.96); high degree of disablement, HR = 1.38 (95% CI = 1.06–1.80); strong fear of falling, HR = 0.78 (95% CI = 0.60–1.02). The nursing home cluster was a significant predictor in the control group ( $P = .029$ ), but not in the intervention group ( $P = .100$ ).

**CONCLUSION:** Only a few and weak predictors of hip-protector use of questionable relevance could be identified in both groups. Future research should concentrate on the implementation of interventions of proven efficacy, such as provision of hip protectors combined with structured education of staff and residents. *J Am Geriatr Soc* 52:340–345, 2004.

**Key words:** patient compliance; frail elderly; hip fracture prevention and control; nursing homes; orthopedic equipment

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The use of hip protectors can effectively prevent hip fractures.<sup>1</sup> Trials of hip protectors in nursing homes have reported a reduction in hip fractures of more than 50%,<sup>1</sup> but adherence to the use of hip protectors is poor.<sup>1–3</sup> Even with free provision of hip protectors and structured education of nursing staff and residents to increase their use, hip protectors are only used in about 60% of falls.<sup>4</sup> Therefore, identification of predictors of adherence to the use of hip protectors might help to design more specific interventions. The purpose of the present study was to analyze predictors of adherence as part of a randomized, controlled trial under usual- and optimized-care conditions in nursing homes.

## PARTICIPANTS AND METHODS

### Main Study

The objective of the main study was to evaluate the effects of an intervention program aimed at increasing adherence to the use of external hip protectors and thereby reducing

hip fractures. A detailed description of the study has been published.<sup>4,5</sup> In short, 49 nursing home clusters in Hamburg, Germany, including 942 residents (intervention group, 25 clusters with 459 residents; control group, 24 clusters with 483 residents) participated in a randomized, controlled trial with an 18-month follow-up. A cluster was defined as a nursing home by itself or an independently operating ward of a large nursing home. Each nursing home cluster selected residents according to the following inclusion criteria: aged 70 and older, not bedridden, and living in the nursing home for more than 3 months. The ethics committee of the Hamburg chamber of physicians approved the study.

### Intervention Group

The goal of the intervention was prevention of hip fractures by increasing the use of hip protectors.

Intervention consisted of structured education of nurses and residents and provision of free hip protectors. Three hip protectors per participant were provided. Safehip (Tytex Denmark, Ikast, Denmark) was used because it was the only evaluated hip protector available at the initiation of the study.<sup>2</sup> The information program was based on the principles of the social learning theory, which considers modeling as a powerful means of transmitting values, attitudes, and patterns of thought and behavior.<sup>6</sup> The investigators conducted single education sessions for nursing staff, who then educated residents. The education session for nursing staff lasted 60 to 90 minutes. The program covered information about the risk of hip fracture and related morbidity; effectiveness of hip protectors; and relevant aspects known to interfere with the use of hip protectors, such as aesthetics, comfort, fit, handling, and use in residents with incontinence. The session included experience-based, theoretical, and practical aspects. In addition to the printed curriculum, 16 colored flip charts illustrating the main objectives and a leaflet for residents, relatives, and physicians were developed and provided. A detailed description of the program has been published.<sup>4,5</sup>

### Control Group

German health insurance does not cover hip protectors. Usual care was enhanced with brief information sessions (10 minutes) about and demonstration of the hip protector to the nominated study coordinator of each cluster. Two hip protectors were provided for demonstration purposes.

Nursing staff prospectively collected outcome variables using a specially developed fall documentation sheet. The following variables were assessed: hip fractures, other fall-related fractures, falls, and fall-related hip-protector use. The investigators checked the data every 2 months during site visits. At the end of the study, one investigator and the nominated study coordinator from each cluster reviewed all records to verify the completeness of data. Adherence to hip-protector use was expressed as the proportion of fallers with documented use of the protector during at least one fall and the proportion of fall events with documented use of the protector.

### Predictor Analysis

Predictor analysis was performed separately for the fallers in each of the two groups: intervention and control. The dependent variable was time to the first fall without hip-protector use. The following predefined parameters were considered as explanatory variables.

#### *Nursing Home Cluster-Related Variables*

- (a) Center: It was hypothesized that the intervention would significantly decrease center variation in adherence. Center variation was defined as the variation between nursing home clusters.
- (b) Number of nursing staff per 10 residents: Level of staffing (registered nurses, registered geriatric nurses, nurse's aides) as full-time equivalents per 10 residents. For both groups, it was assumed that the higher the number of nursing staff per residents, the better the acceptance of hip protectors would be.
- (c) Proportion of registered nurses to total nursing staff: It was hypothesized that the higher the proportion of registered nurses in a nursing home cluster, the better the acceptance of hip protectors would be. A registered nurse was defined as registered nurse or registered geriatric nurse.
- (d) Hip protector in use before study period: Better adherence was assumed if hip protectors were already used in the cluster before the study (yes = 1; no = 0).

#### *Resident-Related Variables*

- (a) Sex: As in previous hip protector studies,<sup>7,8</sup> better adherence to hip-protector use was assumed for female participants (yes = 1; no = 0).
- (b) Falls and fractures: Assuming better adherence to hip-protector use for participants with a history of falls or fractures, the following variables were included (yes = 1; no = 0): falls during preceding 12 months, falls during preceding 4 weeks, history of hip fracture, other fractures during preceding 12 months.
- (c) Strong fear of falling: Fear of falling of the participants was estimated by proxy rating of the nursing staff, with scores ranging from 1 (very strong fear of falling) to 5 (no fear of falling). In a quality-of-life study, the authors assessed a proxy rating of nursing staff regarding fear of falling and subjective fear of falling of nursing home residents using a newly developed quality-of-life questionnaire. The proxy rating of fear of falling was significantly correlated with the subscale "fear of falling" of the questionnaire addressing subjective fear of falling (correlation coefficient ( $r$ ) = 0.36;  $P < .01$ ).<sup>5</sup> The proxy rating was used for predictor analyses because not all participating residents were able to complete the questionnaire on subjective fear of falling. Details are published elsewhere.<sup>5,9</sup> For predictor analyses, a variable "strong fear of falling" was used combining scores 1 and 2. It was hypothesized that participants with a strong fear of falling would have better acceptance of the hip protector (yes = 1; no = 0).
- (d) No urinary incontinence (UI): It was hypothesized that UI interferes with the use of hip protectors and therefore would result in a lower level of acceptance.

Better adherence to hip-protector use was assumed for participants without UI (yes = 1; no = 0).

- (e) Use of walking aid: It was hypothesized that participants using a walking aid would have better acceptance of the hip protector (yes = 1; no = 0).
- (f) High degree of disablement: For description of the functional and cognitive status, the degrees of disablement as assessed by expert raters of the medical service of the German statutory health insurance system (0 = none, 1 = considerable, 2 = severe, 3 = most severe) were used.<sup>10</sup> The grading system is based on a standardized examination. Reliability and validity have been sufficiently proven in several studies.<sup>11,12</sup> The interrater reliability of the standardized examination is high (kappa = 0.82).<sup>11</sup> Scores 2 and 3 were combined to the form variable “high degree of disablement.” Better adherence to hip-protector use was assumed if the degree of disablement was high (yes = 1; no = 0).

### Statistical Analysis

Cox proportional hazards models with and without frailty (random cluster effect) were applied to investigate the effects of the described explanatory variables on the risk of suffering a fall without hip protection. With the frailty model, which is a common notation in the modern survival analysis literature, it is possible to take the dependence of clustered time-to-event data (residents nested within clusters) into account. The term “frailty” in this context does not refer to a level of dependency or disablement. Time to the first fall without hip protection was used as response. Analyses were performed for the subgroup of fallers separately for the usual care and intervention groups. Backward selection based upon standard Cox models without frailty was used to identify the most important

risk factors. The significance level for removing an explanatory variable from the model in the backward selection procedure was chosen as  $\alpha = 0.10$ . The proportional hazards assumption of the resulting Cox models was checked by plotting the log of the negative log of the estimated survival functions, against log time and by tests of trend in the hazard ratio (HR). To allow for differences between clusters, a random cluster effect (frailty) was added by applying Cox proportional hazards models with frailty parameter. Adjusted HRs for the risk factors were calculated based upon the final frailty models. For calculations the SAS 6.12 procedure PHREG (SAS Institute, Inc., Cary, NC) and S-Plus 6.0 (Insightful Corporation, Seattle, WA) were used. All tests were two-tailed.  $P < .05$  was regarded as significant.

### RESULTS

Figure 1 shows the flow of participants through the study period regarding hip protector use.

Baseline characteristics of the nursing home clusters were comparable between the study groups (mean number of residents  $\pm$  standard deviation =  $137 \pm 72$  in the intervention group,  $116 \pm 69$  in the control group; mean number residents per nursing staff =  $3 \pm 1$  in both groups; mean proportion of registered nurses to the total nursing staff =  $53 \pm 10$  in the intervention group,  $52 \pm 7$  in the control group).<sup>4</sup>

In the intervention group, 292 residents completed the 18-month follow-up, compared with 276 residents in the control group. One hundred sixty-seven residents in the intervention group and 207 in the control group died or moved. Data from all participants were included in the analyses. The mean follow-up was  $15 \pm 6$  months for the intervention group and  $14 \pm 6$  months for the

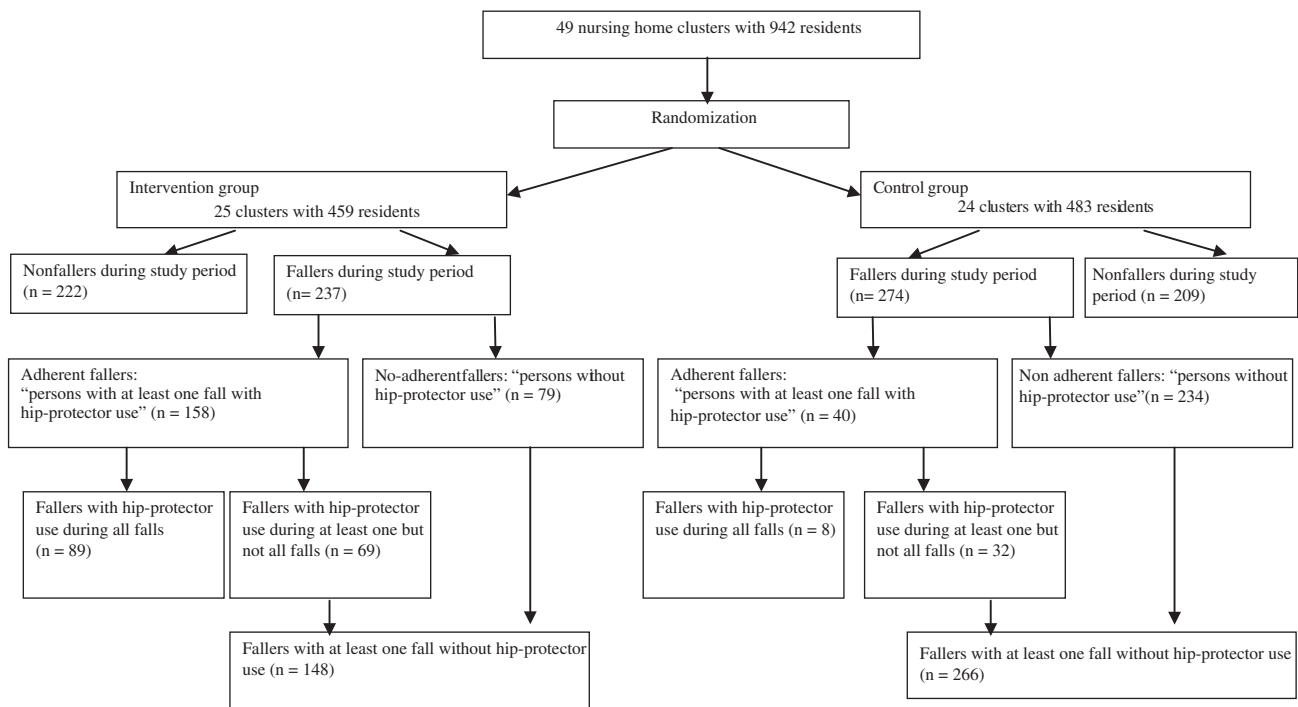


Figure 1. Flow of participants through the study period.

control group. Results of the follow-up data on falls, fractures, and adherence to hip protector use have been published elsewhere.<sup>4</sup> In short, the intervention significantly increased hip-protector use and resulted in a reduction in hip fractures of approximately 40%. There were 21 hip fractures in 21 residents in the intervention group and 42 hip fractures in 39 residents in the control group ( $P = .072$ ). In the intervention group, 237 residents (52%) experienced at least one fall, compared with 274 (57%) in the control group. One hundred forty-eight fallers (62%) in the intervention group and 266 fallers (97%) in the control group had at least one fall without hip protection. The total number of falls was 946 in the intervention group and 1,409 in the control group. Frequency of falls per resident was not significantly different between groups ( $P = .14$ ).<sup>4</sup>

The predictor analysis was performed for the subgroups of residents with at least one fall during the study period (intervention group,  $n = 237$ ; usual care group,  $n = 274$ ).

Descriptive data for the subgroups of adherent and nonadherent fallers are summarized in Table 1.

The plots of the log of the negative log of the estimated survival functions against log time and the tests for trend in the HRs showed no clear violations of the proportional hazards assumption of the Cox models resulting from the backward selection. In both groups, the adjusted HRs of the

risk factors in the Cox models with and without frailty were similar, but the consideration of a random cluster effect by means of frailty clearly increases the amount of explained variation. The results of the final Cox proportional hazards frailty models are shown in Table 2. The frailty model describes the predictors of nonadherence to hip-protector use accommodating information on intercluster variation. In contrast to the primary assumption in the intervention group, nonadherence was more likely in residents using a walking aid and those without UI. In accordance with the original hypothesis, in the control group, a higher level of staffing and strong fear of falling were predictors of adherence, but a high degree of disablement was a predictor of nonadherence rather than adherence. The center (nursing home cluster) was a statistically significant predictor of adherence in the control group ( $P = .029$ ) but not in the intervention group ( $P = .100$ ). Overall associations between predictors and adherence were weak.

**DISCUSSION**

This nested cohort analysis is the first comprehensive evaluation of predictors of adherence to the use of hip protectors in nursing home residents. The study included a large number of participants and nursing home clusters

**Table 1. Baseline Characteristics of Fallers Using and Not Using Hip Protectors and Nonfallers During Follow-Up**

Characteristic	Intervention Group			Control Group		
	Fallers (n = 237)		Nonfallers (n = 222)	Fallers (n = 274)		Nonfallers (n = 209)
	Hip Protector Use (n = 158)	No Hip Protector Use (n = 79)		Hip Protector Use (n = 40)	No Hip Protector Use (n = 234)	
Female, n (%)	145 (92)	75 (95)	185 (83)	27 (68)	202 (86)	179 (86)
Age, mean ± SD	87 ± 5	87 ± 6	86 ± 7	82 ± 9	87 ± 7	86 ± 7
Degree of disablement, n (%)						
None	2 (1)	3 (4)	8 (4)	0 (0)	10 (4)	9 (4)
Considerable	51 (32)	39 (49)	83 (37)	8 (20)	85 (36)	68 (33)
Severe	84 (53)	29 (37)	105 (47)	22 (55)	120 (51)	100 (48)
Most severe	19 (12)	6 (8)	19 (9)	10 (25)	17 (7)	31 (15)
NA	2 (1)	2 (3)	7 (3)	0 (0)	2 (1)	1 (0.5)
Urinary incontinence, n (%)	117 (74)	47 (59)	157 (71)	37 (93)	175 (75)	158 (76)
Use of walking aid, n (%)	114 (72)	64 (81)	167 (75)	22 (55)	169 (72)	155 (74)
Falls and fractures, n (%)						
Falls during preceding 12 months	136 (86)	58 (73)	153 (69)	36 (90)	168 (72)	140 (67)
NA	4 (3)	5 (6)	8 (4)	0 (0)	4 (2)	6 (3)
Falls during preceding 4 weeks	72 (46)	28 (35)	58 (26)	23 (58)	60 (26)	50 (24)
NA	0 (0)	0 (0)	1 (0.5)	0 (0)	1 (0.4)	0 (0)
History of hip fracture	45 (28)	16 (20)	56 (25)	5 (13)	58 (25)	43 (21)
NA	4 (3)	5 (6)	5 (2)	1 (3)	4 (2)	2 (1)
Other fractures during preceding 12 months	22 (14)	8 (10)	22 (10)	8 (20)	25 (11)	15 (7)
NA	7 (4)	3 (4)	6 (3)	1 (3)	4 (2)	7 (3)
Fear of falling, mean ± SD*	3.1 ± 1.5	3.1 ± 1.2	3.2 ± 1.4	3.6 ± 1.6	3.1 ± 1.4	3.1 ± 1.4

\* Value range 1 (very strong) to 5 (not at all).  
NA = not available.

**Table 2. Predictors of Nonadherence with Hip-Protector Use in Intervention and Control Group, Based on Cox Proportional Hazards Frailty Models**

Variable*	Regression Coefficient	Standard Error	P-value	Unit for HR	HR	95% Confidence Interval
<b>Intervention group</b>						
Frailty <sup>†</sup> (random cluster effect <sup>‡</sup> )			.100			
Use of walking aid	0.427	0.227	.059	yes/no	1.53	0.98–2.39
No urinary incontinence	0.383	0.180	.033	yes/no	1.47	1.03–2.09
<b>Control group</b>						
Frailty (random cluster effect)			.029			
Staff (registered nurses, registered geriatric nurses, nurse's aides) per 10 residents	–0.249	0.106	.018	1	0.78	0.63–0.96
High degree of disablement	0.322	0.137	.018	yes/no	1.38	1.06–1.80
Strong fear of falling	–0.248	0.134	.065	yes/no	0.78	0.60–1.02

Intervention group:

Explained variation:  $R^2 = 0.131$ .

Total n = 237 (fallers), events n = 148 (event = first fall without hip-protector use) [see Figure 1].

Control group:

Explained variation:  $R^2 = 0.156$ .

Total n = 272 (fallers, missing values for n = 2), events n = 266 (event = first fall without hip-protector use) [see Figure 1].

\* For definition see Participants and Methods.

<sup>†</sup> Frailty model = statistical model to investigate the effect of predictors on time to event data accommodating information on intercluster variation by including random cluster effect (see Statistical Analysis).

<sup>‡</sup> Cluster = nursing home cluster.

HR = hazard ratio.

with a sufficiently long follow-up period, but only a few items emerged as predictors of hip-protector use, and predictive values were low and partly in contrast with the underlying assumptions. In addition, these negative findings were observed under usual-care conditions and after the intervention of a structured education program and free provision of hip protectors.

It was assumed that nursing staff level and proportion of registered nurses in nursing staff would be important for adherence to hip-protector use. In recent studies, these parameters have been identified as important predictors of outcome in hospital patients and nursing home residents.<sup>13–16</sup> In the present study, it was found that only the nurse-to-resident ratio was a weak predictor and only in the control group. This difference between usual care and the intervention group might be interpreted as an intervention effect.

UI has been reported to interfere with hip-protector use,<sup>3,17,18</sup> but in the present analyses, UI was associated with better adherence to hip-protector use, at least in the intervention group. Because the problem of hip-protector use in persons with UI was an explicit part of the education program, this unexpected finding could at least partly be due to the educational intervention, but nurses have also reported that the hip-protector pants are useful for fixing the incontinence pad and pant systems. Thus, UI does not appear to be a barrier to the use of hip protectors in general.

During the study visits in various nursing home clusters, the investigators (AW and GM) had the impression that the commitment, the support, and the motivation of the caregiver in charge and the management of the facility were essential for the acceptance of the hip protector. In accordance with these observations, the nursing home

cluster was an independent predictor of hip-protector use under usual-care conditions. This nursing home cluster effect diminished in the intervention group. Thus, this finding supports the primary hypothesis that a structured intervention program reduces differences in care between nursing homes. Some investigators have also stressed the importance of the effect of the nursing home (center effect) with respect to hip-protector use.<sup>19,20</sup> They suggested that the organizational commitment of the institutions largely determines adherence to hip-protector use. In addition, the literature on inter-nursing home variation (center variation) between nursing care and patient outcome supports the results of the current study.<sup>21,22</sup>

The present study has several limitations. Adherence was assessed by documenting hip-protector use during falls rather than by unscheduled visits. Advantages and disadvantages of this assessment method have been discussed elsewhere.<sup>4</sup> As a consequence, analyses in the present study were restricted to the subgroups of fallers. It remains unknown whether the findings are transferable to the participants who did not fall during the study period. In addition, investigators and the statistician were not blinded to group allocation. Although a sufficient number of nursing home clusters and residents had been recruited to the main study, the subgroups of fallers available for the present analyses were smaller, thus rendering results uncertain to some extent. In addition, predictors of adherence to the use of hip protectors might be different in people living in the community.

The present study has several strengths. In contrast with one study,<sup>23</sup> residents who declined to use the hip protector were not excluded and not substituted after randomization. Unlike previous studies,<sup>2,19,23–26</sup> hip-protector use in the

control group was documented. Therefore, the present results have a high generalizability to high-risk nursing home residents. In addition, this is the first study taking cluster randomization and time-dependent correlated frailty into account.

In conclusion, the study shows that there are only a few and weak predictors of adherence to hip-protector use. The difference in adherence between intervention group and usual care is more pronounced than the variation between nursing home clusters. Thus, free provision of hip protectors combined with structured education of nursing staff and residents remains the most important determinant in increasing the use of hip protectors and thereby reducing hip fractures.

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