

K.-G. Gaßmann
R. Rupprecht
E. Freiburger
for the IZG Study Group

Predictors for occasional and recurrent falls in community-dwelling older people

Received: 31 July 2007
Accepted: 7 November 2007
Published online: 11 March 2008

Members of the IZG Study Group: Participating centres and investigators (alphabetical by centre): Carl-Korth-Institute, Erlangen: Lang, E.; Chair for Health Management, FAU Erlangen-Nuremberg: Schöffski, O.; Chair of Internal Medicine V and Institute of Biomedicine of Aging, FAU Erlangen-Nuremberg: Mühlberg, W., Sieber, C.; Clinic for Geriatric Medicine, Waldkrankenhaus St. Marien, Erlangen: Gaßmann, K.-G.; Clinic for Neurology, FAU Erlangen-Nuremberg: Kolominsky-Rabas, P.; Clinic for Psychiatry and Psychotherapy, FAU Erlangen-Nuremberg: Gräßel, E., Kornhuber, J.; Department of Management, FAU Erlangen-Nuremberg: Esslinger, A. S.; Institute of History and Ethics in Medicine, FAU Erlangen-Nuremberg: Wittern-Sterzel, R.; Institute of Psychogerontology, FAU Erlangen-Nuremberg: Ackermann, A., Engel, S., Kaiser, H.-J., Lang, F.R., Oswald, W.D., Rupprecht, R., Schüssel, K.; Institute of Sport Science, FAU Erlangen-Nuremberg: Freiburger, E., Pfeifer, K., Rütten, A.; Members without affiliation: Schneider, H., Stosberg, M.

All research work was performed at the “Interdisciplinary Centre of Gerontology” at the University of Erlangen-Nuremberg.

Gaßmann, Karl-Günter, MD (✉)
Clinic for Geriatric Medicine
Waldkrankenhaus St. Marien
Rathsberger Str. 57
91054 Erlangen, Germany
Tel.: +49-9131/822-3702
Fax: +49-9131/822-3703
E-Mail:
karl.gassmann@waldkrankenhaus.de

Prädiktoren für einmalige und mehrfache Stürze bei selbständigen älteren Menschen

► **Abstract** *Background* Little is known about the prevalence of falls and the related risk factors in the general population of community-living older people in Germany. *Objectives* To assess the prevalence and related predictors of different types of falls in a sample of community-dwelling 65 years and older people in Germany living in a metropolitan area. *Study design and setting* prospective cohort study in 622 community dwelling people aged ≥ 65 years. *Results* A total of 107 persons (17.2%) reported falling at least once (occasional fallers), while 36 (5.7%) experienced two or more falls (recurrent fallers) in

Rupprecht, Roland, PhD
Institute of Psychogerontology
University of Erlangen-Nuremberg
Naegelsbachstr. 25
91052 Erlangen, Germany
Tel.: +49-9131/85-26530
Fax: +49-9131/85-26554
E-Mail: rupprecht@geronto.uni-erlangen.de

Freiburger, Ellen, PhD
Institute of Sport Science
University of Erlangen-Nuremberg
Gebbertstr. 123
91054 Erlangen, Germany
Tel.: +49-9131/85-25005
Fax: +49-9131 85-25005
E-Mail: ellen.freiburger@sport.uni-erlangen.de

the last 6 months. *Main predictors* for all fallers were age (OR 1.8; 95% CI 1.1–3.0), being female (OR 1.7; 95% CI 1.1–2.2), living alone (OR 1.9; 95% CI 1.2–2.9), poor health status (OR 3.3; 95% CI 2.1–5.3), varifocals (OR 1.7; 95% CI 1.0–3.1), disturbance of memory (OR 1.7; 95% CI 1.0–3.0), depression (OR 4.8; 95% CI 2.5–9.2), sleep disturbances (OR 2.7; 95% CI 1.7–4.3), incontinence (OR 2.1; 95% CI 1.3–4.9), dizziness (OR 3.0; 95% CI 1.9–5.0), 3 medical conditions or more (OR 3.3; 95% CI 2.1–5.1), lower physical functioning and mobility. Two of the strongest predictors were reported falls (OR 4.9; 95% CI 3.1–7.7) and recurrent falls (OR 10.0; 95% CI 5.0–20.0) in the last 6 months. *Conclusion* Older adults living at home should be screened for falls in history and problems in gait and mobility in any anamnesis to identify those who are at risk for falls.

► **Key words** aged – falls – risk factors – prospective cohort study

► **Zusammenfassung** Ziel der Studie war die Untersuchung von Prävalenz und Prädiktoren für Stürze bei selbständig lebenden Menschen mit einem Alter von 65 Jahren und darüber in der Bundesrepublik Deutschland. 622 Personen aus einer Bevölkerungs-Zu-

fallsstichprobe wurden in einer prospektiven Kohortenstudie untersucht. Ergebnisse: 107 Personen (17,2%) berichteten über mindestens einen, 36 (5,7%) 9 über mindestens zwei Stürze in den letzten sechs Monaten. Die wichtigsten Prädiktoren waren Alter (OR 1,8; 95% CI 1,1–3,0), weibliches Geschlecht (OR 1,7; 95% CI 1,1–2,2), allein lebend (OR 1,9; 95% CI 1,2–2,9), ein schlechter subjektiver Gesund-

heitszustand (OR 3,3; 95% CI 2,1–5,3), das Tragen einer Gleitsichtbrille (OR 1,7; 95% CI 1,0–3,1), Gedächtnisstörungen (OR 1,7; 95% CI 1,0–3,0), Depressionen (OR 4,8; 95% CI 2,5–9,2), Schlafstörungen (OR 2,7; 95% CI 1,7–4,3), Inkontinenz (OR 2,1; 95% CI 1,3–4,9), Schwindel (OR 3,0; 95% CI 1,9–5,0), 3 oder mehr Diagnosen (OR 3,3; 95% CI 2,1–5,1), schlechter funktioneller Zustand oder Mobilität. Einer der

stärksten Prädiktoren waren Stürze (OR 4,9; 95% CI 3,1–7,7) und Mehrfachstürze (OR 10,0; 95% CI 5,0–20,0) in der Vorgeschichte. *Schlussfolgerung* Ältere selbständige Personen mit Stürzen oder Gangstörungen in der Vorgeschichte sollten im Sinne der Prävention näher untersucht werden.

► **Schlüsselwörter** Stürze – Risikofaktoren – Prospektive Kohortenstudie

Background

In community dwelling older people, falls are common events affecting every third person in this population [6, 12, 15–28]. In community dwelling residents older than 80 years, the fall rate can be as high as 50% per year [25]. The incidence of falls in community-based older populations has been reported to vary between 224 and 809 per 1000 person years [e.g. 11, 17]. There may be several reasons for the variations including recall bias related to the ascertainment of falls in retrospective studies and the age and race of the study subjects.

Given the fact that a high percentage of fallers experience multiple falls and are at a high risk of future falls during the next year [26, 32], identification at an early stage for the purposes of the prevention of falls would seem to be imperative in order to reduce the burden both on the people affected and on the public health system.

Falls in the elderly possess a multi-factorial aetiology that involves the interaction between intrinsic (those related to the individual) and extrinsic factors (those associated with environmental features) [26]. Intrinsic factors include age-related changes, lower-extremity weakness, neurological conditions, diminished cognitive function, reduced vision and hearing, low blood pressure, acute illness, and medication use [21, 24, 27, 29].

Unfortunately, no national data on the prevalence and incidence of falls is available for Germany. In addition, the number of falls and percentage of fallers are not always conclusive [18, 21] due to varying definitions of falls. The objectives of this study therefore, were to determine the prevalence and related predictors of different types of falls, both occasional and recurrent, in a representative sample of community-dwelling older people living in a metropolitan area in Germany. A fall was defined according to the PROFANE group [21] as “an unexpected

event in which a participant comes to rest on the ground, floor, or lower level”.

Methods

Study population

In 2004 a representative sample of 6000 community-dwelling persons aged 65 years and older who were living in the metropolitan area of Erlangen, Nuremberg, and Fuerth was selected completely at random from the local registration offices (2000 from each city). No stratified sampling according to gender, age or living area was done thus ensuring that every person aged 65 years and older had the same opportunity of being selected. These individuals were contacted by mail with a questionnaire including a prepaid return envelope. Support for the study was aided by informing the public about it with articles in local newspapers. Due to limited funding, no further attempts to contact non-respondents with a second mailing or telephone calls were possible. Nevertheless 1985 people (33.1%) returned the questionnaire either voluntarily including their name and address (using a consent form) or anonymously. Questionnaires with missing data were excluded leaving a total of 1801 participants (30%) for data analysis. Out of those total participants, N=622 (34.5%) could be evaluated in 2006 at the follow-up assessment (see Fig. 1).

Baseline assessment (2004)

Basic demographic data was obtained as well as data concerning height, weight, subjective health, medications, and diseases connected with falls. Data on falls during the past 6 months was also obtained includ-

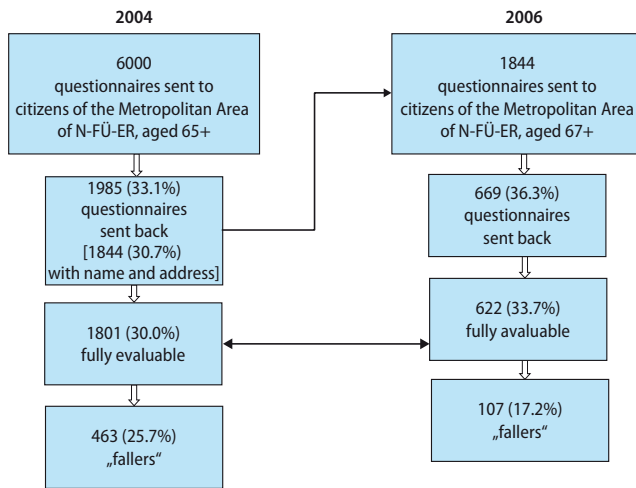


Fig. 1 Flow chart of participants

ing information on the place, time, characteristics, and consequences of the fall. Furthermore, participants were asked to give reasons for their fall. All this data was obtained using a structured questionnaire developed especially for the purpose of this study and is based on the self rating of the study members. Participants were classified as “non-fallers” with no reported falls during the 6 months before the follow-up-assessment, as “all fallers” with at least one fall, as “occasional fallers” with only one fall, and as “recurrent fallers” with two or more falls.

Follow-up assessment (2006)

As in the baseline assessment a specially developed structured questionnaire was used. Data on falls during the last 6 months was asked for as well as the characteristics, and consequences of the falls that were reported. In addition, information was obtained concerning the medical treatment and limitation in mobility status due to the falls. Information on the physical fitness and physical activity of the participants was reported as well as data on anxiety (on a scale from 1 to 6 with 1 being no anxiety). Furthermore, the GDS4 short version for depression [16] was used, and name and numbers of medications were assessed.

Statistical analyses

All analyses in this article are based on the sample of $N=622$ participants, who have taken part both in the baseline assessment and the follow-up-assessment.

Descriptive analyses were performed for demographic, disease and predictor variables. $P<0.05$ (2-tailed) was considered statistically significant. Bivariate odds ratios with their 95% confidence intervals were calculated for the independent variables. Because of the wide use of categorical data no multivariate analysis was provided.

The data analysis was performed in two steps. Variables from the baseline assessment in 2004 were tested with respect to the prospect of future falls in the next two years. Furthermore, risk factors from 2006 were determined retrospectively in connection with the falls which had occurred during the 6 months before the follow-up assessment.

The statistical package SPSS version 14 for Windows (SPSS, Inc. Chicago, IL) was used for data analyses.

Results

Prevalence of falls according to gender and age

In the *Follow-up assessment*, 82.8% of the sample ($n=622$) reported having no falls in the previous six months. 107 (17.2%) reported falling once or more during this period. Of those, 71 (11.4%) had one fall (occasional fallers), and 36 (5.8%) two or more falls (recurrent fallers).

Women showed a greater prevalence of falls (27.4% vs 13.4% of all falls). The prevalence of falls was also dependent on age. The prevalence increased from 15.3% ($n=31$) in the 65–69 age group, to 15.9% ($n=50$) in the 70–79 group, 22.8% ($n=21$) in the group between 80 and 89 years and 45.5% ($n=5$) in the oldest group (90 years of age and older). A similar increase dependent on age could be seen in recurrent fallers (see Table 1 for details).

Table 1 Prevalence of falls in 2006 according to sex and age

	Any fallers		Occasional fallers		Recurrent fallers		Non-Fallers	
	N	%	N	%	N	%	N	%
Total (N=622)	107	17.2	71	11.4	36	5.8	515	82.8
Men (n=322)	43	13.4	25	7.8	18	5.6	279	86.7
Women (n=297)	64	27.4	46	15.5	18	6.1	233	78.5
65–69 years (n=202)	31	15.3	23	11.4	8	4.0	171	84.7
70–79 years (n=315)	50	15.9	32	10.2	18	5.7	265	84.1
80–89 years (n=92)	21	22.8	12	22.8	9	9.8	71	77.2
90 years (n=11)	5	45.5	4	36.4	1	9.1	6	54.5

■ Medical predictors of falls

Among the medical conditions, the strongest predictors for any falls were a poor subjective health status (OR 3.37 [2.14–5.36]), 3 or more medical conditions (OR 3.31 [2.11–5.18]), dizziness (OR 3.09 [1.90–5.03]), depression (OR 4.83 [2.52–9.25]), and fear of falling (OR 2.99 [1.95–4.61]). The use of varifocals, hip joint endoprosthesis, sleep disorders and incontinence were also predictors. The intake of 4 or more medications had no effect on the fall history. Parameters associated with restrictions of mobility such as the use of a walker (OR 3.62 [2.22–5.92]) or fear of falling (OR 2.99 [1.95–4.61]) and other functional factors were significant predictors for any falls: problems in getting out of bed, mobility in the home, shopping or visiting friends. If a previous fall was reported in the baseline assessment, the risk of falls in the follow-up assessment was considerably increased (OR 4.95 [3.16–7.75]).

■ Retrospective analysis of falls

In addition to the analysis in relation to the prospect of future falls, risk factors for falls in the previous 6 months before the follow-up assessment were determined retrospectively. We found that problems in walking 500 m (OR 3.89 [2.49–6.07]), physical inactivity (OR 2.85 [1.84–4.42]), being unable to climb three stairs (OR 2.17 [1.44–3.33]) and dizziness (OR 3.25 [2.12–5]) were associated with an increased risk of falls within the previous 6 months. Important risk factors amongst the affective and cognitive parameters were depressive symptoms (OR 2.30 [1.22–4.32]), and anxiety (OR 1.64 [1.06–2.53]), measured on a scale from 1 to 6. A poor memory as reported by the participants could not be identified as a risk factor. Table 2 summarizes the analysis of predictors for any falls.

■ Occasional and recurrent falls

The predictors of occasional and recurrent falls are shown in Table 3. The influence of age was not significant in the dichotomized analyses of under and over 80 year old occasional fallers, whereas the chi-square test for 4 age-groups was significant: the prevalence in persons up to 69 years was 11.4%, 70–79 years 10.2%, 80–89 years 22.8% and 90 years and older 36.4%.

Predictors were female gender (OR 2.2 [1.31–3.69]) and medical factors as was the case with all falls. Functional predictors were the use of a walker and fear of falling.

No significant difference could be observed in the prevalence of recurrent falls between men (6.1%) and females (7.2%). The strongest predictors were factors involving impairment of mobility: problems with getting out of bed (OR 10.81 [2.90–40.33]), mobility in the home (OR 6.06 [1.53–23.98]), visiting friends (OR 6.93 [2.93–16.42]), or the use of a walker (OR 6.13 [3.01–12.51]). All these variables were strongly related to recurrent falls. A previous history of recurrent falls however was the strongest predictor in our study (OR 31.985 [12.99–78.71]). Recurrent fallers were more impaired in their mobility and had a subjectively worse health status compared with occasional fallers. There were no significant differences in gender and mean age, 75.5 years in occasional fallers and 76.6 years in recurrent fallers.

In the follow-up assessment we found the same risk factors for falls in the previous 6 months for occasional and recurrent fallers such as dizziness during that period, problems in walking 500 m, being unable to climb 3 stairs and physical inactivity. These risk factors were more frequent in recurrent fallers. Depression, measured by GDS4, only showed significant effects in recurrent fallers.

Discussion

The objective of this study was to determine the prevalence and related predictors of different types of falls, both occasional and recurrent, in a representative sample of community-dwelling older people living in a metropolitan area in Germany.

At the follow-up assessment in 2006, one or more falls within the last 6 months period was reported by 17.2% of our population. Compared to other studies [6, 15, 24, 28], this seems to be a relatively low prevalence. We assume that this finding is due to the dropout of participants between the initial baseline and the follow-up assessments. Those participants taking part in the follow-up assessment were more healthy, better educated and more males, and could therefore be a selection of the fittest and less at risk of falls (unpublished data).

One of the limitations of this study might also be the recall bias. It has been reported that 13 to 32% of older adults who have fallen previously have forgotten about their falls [9]. We therefore chose a recall period of 6 months, even though guidelines of the PROFANE group suggest a recall period of one year [18].

Fall predictors in our study were found among sociodemographic, medical and functional variables.

Among the *sociodemographic* variables, advancing age and female gender were demonstrated to be pre-

Table 2 Predictors for any falls

Predictor variable	Any falls N = 107* (%)	OR [95% CI]	p
Baseline data			
<i>Sociodemographic</i>			
Age (≥80)	26 (24.3)	1.80 [1.10–3.01]	0.021
Sex (female)	64 (59.8)	1.78 [1.17–2.27]	0.007
Living alone	47 (44.3)	1.90 [1.23–2.91]	0.003
Education < 10 y	52 (58.6)	1.04 [0.68–1.57]	n.s.
<i>Medical</i>			
Poor subjective health status (≥4)	42 (39.3)	3.37 [2.14–5.36]	< 0.001
Body mass index (<20 bzw. > 30)	24 (22.6)	1.39 [0.84–2.34]	n.s.
Varifocals	55 (75.3)	1.76 [0.99–3.13]	0.05
Cardiovascular disease	43 (45.3)	1.19 [0.76–1.85]	n.s.
Diabetes	15 (15.6)	1.10 [0.60–2.02]	n.s.
Osteoporosis	21 (23.9)	1.58 [0.91–2.75]	n.s.
Disturbance of memory	22 (25.0)	1.75 [1.02–3.02]	0.042
Depression	19 (22.4)	4.83 [2.52–9.25]	< 0.001
Parkinson's disease	2 (2.3)	2.61 [0.47–14.52]	n.s.
Sleep disorder	46 (46.9)	2.79 [1.77–4.38]	< 0.001
Hip joint endoprosthesis	16 (17.8)	2.61 [1.38–4.97]	0.002
Incontinence	28 (30.1)	2.15 [1.30–3.58]	0.003
Dizziness	35 (37.6)	3.09 [1.90–5.03]	< 0.001
≥3 medical conditions	43 (40.2)	3.31 [2.11–5.18]	< 0.001
≥4 medications	35 (33.0)	1.40 [0.89–2.10]	n.s.
Fear of falling	56 (53.8)	2.99 [1.95–4.61]	< 0.001
<i>Functional</i>			
Walker	34 (32.1)	3.62 [2.22–5.92]	< 0.001
Problems in getting up from bed	6 (5.7)	5.08 [1.61–16.08]	0.002
Problems in home mobility	4 (3.8)	2.51 [0.74–8.48]	n.s.
Problems in going outside	10 (9.5)	3.03 [1.36–6.83]	0.005
Problems in shopping on foot	16 (15.4)	2.79 [1.46–5.31]	0.001
Problems in visiting friends	15 (14.4)	3.38 [1.71–6.70]	< 0.001
Data from follow-up assessment			
Fall in the past	51 (47.7)	4.95 [3.16–7.75]	< 0.001
Recurrent falls in the past	22 (20.6)	10.05 [5.04–20.07]	< 0.001
≥4 medications	41 (40.6)	1.02 [0.66–1.59]	n.s.
Problems in walking 500 m	48 (44.9)	3.89 [2.49–6.07]	< 0.001
Being unable to climb 3 stairs	59 (57.3)	2.17 [1.44–3.33]	< 0.001
Physical inactivity	48 (46.6)	2.85 [1.84–2.42]	< 0.001
Poor memory (degree 3–6)	59 (59.6)	1.16 [0.75–1.80]	n.s.
Problems in multitasking (degree 3–6)	62 (63.9)	1.30 [0.83–2.05]	n.s.
Displeased with life	14 (13.7)	3.56 [1.74–7.26]	< 0.001
No acceptance of life	12 (12.6)	4.46 [2.01–9.87]	< 0.001
Fear of life	21 (22.8)	1.2 [0.70–2.05]	n.s.
Unhappiness	24 (25.5)	1.53 [0.91–2.57]	n.s.
GDS short version ≥1 question positive	16 (19.3)	2.30 [1.22–4.32]	0.008
Anxiety (degree 3–6)	45 (45.0)	1.64 [1.06–2.53]	0.026

* Due to missing data in some variables the basis for percentage may be different

dictors of falls in our study, as is the case according to other studies [1].

Fall predictors in the *functional* domain in our study were mobility impairment which is in line with other findings [1, 2, 6]. Impairment of mobility is one of the most important contributors for falls, and as a consequence injuries related to falls [20, 19], contributing even to the loss of independence in

our study, problems to manoeuvre through one's apartment or environment showed a predictive value of OR 2.5, difficulties in getting out of bed demonstrated an OR of 5.0, and a history of falls also showed an OR of 4.9. These results are more marked than in other studies [3, 7]. Being a recurrent faller was the most profound risk of falls in our study with an OR of 10.0.

Table 3 Predictors for and comparison between non fallers (NF) occasional fallers (OF) and recurrent fallers (RF)

Predictor variable	N = 515* (NF) (%)	N = 71* (OF) (%)	OR (OF vs NF) [95% CI]	p	N = 36* (RF) (%)	OR (RF vs NF) [95% CI]	p	p (OF vs RF)
Baseline Data								
<i>Sociodemographic</i>								
Age (≥80)	77 (15.0)	16 (22.5)	1.64 [0.89–3.02]	n.s.	10 (27.8)	2.17 [1.01–4.69]	0.04	
Sex (female)	233 (45.5)	46 (64.8)	2.2 [1.31–3.69]	0.002	18 (50.0)	1.19 [0.60–2.35]	n.s.	
Living alone	148 (29.6)	31 (44.3)	1.89 [1.13–3.14]	0.013	16 (44.4)	1.9 [0.95–3.77]	n.s. (0.06)	
Education (<10 y)	244 (47.7)	32 (45.1)	0.89 [0.54–1.47]	n.s.	20 (55.6)	1.36 [0.69–2.70]	n.s.	
<i>Medical</i>								
Poor subjective health status (≥4)	82 (16.1)	23 (32.4)	2.4 [1.43–4.32]	0.001	19 (52.8)	5.82 [2.90–11.67]	<0.001	0.04
Body mass index (< 20 bzw. >30)	89 (17.4)	14 (19.7)	1.16 [0.62–2.18]	n.s.	10 (28.6)	1.90 [0.88–4.09]	n.s.	
Varifocals	222 (63.4)	36 (73.5)	1.59 [0.81–3.12]	n.s.	19 (79.2)	2.19 [0.79–6.00]	n.s.	
Cardiovascular disease	191 (41.1)	29 (44.6)	1.15 [0.68–1.94]	n.s.	14 (46.7)	1.25 [0.59–2.63]	n.s.	
Diabetes	66 (14.4)	12 (14.1)	0.97 [0.45–2.06]	n.s.	6 (18.8)	1.37 [0.54–3.45]	n.s.	
Osteoporosis	74 (16.5)	12 (20.7)	1.31 [0.66–2.61]	n.s.	9 (30.0)	2.16 [0.95–4.91]	0.05	
Disturbance of memory	71 (16.0)	14 (24.1)	1.62 [0.87–3.21]	n.s.	8 (26.7)	1.91 [0.81–4.46]	n.s.	
Depression	25 (5.6)	14 (24.6)	5.45 [2.64–11.27]	<0.001	5 (17.9)	3.64 [1.27–10.39]	0.01	
Parkinson's disease	4 (0.9)	1 (1.7)	1.93 [0.21–17.56]	n.s.	1 (3.6)	4.07 [0.44–37.71]	n.s.	
Sleep disorder	108 (24.1)	30 (46.2)	2.69 [1.58–4.61]	<0.001	16 (48.5)	2.96 [1.44–6.06]	0.002	
Hip joint endoprosthesis	35 (7.6)	11 (17.7)	2.61 [1.25–5.46]	0.008	5 (17.9)	2.63 [0.94–7.35]	0.05	
Incontinence	76 (16.7)	17 (27.4)	1.88 [1.02–3.47]	0.038	11 (35.5)	2.75 [1.26–5.97]	0.008	
Dizziness	74 (16.3)	20 (32.8)	2.49 [1.38–4.51]	0.002	15 (46.9)	4.51 [2.16–9.44]	<0.001	
≥3 medical conditions	87 (16.9)	27 (38.9)	3.01 [1.77–5.13]	<0.001	16 (44.4)	3.93 [1.96–7.89]	<.001	
≥4 medications	132 (26.0)	22 (31.0)	1.27 [0.74–2.19]	n.s.	13 (37.1)	1.67 [0.82–3.42]	n.s.	
Fear of falling	143 (28.0)	30 (44.1)	2.02 [1.2–3.39]	0.007	26 (72.2)	6.67 [3.13–14.18]	<0.001	0.006
<i>Functional</i>								
Walker	58 (11.5)	18 (25.7)	2.65 [1.45–4.84]	0.001	16 (44.4)	6.13 [3.01–12.51]	<0.001	0.05
Problems in getting up from bed	6 (1.2)	2 (2.9)	2.46 [0.48–12.46]	n.s.	4 (11.4)	10.81 [2.90–40.33]	<0.001	(0.07)
Problems in home mobility	8 (1.6)	1 (1.4)	0.9 [0.11–7.36]	n.s.	3 (8.8)	6.06 [1.53–23.98]	0.004	(0.06)
Problems in going outside	17 (3.4)	4 (5.7)	1.74 [0.57–5.34]	n.s.	6 (17.1)	5.96 [2.18–16.26]	<0.001	(0.06)
Problems in shopping on foot	31 (6.1)	7 (10.0)	1.7 [0.72–4.02]	n.s.	9 (26.5)	5.51 [2.37–12.83]	<0.001	0.02
Problems in visiting friends	24 (4.8)	6 (8.7)	1.9 [0.75–4.84]	n.s.	9 (25.7)	6.93 [2.93–16.42]	<0.001	0.02
Data from follow-up assessment								
One fall in the last 6 months	63 (12.1)	20 (28.2)	3.13 [1.95–5.69]	<0.001	9 (25.0)	5.17 [2.09–12.78]	<0.001	
Recurrent falls in the last 6 months	17 (3.3)	7 (9.9)	4.07 [1.6–10.35]	0.002	15 (41.7)	31.98 [12.99–78.71]	<0.001	<0.001
Dizziness	126 (24.6)	31 (43.7)	2.38 [1.42–3.96]	0.001	24 (66.7)	6.14 [2.98–12.63]	<0.001	0.02
≥4 medications	176 (40.1)	29 (42.6)	1.11 [0.66–1.86]	n.s.	12 (36.4)	0.85 [0.41–1.78]	n.s.	
Problems in walking 500 m	88 (17.3)	24 (33.8)	2.44 [1.42–4.21]	0.001	24 (66.7)	9.56 [4.61–19.85]	<0.001	0.001
Being unable to climb 3 stairs	193 (38.2)	33 (48.5)	1.52 [0.91–2.53]	n.s.	26 (74.3)	4.67 [2.14–10.17]	<0.001	0.01
Physical inactivity	118 (23.5)	25 (36.2)	1.85 [1.08–3.15]	0.022	23 (67.6)	6.82 [3.23–14.40]	<0.001	0.003
Poor memory (degree 3–6)	271 (56.0)	41 (61.2)	1.23 [0.73–2.09]	n.s.	18 (56.3)	1.01 [0.49–2.07]	n.s.	(0.08)
Problems in multitasking (degree 3–6)	280 (57.6)	41 (63.1)	1.25 [0.73–2.14]	n.s.	21 (65.6)	1.40 [0.66–2.97]	n.s.	
Displeased with life	21 (4.3)	7 (10.3)	2.56 [1.04–6.29]	0.033	7 (20.6)	5.80 [2.26–14.84]	<0.001	
No acceptance of life	15 (3.1)	6 (9.7)	2.2 [1.23–8.86]	0.012	6 (18.2)	6.85 [2.46–19.08]	<0.001	
Fear of life	92 (19.7)	12 (19.7)	0.99 [0.5–1.94]	n.s.	9 (29.0)	1.66 [0.74–3.73]	n.s.	
Unhappiness	85 (18.3)	14 (23.3)	1.36 [0.71–2.58]	n.s.	10 (29.4)	1.86 [0.85–4.04]	n.s.	
GDS short version 1 question positive	42 (9.4)	7 (13.5)	1.49 [0.63–3.52]	n.s.	9 (29.0)	3.93 [1.70–9.09]	0.001	
Anxiety (degree 3–6)	164 (33.3)	29 (43.9)	1.56 [0.93–2.63]	n.s. (0.08)	16 (47.1)	1.77 [0.88–3.57]	n.s.	

* Due to missing data in some variables the basis for percentage may be different

The strongest *medical predictors* were depression, comorbidity, poor subjective health status and dizziness. These predictors could also be found in other studies [11, 13]. Depression is associated with falls among older people, even though it is still undetermined which of the two syndromes come first. There are at least three different ways in which depression

and falls may be related. Depression may precede a fall, or vice versa or they may both be outcomes of a third factor that adversely affects health in older persons, and they may even develop parallel to each other. It seems that there is a common set of risk factors for falls and depression, including comorbidity, poor self-rated health and impaired mobility [4].

There is also a strong association between perceived health status and the number of medical problems [5].

Further fall predictors were sleep disorders, fear of falling, hip endoprosthesis, varifocals, incontinence, and disturbance of memory. Sleep disorders are common in older people and are associated with their risk of falling, although the reasons are still not clear. As is also the case with depression, sleep problems are associated with poor health status and comorbidity [22]. Hip endoprosthesis and the fear of falling may indicate gait problems which thus lead to falls. It is quite clear that the visual system as a sensory input is important for the normal physiology of balance and gait. We also found varifocals to be associated with an increased risk of falling. Varifocal glasses impair depth perception and edge-contrast sensitivity at critical distances for detecting obstacles in the environment. Older people may therefore benefit from wearing non-multifocal glasses when climbing stairs, especially in unfamiliar settings outside the home [23].

In contrast to other findings, there was only a significant correlation of such fall predictors such as cardiovascular disease, osteoporosis, Parkinson's disease and the intake of 4 and more medications during the baseline assessment where the information on fallers was obtained retrospectively. In the prospective study, they could not be confirmed as fall predictors. Although multi-medication did not act as a fall predictor per se, some groups of medications acted in a retrospective manner as a risk factor for falls during the last 6 months. Significant results were obtained for antidementives, antidepressants, opioid analgesics and gout medication. These groups of medications were also found to be risk factors of falls in other studies [14, 33], although the Odds Ratios showed great heterogeneity.

Recurrent fallers are at high risk of injurious falls [30]. Therefore, we compared factors and variables of occasional and recurrent fallers to non-fallers. We were only able to demonstrate a significant age-relationship in recurrent fallers. In contrast to this finding, the mean age in both groups did not differ significantly, thus calling into question the fact that chronological age per se is an important independent factor for the risk of falling. No differences between the two groups were observed in sociodemographic variables. Female gender was a predictor only in occasional fallers.

A low subjective health status increased the risk of falling in both occasional and especially recurrent fallers. In addition, dizziness was an important predictor for future falls as well as in retrospective analyses a risk factor for previous falls, and dizziness again was significantly more present in recurrent fallers.

In essence, the most significant differences between occasional and recurrent fallers could be demonstrated in the functional domain. Impairment in mobility as well as physical inactivity constituted strong predictors as well as retrospective risk factors which again were more significant for recurrent fallers. Thus the most important predictor for future multiple falls was shown to be multiple falls in the past (OR 31.9) which is not surprising and in line with other findings [1, 8].

In conclusion, the findings of this study indicate that gait disorders and impairment of mobility play an important role in falls in older age. We found impairment in daily mobility and previous falls were the strongest predictors for future falls. As we have successful methods for dealing with the reduction of the risk of falling, these predictors should be detected during the medical examination [31], as defined in the guidelines for general practitioners [10]. Therefore no special assessment or special examination is needed in the first step of a screening process. People aged 65 years and older should be asked if they had problems in mobility or falls within the last 6 months. If so, they are at risk for future falls, especially if more than one fall had already happened. These people need a special geriatric assessment to evaluate the possible reasons for their falls and to plan appropriate methods for dealing with them.

Key points

- Until now there is no data about the prevalence and predictors of falls in community living older people in Germany.
- Falls are frequent in our sample, even if the prevalence is lower than in other findings. We found impairments in daily mobility and previous falls were the strongest predictors for future falls.
- Other predictors were depression, comorbidity, poor subjective health status and dizziness.
- Impairment in mobility as well as physical inactivity constituted strong predictors and are more significant for recurrent fallers.
- People aged 65 years and over should therefore be asked in the medical examination about these predictors as a basic assessment.

► **Acknowledgements** The authors would like to thank both the "Nuernberger Zeitung" and the "Nuernberger Versicherungsgruppe" for supporting this project.

► **Conflicts of interest** The authors declare no conflicts of interest.

References

- American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention (2001) Guideline for the Prevention of Falls in Older Persons. *J Am Geriatr Soc* 49:664–672
- Anders J, Dapp U, Laub S, von Renteln-Kruse W (2006) Screening of fall risk in frail, but still independently living senior citizens. *Z Gerontol Geriatr* 39:268–276
- Bergland A, Jarnlo GB, Laake K (2003) Predictors of falls in the elderly by location. *Aging Clin Exp Res* 15:43–50
- Biderman A, Cwikel J, Fried AV, Galinsky D (2002) Depression and falls among community dwelling elderly people: a search for common risk factors. *J Epidemiol Community Health* 56:631–636
- Bluestein D, Rutledge CM (2006) Perceived health and geriatric risk stratification: observations from family practice. *Can Fam Physician* 52:626–627
- Cesari M, Landi F, Torre S, Onder G, Lattanzio F, Bernabei R (2002) Prevalence and risk factors for falls in an older community-dwelling population. *J Gerontol A Biol Sci Med Sci* 57:M722–M776
- Chu LW, Chi I, Chiu AY (2005) Incidence and predictors of falls in the Chinese elderly. *Ann Acad Med Singapore* 34:60–72
- Coll-Planas L, Kron M, Sander S, Reißmann U, Becker C, Nikolaus Th (2006) Accidental falls among community-dwelling older adults. Improving the identification process of persons at risk by nursing staff. *Z Gerontol Geriatrie* 39:277–282
- Cummings SR, Nevitt MC, Kidd S (1988) Forgetting falls. The limited accuracy of recall of falls in the elderly. *J Am Geriatr Soc* 36:613–616
- Deutsche Gesellschaft für Allgemeinmedizin (DEGAM) (2004) Leitlinie Nr. 4: Ältere Sturzpatienten. Omikron, Düsseldorf
- Downton JH, Andrews K (1991) Prevalence, characteristics and factors associated with falls among the elderly living at home. *Aging* 3:219–228
- Freiberger E, Menz HB (2006) Characteristics of falls in physically active community-dwelling older people. Findings from the “Standfest im Alter” study. *Z Gerontol Geriatrie* 39:261–267
- Ganz D, Bao Y, Shekelle PG, Rubenstein L (2007) Will my patient fall? *JAMA* 297:77–86
- Gerdhem P, Ringsberg KA, Akesson K, Obrant KJ (2005) Clinical history and biologic age predicted falls better than objective functional tests. *J Clin Epidemiol* 58:226–232
- Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH (2003) Interventions for preventing falls in elderly people. *Cochrane Database Syst Rev* CD000340
- Goring H, Baldwin R, Marriott A, Pratt H, Roberts C (2004) Validation of short screening tests for depression and cognitive impairment in older medically ill inpatients. *Int J Geriatr Psychiatry* 19:465–471
- Graham HJ, Firth J (1992) Home accidents in older people: role of primary health care team. *BMJ* 305:30–32
- Hauer K, Lamb SE, Jorstad EC, Todd C, Becker C, PROFANE-Group (2006) Systematic review of definitions and methods of measuring falls in randomised controlled fall prevention trials. *Age Ageing* 35:5–10
- Hausdorff JM, Edelberg HK (2001) Gait variability and fall risk in community-living older adults: A 1-year prospective study. *Arch Phys Med Rehabil* 82:1050–1056
- Judge JO (2003) Balance training to maintain mobility and prevent disability. *Am J Prev Med* 25:150–156
- Lamb SE, Jorstad-Stein EC, Hauer K, Becker C (2005) Prevention of Falls Network Europe and Outcomes Consensus Group. Development of a common outcome data set for fall injury prevention trials: the Prevention of Falls Network Europe consensus. *J Am Geriatr Soc* 53:1618–1622
- Latimer Hill E, Cumming RG, Lewis R, Carrington S, Le Couteur DG (2007) Sleep disturbances and falls in older people. *J Gerontol A Biol Sci Med Sci* 62:62–66
- Lord SR, Dayhew J, Howland A (2002) Multifocal glasses impair edge-contrast sensitivity and depth perception and increase the risk of falls in older people. *J Am Geriatr Soc* 50:1760–1766
- Lord SR, Sherrington C, Menz HB, Close JC (2007) Falls in older people: Risk factors and strategies for prevention. 2nd Edition. Cambridge University Press, Cambridge
- Masud T, Morris RO (2001) Epidemiology of falls. *Age & Ageing* 30:S4:3–7
- Mustard CA, Mayer T (1997) Case-control study of exposure to medication and the risk of injurious falls requiring hospitalization among nursing home residents. *Am J Epidemiol* 145:738–745
- Robbins AS, Rubenstein LZ, Josephson KR et al (1989) Predictors of falls among elderly people. Results of two population-based studies. *Arch Intern Med* 149:1628–1633
- Rubenstein LZ (2006) Falls in older people: epidemiology, risk factors and strategies for prevention. *Age Ageing* 35(Suppl 2):ii37–ii41
- Shumway-Cook A, Baldwin M, Polissar NL, Gruber W (1997) Predicting the probability for falls in community-dwelling older adults. *Phys Ther* 77:812–819
- Stalenhoef PA, Diederiks JP, Knottnerus JA, Kester AD, Crebolder HF (2002) A risk model for the prediction of recurrent falls in community-dwelling elderly: a prospective cohort study. *J Clin Epidemiol* 55:1088–1094
- Swift CG (2006) The role of medical assessment and intervention in the prevention of falls. *Age Ageing* 35(Suppl 2):ii65–ii68
- Tinetti ME, Mendes de Leon CF, Doucette JT, Baker DI (1994) Fear of falling and fall-related efficacy in relationship to functioning among community-living elders. *J Gerontol* 49:M140–M147
- Tromp AM, Pluijm SM, Smit JH, Deeg DJ, Bouter LM, Lips P (2001) Fall-risk screening test: a prospective study on predictors for falls in community-dwelling elderly. *J Clin Epidemiol* 54:837–844