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Shared risk factors for involvement in accidents and falls in and around home, outside home and in traffic among the elderly

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Summary

In the Netherlands, per 100.000 older persons (55+) about *70* persons are killed and *1050* are treated at the hospital each year (den Hertog & Toet, 1995) as a consequence of accidents in different domains: in and around home, outside the home and in traffic.For prevention programmes of accidents among the elderly it was considered to be important to identify shared risk factors for different types of accidents (falls at the same level, falls from height, or all accidents) that happen in different domains (in and around home, outside the home and in traffic). If shared risk factors could be identified and modified, prevention could be more effective in reducing accidents and injuries among the elderly.

The purpose of this exploratory study is to identify shared risk factors for involvement in at least two types of accidents among the elderly living in the community.

From 1993 until 1996 TNO Prevention and Health completed the Safety Observed study (Wijlhuizen et al., 1996). Among about 1055 older persons (65-84), living independently in the community of Leiden, TNO registered 845 accidents. A secondary analysis was done on the database of the Safety Observed study. The database contained accident data and risk factors for accidents. The available risk factors were related to social economic status, behaviour and health. Outcome variables were falls at the same level, falls from height and all accidents (falls at the same level, falls from height, burns, cuts, collisions, bruises, being jammed, (near) drownings, abrasions of skin, piercings, sprainings of ankle, explosions, electric shocks, suffocations and bites of animal). We differentiated between three domains where accidents happened: in and around the home, outside the home and in traffic.

For each outcome variable separate multivariate logistic regression analysis was applied. We treated missing values by applying multiple imputation.
The main results from the current study show, first of all, that there are shared risk factors for different types of accidents in several domains. In particular, three specific risk factors were shared by persons involved in different types of accident in all domains. The three risk factors are:

1. Women living alone;
   The risk factor is related to increased accident risk in all domains compared to men who do not live alone. Only for falls from height in and around the home, no increased risk is found.
2. High educational level;
   The risk factor is related to increased accident risk in all domains compared to persons with basic education. Only for falls from height in and around home and falls at the same level outside the home, no increased risk was found.
3. Pain in neck and shoulder region.
   The risk factor is related to increased accident risk in all domains. Only for falls from height in and around home and falls outside the home, no increased risk was found.

Considering the purpose of the study, the following conclusions are drawn from the results and discussion:

1. We identified several risk factors that are shared by different types of accidents in different domains;

2. We identified three risk factors that are shared by all accidents in all domains. Intervention on these three risk factors will have a relatively high impact on the incidence of all accidents among older persons;
3. We identified several risk factors that are shared by some of the types of falls in one or more domains. The picture that emerges for falls is, that intervention on only one or two risk factors will not influence the incidence of all falls substantially. It is concluded that intervention on multiple risk factors simultaneously is essential for optimal reduction of the incidence of falls.
4. The exposure to the identified risk factors will most probably increase in the coming decades, and some of the risk factors will change relatively autonomously in the direction of higher exposure. Therefore, an active prevention policy is required in order to reduce the incidence of accidents in general and falls in particular among older persons.
5. A validation of the final model is needed on a data set from another population. From a current and comparable study, data are obtained that will make this validation possible.

Contents

1 Introduction

In the Netherlands, per 100.000 older persons (55+) about *70* persons are killed and *1050* are treated at the hospital each year (den Hertog & Toet, 1995) as a consequence of accidents in different domains: in and around home, outside the home and in traffic. The injuries are mainly due to falls but also arise from other accidents like burns, cuts, bruises, etc.. However, many accidents happen among older persons that are not reported in the regular statistics. For falls, for instance it is known that about 30% of all persons over 65 fall each year at least once (Tromp et al, 1998). Most of these falls do not appear in statistical reports because these falls do not result in serious injury. From 1993 until 1996 TNO Prevention and Health completed the Safety Observed study (Wijlhuizen et al., 1996). Among about 1055 older persons (65-84), living independently in the community of Leiden, TNO registered 845 accidents (incidence: 710 per 1000 person-years) within a period of 15 months; 61% happened in and around home, 27% outside the home and 12% in traffic. About 50% (N=400) were falls and from all accidents that were reported about 20% was medically treated. In the report (Wijlhuizen et al., 1996), results of some univariate analyses are presented, related to accidents that happened in the domain: in and around the home.
For prevention programmes of accidents among the elderly it was considered to be important to identify shared risk factors for different types of accidents (falls at the same level, falls from height, or all accidents) that happen in different domains (in and around home, outside the home and in traffic). If shared risk factors could be identified and modified, prevention could be more effective in reducing accidents and injuries among the elderly. Also non-modifiable risk factors were included in the study, in order to identify shared risk factors that can counteract the prevention programmes.
Although the literature on risk factors for falls is quite extensive, no specific studies are known from literature that relate to falls at the same level and from height for each of the domains that we differentiated. Neither there is any publication found about risk factors for accidents in general among older persons for the three domains. For this reason this study is an explorative study. The risk factors that are included in the explorative study are based on data that was obtained in the Safety Observed study (Wijlhuizen et al., 1996). This project was funded by Preventie fonds/ Zorg Onderzoek Nederland.

1.1 Purpose of the study

The purpose of this exploratory study is to identify shared risk factors for involvement in at least two types of accidents among the elderly living in the community.

2 Methods

2.1 Subjects and procedure

In 1993, 3500 older persons (65-85) living independently in the community of Leiden, received an initial questionnaire by mail and were asked to participate in the Safety Observed study. Those who agreed to participate, 1055 persons, were included in a follow-up registration of accidents for 15 months.
From March 1994, the accident data were obtained by telephoning all participants each month by the Telephony Inquiry System (TIS). This computer system had a short automatic dialogue with the participants and asked them about accident involvement in the previous month. People could answer to the questions by responding 'Yes' or 'No'. If a person reported involvement in an accident, a personal telephonic computer assisted interview was held in which details were asked about the accidents like type of accident, domain, time, location, activity, injuries and medical treatment. During the follow-up, 148 respondents dropped out for various reasons, like death, moving to other city or into a nursing home, health problems and problems with the dialogue with the TIS. At the end of the follow-up, the remaining 907 respondents received a second questionnaire and 775 of those were returned.

2.2 Data

2.2.1 Risk factors

All risk factors were obtained by two structured questionnaires (Wijlhuizen et al., 1996). In the initial questionnaire, data were obtained about age, gender, number of persons within the household, education and income. Also health related data were obtained about: subjective general health (CBS, 1993), disabilities related to hearing, vision, strength and mobility (Sonsbeek, 1988), pain complaints in the preceding 12 months in the neck, shoulders, elbows, hands or wrists, hip, knees, ankles or feet, upper and lower part of the back (Hildebrandt, 2001) and fear of falling inside and outside the home.
In the second questionnaire, the questions of the initial questionnaire were repeated. Additional data were obtained about general exposure during summer and winter outside the home (walking at least weekly or less than weekly for a half an hour or more outside the home) and in traffic (cycling at least weekly or less than weekly).
We also included 25 questions about chronic diseases and related use of medication in the preceding year as they are asked in the Dutch health survey (CBS, 1993), the diseases are listed in table 1. Additional questions were asked about sleeplessness, Parkinson, accidental loss of urine, severe stress, amnesia, and paralysis or loss of strength, because they were not included in the Dutch health survey and appeared to be risk factors for falls from a review of literature (Wijlhuizen et al., 1996).

Table 1 Chronic diseases from Dutch health survey (CBS, 1993)

Arthritis	Chronic other rheuma	Hernia	Liver disease	Sinusitis
Arthrosis	Diabetes	Hypertension	Malignant cancer	Skin disease
Asthma	Dizziness with falling	Intestine disorder	Migraine	Stomach or dusdenal ulcer
Bladder inflammation	Epilepsy	Kidney disease	Other chronic diseases	Stroke (consequences)
Cardiac disease	Gall stone	Kidney stones	Prolaps	Thyroid disease

2.3 Outcome variables

Accidents were defined to the participants as a number of specific situations that should be reported. These situations (types of accidents) included: falls at the same level, falls from height, burns, cuts, collisions, bruises, being jammed, (near) drownings, abrasions of skin, piercings, sprainings of ankle, explosions, electric shocks, suffocations and bites of animal. Also those accidents that did not result in injury or did not require medical treatment were included in the registration.
We differentiated between three domains where accidents happened: in and around the home, outside the home and in traffic. Traffic accidents were defined as an accident with a vehicle (including bicycles) or a pedestrian. It includes accidents with only vehicles involved, or vehicles and objects or pedestrians involved. We differentiated between domains, because older persons who expose themselves to situations outside the home or in traffic might have better health and different lifestyle than those who do not.
Outcome variables in this study are defined as: involvement in at least one accident of any type, aggregated for each domain ('All accidents'), and involvement in at least one fall at the same level and fall from height for each domain. Falls were taken apart because they represent an important category for prevention within the accidents among the elderly.
We included eight outcome variables in this study, namely:

- In and around home: All accidents, Falls at same level, Falls from height;
- Outside home: All accidents, Falls at same level, Falls from height;
- Traffic: All accidents, Falls from height.

In traffic we excluded falls at same level because the number of cases was not sufficient, less than 20, for applying the appropriate analysis.

2.4 Analysis

Before the statistical analysis were performed, we constructed from the available data a general measure of exposure to situations outside the home and exposure to traffic that was initially measured separately for summer and winter. General exposure throughout a year was computed by combining the exposure during winter and summer into three categories. The extremes (high and low exposure) were the result of the combination for summer and winter of respectively high or low exposure levels and moderate exposure was defined as the combination of high and low exposure levels.
We also created a combined variable of pain in shoulder, neck or upper back. The separate variables were combined because the areas are closely related at the upper part of the body. The resulting variable is referred to as 'pain in neck and shoulder region'.
The analysis was separated into two steps. The first step was to select relevant risk factors that were used subsequently as input for the second step of the analysis in which a final model was analysed.

Some of the risk factors were selected, based on conceptual relevance:
First of all we included the level of exposure outside the home and in traffic (moderate, high) in the model, because of the conceptual relevance of this risk factor. Its presence in the model takes into account the general notion that if a person is not or only moderately exposed to a certain domain, the opportunity of involvement in an accident will most probably vary;

Second, we included Age and gender, because of the strong univariate association that is commonly found in accident statistics between age and gender and the incidence of falls (Wijlhuizen et al, 1996). Its presence in the final model would give the opportunity to show its association if multivariate analysis is applied;

Third, we included sleeplessness (with/ without medication). Sleeplessness was included in the model because of its conceptual relevance and the high prevalence of persons confronted with it in the elderly population (about 25%) (Herings, 1994).
Apart from those risk factors that were included in the final model based on conceptual relevance (exposure, age, gender, sleeplessness), we included only included those risk factors that were shared by at least two types of accidents. This was done, because the main focus of the study was on describing the risk factors that were shared and not on describing and comparing more elaborate models of each type of accident.
In both steps multivariate logistic regression analysis was applied. The main approach was to explore which of the available risk factors are related to the various outcome variables.

Step 1
The first step in the analyses involved multivariate logistic regression in order to explore for each outcome variable which risk factors were predictive. In table 3 the general approach is presented in a scheme. In the text we will refer to this table.
The number of respondents included in the analyses varied for each domain, depending on the exposure of persons to situation within the domains. All 907 respondents were initially included for analyses within the domain: 'In and around home'. For analyses within the domain 'Outside home' and 'Traffic', we included those respondents who are at least moderately exposed to situations within the domain; 774 and 527 respectively (Table 2).
For each analysis a contrast was made between persons involved in at least one accident of a certain type, versus those persons who were not involved in any accident at all during the follow-up period. Therefore, for analysis related to an outcome variable within a certain domain, we excluded from the analyses those respondents who were not involved in an accident in the relevant domain but who were involved in an accident in one or two of the other domains. In table 2 these persons are referred to as "Only involved in any accident outside domain". For example 122 persons were not involved in an accident in the domain "In and around home", but were involved in an accident in one or two of the other domains (table 2). Therefore they were excluded from analyses related to the domain "In and around home".
This procedure resulted for each analysis within a domain in a contrast between a fixed number of respondents who were not involved in any accident (in any domain) and the number of respondents who were involved in the specific accident type in the relevant domain. With this contrast we created optimal conditions to identify common risk factors for different types of accidents in different domains.

Table 2 The number of persons exposed to a domain and (not) involved in an accident, and the total number of accidents by type of accident in each domain (outcome variables).

	Domain In and around home		Domain Outside home		Domain Traffic	
	# subjects	# accidents	# subjects	# accidents	# subjects	# accidents
Exposed to domain (at least moderately)	907		774		527	
Not involved in any accident (included in analyses)	501		435		340	
Only involved in accident outside domain (excluded from analyses)	122		172		107	
Outcome variables						
Involved in any accident within domain	284	503	167	215	80	94
Falls from height within domain	36	39	20	22	53	63
Falls at same level within domain	110	141	101	131	-	-

An aspect in the application of multivariate logistic regression is that in the data set that is analysed; missing values should be avoided. A common way of treating missing values, among others, is listwise deletion. Based on the 907 respondents who finished the follow-up, 10% of the data concerning the risk factors was missing. This was due to respondents who skipped certain questions and the non-response of the second questionnaire. The listwise deletion treatment would result in 55% reduction of cases; from 907 to 405.

In order to include all 907 cases in the analysis, we used multiple imputation (Rubin, 1987) to impute the values of the missing data. A detailed description of the steps taken is presented elsewhere (Brand, 1999). For each missing data entry in the data set, five values were calculated, based on a statistical model (Gibbs sampling). This procedure resulted in five different completed data sets (DS1 to DS5, table 3). The differences between these data sets reflected the uncertainty about the 'real' unknown values of the missing data.

The general procedure for the statistical analyses was that for each outcome variable we did separate analyses at each of the five data sets and pooled the five results to one common result. Before we started with the pooling procedure, we first reduced the number of risk factors in the model for each outcome variable, by separate analyses with the five data sets. Consequently, we selected those risk factors that were included in the majority (three or more) of the models.

The general procedure is presented in table 3. In the description we will refer to this table. The analysis is divided into two steps.

In Step 1.1 we reduced the number of risk factors. The five completed data sets (DS 1 to DS 5, table 3) were analysed separately, resulting in five, not identical, models for each outcome variable (A-G, table 3). The risk factors (Di) that appeared in at least three out of the five models (Number Di>2) were included in the next analysis; referred to as Step 1.2 in table 3. In this way we dropped those risk factors, that were only related to the outcome variable in a minority of the data sets; indicating that the relation was relatively inconsistent.

In Step 1.2 a common model was created for each data set, that consisted of the risk factors that were selected from Step 1.1. Starting with this common model with a limited number of risk factors for each data set, the results from the analysis were pooled into one result (Meng et al.,1992). Each risk factor with a pooled likelihood ratio p-value >.05 was discarded stepwise. With this procedure, separate models with independent predictors were identified for each outcome variable (A-G).

Based on the results of step 1, in step 2 (table 3) a final model was defined with conceptual relevant risk factors, which were, in general, predictive for two or more outcome variables (Dj). This selection was made, because these risk factors appeared to be shared by at least two outcome variables. However, we made some modifications to this general rule, taking into account considerations of prevalence in the population of older persons and conceptual relevance, as described in the results section.
Multivariate logistic regression analyses was applied separately for all outcome variables based on the final model. No stepwise elimination was used.

Table 3 Schematic representation of the analysis procedure.

Step 1.1 (exploratory procedure applied for outcome variables: A – G)

DS 1	DS 2	DS 3	DS 4	DS 5		Data sets (multiple imputation of missing values)
D1	D1	D1	D1	D1		Risk factors
.	.	.	.	.		
.	.	.	.	.		
Dn	Dn	Dn	Dn	Dn		
A	A	A	A	A		Outcome variable (separately for A-G)
Mva	Mva	Mva	Mva	Mva		Multivariate Analysis (Mva) (stepwise elimination)
					Number Di	Resulting models (p< .05)
D3	D3		D3		3	
D4		D4	D4		3	If Number Di >2 then Di is included in next analysis (D3, D4, D6, D12 are included for A)
	D5			D5	2	
D6	D6	D6	D6	D6	5	
D12	D12		D12		3	

Step 1.2

DS 1	DS 2	DS 3	DS 4	DS 5	Data sets
D3	D3	D3	D3	D3	Selected risk factors
D4	D4	D4	D4	D4	
D6	D6	D6	D6	D6	
D12	D12	D12	D12	D12	
A	A	A	A	A	Outcome variable
Mva	Mva	Mva	Mva	Mva	Mva (stepwise elimination)
Pooling of results					
D3					Resulting model (p< .05) for A
D4					
D6					D12 (p>.05) was removed from the model

A	B	C	D	E	F	G		Outcome variables
							Number Dj	Resulting models (p< .05) for A – G
D3	D3	D3	D3		D3	D3	6	
D4	D4	D4		D4			4	
D6							1	If Number Dj >1 then Dj is included in step 2 of the analysis (D3, D4, D12 are included for A-G)
	D10						1	
	D12				D12		2	

Step 2 (procedure applied for outcome variables: A – G; final model)

DS 1	DS 2	DS 3	DS 4	DS 5	Data sets
D3	D3	D3	D3	D3	Selected risk factors in final model
D4	D4	D4	D4	D4	
D12	D12	D12	D12	D12	
A	A	A	A	A	Outcome variable (separately for A-G)
Mva	Mva	Mva	Mva	Mva	Mva for each outcome variable (no stepwise elimination)
Pooling of results					

3 Results

The first and exploratory step of the analysis revealed seventeen risk factors that were predictive for one or more outcome variables, as presented in table 4.

Table 4 Risk factors that were predictive for one or more outcome variables (Freq.)

Risk factors	Freq.	Risk factors	Freq.
1) Age	1	9) Difficulties with hearing others speak	1
2) Gender	4	10) Pain in ankles or feet	1
3) Living alone	3	11) Pain in wrist or hand	1
4) Educational level	2	12) Skin disease	3
5) Pain in neck and shoulder region	3	13) Afraid to fall inside the home	1
6) Dizziness	3	14) High blood pressure	2
7) Accidental loss of urine	3	15) Able to carry 5 kilos	1
8) Sleeplessness	1	16) Arthrosis	1
		17) Parkinson	1

Apart from the risk factors that were already included as described in the analysis section, as a general rule we included all risk factors in the final model that were predictive for two or more outcome variables (Freq. >1, table 4).
We made, however, the following exceptions to this general rule:

First, we included a combined variable of gender and living alone. The variables gender and living alone were combined in four categories (men/ women living alone, men/ women not living alone) because from explorative analyses we found an interaction between these two variables;

Second, skin disease and high blood pressure were not included because in literature no evidence was found for their conceptual relevance.
Odds ratio's (OR) and confidence intervals (CI) from the variables in the model for each type of accident per domain are presented in table 5. From this table it appears that Exposure, Age and Sleep problems without medication are not significantly associated with any of the outcome variables. All other risk factors are related to at least one of the outcome variables.

Table 5 *Odds ratio's (OR) and confidence intervals (CI) from the risk factors in the final model for each type of accident per domain*

	All Accidents						**Falls at same level**				**Falls from height**					
Outcome variables	**In and around home**		**Outside the home**		**Traffic**		**In and around home**		**Outside the home**		**In and around home**		**Outside the home**		**Traffic**	
Risk Factors	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Exposure low			1.0		1.0				1.0				1.0		1.0	
Exposure moderate	-	-	0.6	(0.2-2.5)	1.9	(0.5-7.1)	-	-	1.5	(0.2-10.6)	-	-	0.0	(0.0 >>)	>>	(0.0->>)
Exposure high	-	-	0.7	(0.3-1.6)	2.1	(0.8-5.8)	-	-	1.8	(0.5-6.4)	-	-	**0.2**	(0.0-0.8)	>>	(0.0->>)
Age	1.0	(0.9-1.0)	1.0	(0.9-1.0)	1.0	(1.0-1.1)	1.0	(0.9-1.0)	1.0	(0.9-1.0)	1.0	(0.9-1.0)	0.9	(0.8-1.0)	1.0	(1.0-1.1)
Men not living alone	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Women not living alone	1.4	(0.9-2.1)	1.6	(0.9-2.8)	1.0	(0.5-2.3)	0.8	(0.4-1.7)	**3.2**	(1.6-6.5)	1.2	(0.4-3.5)	1.5	(0.2-9.3)	1.4	(0.6-3.5)
Men living alone	1.5	(0.8-2.6)	1.5	(0.7-3.3)	1.7	(0.7-4.3)	1.5	(0.6-3.5)	**2.7**	(1.0-7.3)	1.7	(0.4-6.5)	4.3	(0.6-30.3)	1.3	(0.4-4.3)
Women living alone	**1.9**	(1.3-2.9)	**3.0**	(1.8-5.1)	**3.4**	(1.8-6.6)	**2.0**	(1.1-3.6)	**5.6**	(2.9-11.1)	1.1	(0.4-3.3)	**7.1**	(1.8-29.2)	**4.0**	(1.8-8.9)
Education basic	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Education low	1.2	(0.7-1.8)	1.1	(0.6-2.1)	1.0	(0.4-2.2)	0.6	(0.3-1.4)	1.0	(0.5-2.0)	0.6	(0.2-2.3)	2.2	(0.4-12.6)	1.0	(0.4-2.6)
Education mid	**1.7**	(1.1-2.5)	1.4	(0.9-2.3)	1.7	(0.8-3.5)	1.2	(0.7-2.2)	1.1	(0.6-2.0)	2.3	(0.9-5.6)	3.5	(0.8-16.1)	1.4	(0.6-3.4)
Education high	**2.3**	(1.5-3.7)	**2.6**	(1.5-4.5)	**2.3**	(1.0-5.1)	**2.0**	(1.0-3.7)	1.9	(0.9-3.8)	1.3	(0.4-4.3)	**5.6**	(1.1-28.0)	**2.5**	(1.0-6.0)
No pain in neck and shoulder region	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Pain in neck and shoulder region	**1.5**	(1.1-2.1)	**1.6**	(1.1-2.4)	**1.8**	(1.0-3.3)	**1.7**	(1.0-2.8)	1.5	(0.9-2.5)	1.4	(0.6-3.0)	1.3	(0.4-3.6)	**1.9**	(1.0-3.9)
No dizziness	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Dizziness without medication	**3.6**	(1.4-9.2)	1.5	(0.2-10.7)	0.0	(0.0->>)	**4.4**	(1.4-14.0)	1.3	(0.2-10.0)	**9.5**	(2.2-41.5)	0.0	(0.0->>)	0.0	(0.0->>)
Dizziness with medication	2.4	(0.7-7.9)	4.4	(0.8-23.6)	3.1	(0.4-25.5)	3.6	(0.8-15.4)	**5.8**	(1.1-31.3)	1.3	(0.1-17.5)	0.0	(0.0->>)	3.7	(0.4-40.1)
No incontinence	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Incontinence without medication	**1.8**	(1.1-3.0)	1.8	(0.9-3.6)	1.3	(0.5-3.4)	1.7	(0.8-3.7)	**2.1**	(1.0-4.5)	**4.0**	(1.4-11.7)	2.9	(0.4-20.5)	1.5	(0.5-4.5)
Incontinence with medication	**4.4**	(1.5-13.1)	**4.0**	(1.0-16.3)	3.6	(0.6-21.6)	**4.8**	(1.4-17.3)	3.9	(0.7-22.5)	**17.2**	(2.8-104.7)	0.0	(0.0->>)	0.0	(0.0->>)
No sleep problems	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Sleep problems without medication	1.2	(0.7-2.1)	0.8	(0.4-1.8)	1.0	(0.3-3.2)	1.3	(0.6-3.0)	0.9	(0.3-2.2)	2.9	(0.9-9.7)	1.3	(0.2-7.5)	1.1	(0.3-3.7)
Sleep problems with medication	**2.0**	(1.2-3.1)	1.1	(0.6-2.1)	2.3	(0.9-5.7)	**2.6**	(1.4-4.6)	1.2	(0.6-2.4)	**2.8**	(1.0-7.8)	3.2	(0.8-13.9)	2.4	(0.9-6.7)

Profiles of shared risk factors by two or more outcome variables: 'All accidents' or 'fall' are presented respectively in table 6 and table 7.

Table 6 Profile of shared risk factors for the outcome variable: 'All accidents' for each domain.

Shared risk factors for:	**Domains**		
All accidents	**In and around home**	**Outside the home**	**Traffic**
Women living alone	X	X	X
High educational level	X	X	X
Pain in neck and shoulder region	X	X	X
Accidental loss of urine with medication	X	X	

Note: In the table, 'x' represents that the risk factor is associated with an increased risk for accidents within the specific domain.

The shared risk factors for the outcome variable 'All accidents' in all domains are Women living alone, High education and persons with Pain in neck and shoulder region.
Except for traffic accidents, Accidental loss of urine with use of related medication is a shared risk factor for the other domains.

Table 7 Profile of shared risk factors for the outcome variables within the category 'fall' for each domain.

Shared risk factors for:	**Domains**				
Falls	**In and around home**		**Outside the home**		**Traffic**
	Same level	**From height**	**Same level**	**From height**	**From Height**
Women living alone	X		X	X	X
High educational level	X			X	X
Pain in neck and shoulder region	X				X
Accidental loss of urine with medication	X	X			
Dizziness without medication	X	X			
Sleep problems with medication	X	X			
Accidental loss of urine without medication		X	X		

Note: In the table, 'x' represents that the risk factor is associated with an increased risk for falls within the specific domain.

There is no shared risk factor for all outcome variables related to falls in all domains.
Two risk factors are shared by outcome variables in all three domains: Women living alone, and High educational level. Pain in neck and shoulder region and Accidental loss of urine without medication are shared by two outcome variables in different domains.
There are no risk factors that are exclusively related to falls from height or falls at the same level.
In and around the home, falls at the same level and from height share the following risk factors: Accidental loss of urine with use of related medication, Dizziness without medication and Sleep problems with use of related medication. These risk factors are not shared by falls in the other domains.

4 Discussion and conclusions

For preventive interventions of accidents among the elderly, shared risk factors for different types of accidents at different domains are potential important targets. If these risk factors have a high prevalence and are modifiable, interventions should be designed to modify these factors in order to optimise the cost effectiveness of these interventions. The purpose of the present study was to identify shared risk factors. We described these shared risk factors in a common model.

Before we come to the discussion of the results, we will first mention some sources of bias related to the validity of the results. First of all, in the explorative part of the study we included a large number of risk factors in the analysis. In this procedure some risk factors may turn out to be statistically significant, purely by chance. A second source of bias is that we explored the risk factors from the data set that we also used when we analysed our final model. This procedure leads to a bias in such a way that the odds ratios of the selected risk factors will possibly be relatively high. These considerations do lead to the conclusion that further validation of the final model on another comparable data set is needed. In a study that is currently done in the north of the Netherlands, the "Safety in your own hands" study, we monitor the same accidents with the identical procedure among about 2000 older persons (65+) that live independently in the community. The data that we obtain from this study will form the basis for a validation of the final model. Results from this validation will be published in a separate report.

The results from the current study show, first of all, that there are shared risk factors for different types of accidents in several domains. In particular, three specific risk factors were shared by persons involved in different types of accident in all domains. The three risk factors are:

1. Women living alone;

The risk factor is related to increased accident risk in all domains compared to men who do not live alone. Only for falls from height in and around the home, no increased risk is found.

2. High educational level;

The risk factor is related to increased accident risk in all domains compared to persons with basic education. Only for falls from height in and around home and falls at the same level outside the home, no increased risk was found.

3. Pain in neck and shoulder region.

The risk factor is related to increased accident risk in all domains. Only for falls from height in and around home and falls outside the home, no increased risk was found.

Although the three risk factors are related to increase risk of any accident in all domains, for falls a more differentiated picture appears. The three risk factors are related to falls at the same level in and around home, and to falls from height in traffic, but none of them is related to falls from height in and around home. It is therefore reasonable to assume, that a change in exposure to these risk factors will influence the incidence of accidents in general, but that the incidence of certain types of accidents (i.e.: falls from height in and around home) will not change accordingly.

If we consider the results related to falls more closely, it appears that three other risk factors are exclusively related to falls in and around the home (at the same level and from height). These risk factors are:

1. Accidental loss of urine with medication;
2. Dizziness without medication;
3. Sleep problems with medication.

There is no evidence that changes in exposure to these risk factors will influence the incidence of falls happening outside the home and in traffic. In order to influence the incidence of falls in all domains substantially, the intervention should focus on multiple risk factors simultaneously, because most of the individual risk factors were associated with falls in only one or two domains.

In general, the change in exposure to the risk factors that we identified is closely related to the ageing of the population. Because the mean age of the population in the Netherlands will raise, we can expect that the exposure will grow in the near future. It is assumed that for some of the risk factors that related to health, interventions could be developed and applied that will reduce the exposure to these factors. However, if we consider the three first mentioned risk factors that are shared by different types of accidents in all the domains, it is assumed that the increase in exposure to two of the factors seems relatively autonomous. These risk factors are the number of women living alone, and the number of persons that have a high educational level. Therefore we look more closely to these two risk factors.

Women living alone

In several studies living alone was related to the risk of falls (Tromp et al., 1998). For fractures, Tromp (1998) also found a relative high risk for women living alone. It is suggested that persons that live alone need to cope with all the tasks that are essential for a household. There is a limited opportunity for them to ask another person to assist in a certain situation, for instance in situations in which they don't feel comfortable about their capabilities. Further research is needed in order to test the validity of these assumptions, and to find out why especially women that live alone are at risk.

Predictions related to the number of persons who will live alone in a household for the coming years, show that an increase of 30% is expected of women living alone between 1998 (N=603.000) and 2020 (N=784.000) (ABF, Primos Prognose 1999). This trend is mainly the result of a number of factors:

the increase of the number of older people (65+) will lead to an increase the number of widowed persons;

People want to live longer independently in their own house.

It is concluded that exposure to this risk factor will increase substantially in the next 20 years and that this trend is highly autonomous.

High educational level

No evidence is available that suggests a causal relation between education and an increased risk of falling or accidents in general among older persons. It is suggested that life style factors might be involved, but more evidence is needed to draw firm conclusions. Some evidence suggests that persons with an intermediate level of physical activity to some extend have a relative high the risk for falls, compared to persons with a low or high level of physical activity (Graafmans, 1997; Studenski, 1994), although the relationship is considered complex and not extensively studied. There is no evidence, however, that high-educated people in general do have an intermediate level of physical activity.

From several sources, however, it can be concluded that the level of education of the elderly population in the Netherlands will rise in the coming years (van Herten et al, 1997). This can be regarded as an autonomous trend with a possible negative impact on the incidence of accidents among the elderly.

For both risk factors the causal relationship with accidents is not fully understood, therefore it is difficult to estimate the impact of the change in exposures to the incidence of accidents. Nevertheless, it is clear that both risk factors change relatively autonomously in the direction of higher exposure. This fact underlines the importance of a policy that is aimed at developing and implementation of effective intervention programmes in order to reduce the incidence of accidents in general and falls in particular among older persons.

Considering the purpose of the study, the following conclusions can be drawn from the results and discussion:

1. We identified several risk factors that are shared by different types of accidents in different domains;
2. We identified three risk factors that are shared by all accidents in all domains. Intervention on these three risk factors will have a relatively high impact on the incidence of all accidents among older persons;
3. We identified several risk factors that are shared by some of the types of falls in one or more domains. The picture that emerges for falls is, that intervention on only one or two risk factors will not influence the incidence of all falls substantially. It is concluded that intervention on multiple risk factors simultaneously is essential for optimal reduction of the incidence of falls.
4. The exposure to the identified risk factors will most probably increase in the coming decades, and some of the risk factors will change relatively autonomously in the direction of higher exposure. Therefore, an active prevention policy is required in order to reduce the incidence of accidents in general and falls in particular among older persons.
5. A validation of the final model is needed on a data set from another population. From a current and comparable study, data are obtained that will make this validation possible.

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