sciendo
10.2478/sjph-2023-0011 Zdr Varst. 2023;62(2):76-86
Ružić-Gorenjec N, Klemenc Ketiš Z, Blagus R, Poplas Susič A. Fall risk in adult family practice non-attenders: A cross-sectional study from Slovenia. Zdr Varst. 2023;62(2):76-86. doi: 10.2478/sjph-2023-0011.

FALL RISK IN ADULT FAMILY PRACTICE NON-ATTENDERS: A CROSS-SECTIONAL STUDY FROM SLOVENIA

TVEGANJE ZA PADEC MED ODRASLIMI REDKIMI OBISKOVALCI AMBULANT DRUŽINSKE MEDICINE: PRESEČNA RAZISKAVA IZ SLOVENIJE

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Received: Jun 9, 2022
Accepted: Dec 22, 2022

Original scientific article

ABSTRACT

Keywords:
Fall risk
Primary healthcare
Family practice
Non-attenders
Cross-sectional studies

Introduction: Not much is known about the fall risk among the adult population of those who rarely visit doctors. We wanted to determine the prevalence of increased fall risk in a population of family practice non-attenders and the factors associated with it.

Methods: We included participants from family medicine practices in this cross-sectional study. To be included in the study, the participants had to be adults living in the community (home-dwelling people) who had not visited their chosen family physician in the last five years (non-attenders). The identification of the eligible persons was done through a search of electronic medical records, which yield 2,025 non-attenders. Community nurses collected data in the participants' homes. The outcome measure was increased fall risk as assessed by the Morse fall scale: increased risk (≥25) vs. no risk.

Results: The sample consisted of 1,945 patients (96.0% response rate) with a mean age of 60.4 years (range 20.5 to 99.7 years). An increased fall risk was determined in 482 or 24.8% (95% CI: [22.9, 26.8]) of the patients. The multivariate model showed a significant association of increased fall risk with higher age (p<0.001), lower systolic blood pressure (p=0.047), poor family function (p=0.016), increased risk of malnutrition (p=0.013), higher number of chronic diseases (p=0.027), higher pain intensity (p<0.001), lower self-assessment of current health (p=0.002), and higher dependence in daily activities (p<0.001).

Conclusion: Non-attenders may have an increased risk of falling which depends on their health status and age. The inclusion of community nurses in primary healthcare teams could be of use not only to identify the non-attenders' health needs, but also to better manage their health, especially the factors that were identified to be associated with greater fall risk.

IZVLEČEK

Ključne besede:
tveganje za padce
primarno zdravstveno varstvo
družinska medicina
redki obiskovalci
presečne raziskave

Uvod: *O tveganju za padec med odraslo populacijo, ki redko obiskuje zdravnika, ni znanega veliko. Želeli smo ugotoviti razširjenost povečanega tveganja za padce v populaciji pacientov, ki redko obiskujejo svojega zdravnika družinske medicine, in s tem povezane dejavnike.*

Metode: *V to presečno študijo smo vključili paciente iz ambulant družinske medicine. Za vključitev v študijo so morali biti udeleženci odrasli, živeči v skupnosti, ki v zadnjih 5 letih niso obiskali svojega izbranega zdravnika družinske medicine. Identifikacija pacientov je potekala preko elektronskega sistema. Kriterijem je ustrezalo 2.025 posameznikov. Patronažne medicinske sestre so zbirale podatke, in sicer na domovih pacientov. Opazovana spremenljivka je bilo povečano tveganje za padec, ocenjeno z Morsejevo lestvico padcev: povečano tveganje.*

Rezultati: *Vzorec je sestavljalo 1.945 bolnikov (96,0-odstotna stopnja odziva) s povprečno starostjo 60,4 let (razpon od 20,5 do 99,7 let). Povečano tveganje za padec je bilo ugotovljeno pri 482 ali 24,8 % (95 % IZ: [22,9; 26,8]) bolnikov. Multivariatni model je pokazal pomembno povezavo povečanega tveganja za padec z višjo starostjo (p < 0,001), nižjim sistoličnim krvnim tlakom (p = 0,047), slabim družinskim delovanjem (p = 0,016), povečanim tveganjem za podhranjenost (p = 0,013), večjim številom kroničnih bolezni (p = 0,027), višjo intenzivnostjo bolečine (p < 0,001), nižjo samooceno trenutnega zdravja (p = 0,002) in večjo odvisnostjo pri vsakodnevnih aktivnostih (p < 0,001).*

Zaključek: *Pacienti, ki redko obiskujejo zdravnika, zlasti starejši, imajo lahko povečano tveganje za padec, ki je odvisno od zdravstvenih in socialno-ekonomskih dejavnikov. Vključitev patronažnih medicinskih sester v primarni zdravstveni tim bi lahko bila koristna ne le za ugotavljanje zdravstvenih potreb neodzivnikov, temveč tudi za boljše upravljanje njihovega zdravja, zlasti dejavnikov, za katere je bilo ugotovljeno, da so povezani z večjim tveganjem za padec.*

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1 INTRODUCTION

Falls are a major public health problem all over the world (1), and are mainly associated with elderly people (aged 65 years or more). Risk factors for falls in the elderly involve intrinsic and extrinsic risk factors: biological, socioeconomic, behavioural, and environmental (2, 3). Most falls, however, are a result of complex interactions among several risk factors (3).

Most of the related studies have concentrated on falls in a specific population. Among the elderly, the prevalence of falls is around one third (2, 4). A limited number of studies have focused on younger adults (5-7), where different mechanisms, causes and features of falls can be found. Nevertheless, falls are also a considerable problem in younger and middle-aged people, and may affect as many as one fifth of this population (5, 7, 8).

Studies on fall risk have mainly been done in acute and hospital settings and showed that around two thirds of patients had moderate or high fall risk (9-11). However, we could not find any studies reporting on the prevalence of increased fall risk among the general or primary care population.

In primary care, non-attenders are a specific group of individuals with significantly different characteristics than those of attenders. For example, they are most likely to be men on low incomes, have low socio-economic status, be unemployed or less educated, be older and single, have greater cardiovascular risk factors, and be smokers. They also appear to value their health less strongly and are less likely to believe in the efficacy of health checks (12). Moreover, our previous study indicated that as many as a quarter of adult non-attenders in primary care had some level of disability (13), which has been recognised as one of the risk factors for falls (14, 15).

The goal of this study was to determine the prevalence of increased fall risk in a population of family practice non-attenders and the factors associated with it. This would enable us to recognise the extent of the problem in this specific subgroup of patients whose health status is not well-known to family practice teams, and provide valuable insights that could enable specific interventions aimed at family practice non-attenders.

2 METHODS

2.1 Type of study and settings

We conducted a cross-sectional observational study. We included family practices in the largest healthcare centre in Slovenia, the Community Health Centre Ljubljana. This work was part of a larger study called "Upgraded Comprehensive Patient Care", from which two papers have already been published. One of them focused on malnutrition (16) and the other on dependence in daily activities (13). Both used a different subsample from the current study, and the aims were also different, and hence the results were different in comparison to this paper.

2.2 Participants

The participants included in the study were family practice non-attenders, who were 18 years old or older, had not visited their chosen family practice in the last five years, were living in the community (home-dwelling people), and gave signed informed consent. The identification of the eligible persons was done through a search of the electronic medical records in each family practice, which yield 2,025 non-attenders. The final sample consisted of 1,945 patients (96.0% response rate) with recorded fall risk.

2.3 Data collection

Data were collected from September 2015 until May 2016 by community nurses in the patients' homes using questionnaires on chronic diseases and screening tools already used in upgraded family medicine practices (17). Prior to the collection of the data, the nurses underwent training on the use of the tools used in the study. All the data was anonymised before entered into an electronic database and analysed.

We assessed fall risk using the Morse Fall Scale (MFS) (18), which is a rapid and simple method of assessing a patient's fall risk derived from six variables: history of falling, secondary diagnosis, ambulatory aids, intravenous therapy/heparin lock, gait/transferring, and mental status. It has been shown to have good predictive validity and interrater reliability. Based on the MFS with values 0-125, a patient is classified as having no fall risk (score ≤24), low risk (25-50) or high risk (≥51) of falling. According to the MFS tool, patients with low or high fall risk are advised to implement fall prevention interventions (18). Therefore, our outcome was dichotomous: increased fall risk (MFS ≥25) vs. no fall risk (MFS ≤24).

Community nurses collected the following data: demographic characteristics (gender, age), weight and height, systolic and diastolic blood pressure, and self-reported presence of chronic diseases by the participants themselves (cardiovascular diseases, diabetes, hypertension, chronic obstructive pulmonary disease (COPD), asthma, depression, osteoporosis, benign prostatic hyperplasia, obesity, colon cancer, breast cancer, neurological diseases, and dementia). We analysed the number of chronic diseases (out of the 13 listed above), recorded as '0', '1', '2' and '3 or more'. Body mass index (BMI) was divided into four categories: underweight (<20.0 kg/m2), normal (20.0-25.0 kg/m2), overweight (25.1-29.9 kg/m2), and obese (≥30.0 kg/m2) (19).

Family function was determined with the use of the Family APGAR, measuring five items: Adaptation, Partnership, Growth, Affection, and Resolve. Each of the five items is assessed on a three-point scale ranging from 0 (hardly ever) to 2 (almost always) (20). We categorised family function into poor (APGAR score 0-7) and good (APGAR score 8-10).

For the assessment of the risk of malnutrition, we used the Malnutrition Universal Screening Tool (MUST) (21), where a score of one point or more (out of six possible points) was considered as an increased risk of malnutrition.

Dependence in daily activities was determined using eight items, which were: personal hygiene, eating and drinking, mobility, dressing and undressing, urination and defecation, continence, avoiding hazards in the environment, and communication. For each item, the community nurse gave 1 point (independent), 2 points (low dependent), 3 points (high dependent), or 4 points (totally dependent). A joint score for dependence in daily activities was computed as an average of the eight items, ranging from 1 to 4 in steps of 0.125, where higher values indicated a higher level of dependence.

Pain intensity was also assessed by the community nurses on a 10-point Likert scale, as well as self-assessment of current health, and feeling of loneliness, where a score of 10 represented the strongest pain, completely satisfied with current health, and completely lonely, respectively.

2.4 Statistical analysis

Categorical variables were summarised by frequencies and percentages, and numerical variables by medians and interquartile ranges (IQR), as presented in Tables 1 and 2. Clopper-Pearson confidence intervals (CIs) were calculated for proportions.

The multivariate logistic model was fitted for the fall risk using all variables from Tables 1 and 2 with the exception of individual chronic diseases, as the number of chronic diseases (recorded as ‘0’, ‘1’,’2’, ‘3 or more’) was used instead. We used a sample size of 1,474 (75.8% out of 1945) patients who had no missing values for all 12 covariates, of which 382 (25.9%) had increased fall risk. The omitted 471 patients with missing values were comparable to the used subsample of 1,474 patients in terms of the outcome and demographic characteristics, see Supplementary Table 1. The high number of events (participants with increased fall risk) allowed us to use non-linear effects for all numerical variables via flexible functions, thus letting the shape of the effect be data driven. We used restricted cubic splines for all numerical variables (four knots for all except pain intensity and feeling of loneliness, where three knots were chosen instead by the algorithm for default positioning of the knots) except dependence in daily activities, which was transformed using log2 instead (due to its severely asymmetrical distribution that makes the positioning of the knots difficult). This meets the requirement for a sufficient number of events per variable, as 26 coefficients were estimated in the model. Additionally, we performed a sensitivity analysis where we used three or five knots for restricted cubic splines or included dependence in daily activities without the transformation, and the results remained unchanged regarding the statistical significance of the variables.

As the scores for dependence in daily activities and fall risk (assessed by the MFS) depend on some items that are related, including the dependence in daily activities as one of the covariates in the model for fall risk could be problematic (i.e. the covariate predicts the outcome too well). Therefore, we also fitted an alternative multivariate logistic model without covariate dependence in daily activities as a part of sensitivity analysis (Supplementary Table 3).

The discriminative ability of the logistic model was estimated by means of an ROC (receiver operating characteristic curve) analysis reporting the area under the ROC curve (AUC), pseudo R2, with their bias-corrected versions computed through resampling validation of the model using 1,000 bootstrap repetitions, and the calibration curve based on the out-of-bag samples. The odds ratios (ORs) were reported together with 95% CIs based on the profiling of the likelihood function. Interpretable ORs and p values are presented in Table 3, the other associations are displayed graphically, and the whole model is presented in Supplementary Table 2 (as we are using splines to model non-linear effects, coefficients of separate terms in Supplementary Table 2 are non-interpretable, a p value of the whole non-linear effect must be additionally computed, see Table 3).

A p value of less than 0.05 was considered statistically significant. All analyses were carried out with R statistical software, version 3.6. (22); the package rms (23) was used for the bias-corrected AUC, pseudo R2, and calibration curve.

3 RESULTS

3.1 Sample description

A total of 1,945 participants were included in the study (96.0% response rate), out of which 1,230 (63.2%) were women. The participants were on average 60.4 years old (ranging from 20.5 to 99.7 years). There were 563 (28.9%) patients aged up to 45 years, 526 (27.0%) between ages 46 and 64, and 856 (44.0%) aged 65 or more.

All the demographic, clinical and psychosocial characteristics of the participants are presented in Tables 1 (for categorical variables) and 2 (for numerical variables).

Table 1. Increased fall risk according to the demographic, clinical, and psychosocial characteristics of the participants (categorical variables).

Characteristic (n=number of non-missing values)		All participants n (%)	Participants with increased fall risk n (%)	Participants without increased fall risk n (%)
Gender:	Female	1,230 (63.2)	324 (26.3)	906 (73.7)
(n=1,945)	Male	715 (36.8)	158 (22.1)	557 (77.9)
Body mass index:	Underweight	116 (6.1)	34 (29.3)	82 (70.7)
(n=1,916)	Normal	687 (35.9)	158 (23.0)	529 (77.0)
	Overweight	678 (35.4)	154 (22.7)	524 (77.3)
	Obese	435 (22.7)	124 (28.5)	311 (71.5)
Family function:	Poor	232 (12.0)	104 (44.8)	128 (55.2)
(n=1,931)	Good	1,699 (88.0)	373 (22.0)	1,326 (78.0)
Increased risk of malnutrition:	Yes	211 (13.4)	84 (39.8)	127 (60.2)
(n=1,577)	No	1,366 (86.6)	345 (25.3)	1,021 (74.7)
Chronic diseases:	No diseases	1,054 (54.9)	92 (8.7)	962 (91.3)
(n=1,921)	1 disease	421 (21.9)	140 (33.3)	281 (66.7)
	2 diseases	261 (13.6)	123 (47.1)	138 (52.9)
	3 or more diseases	185 (9.6)	117 (63.2)	68 (36.8)
Cardiovascular disease:	Yes	247 (12.7)	162 (65.6)	85 (34.4)
(n=1,939)	No	1,692 (87.3)	318 (18.8)	1,374 (81.2)
Diabetes:	Yes	208 (10.7)	94 (45.2)	114 (54.8)
(n=1,943)	No	1,735 (89.3)	387 (22.3)	1,348 (77.7)
Hypertension:	Yes	621 (32.0)	289 (46.5)	332 (53.5)
(n=1,942)	No	1,321 (68.0)	192 (14.5)	1,129 (85.5)
COPD:	Yes	49 (2.5)	28 (57.1)	21 (42.9)
(n=1,943)	No	1,894 (97.5)	453 (23.9)	1,441 (76.1)
Asthma:	Yes	55 (2.8)	28 (50.9)	27 (49.1)
(n=1,943)	No	1,888 (97.2)	453 (24.0)	1,435 (76.0)
Depression:	Yes	82 (4.2)	38 (46.3)	44 (53.7)
(n=1,943)	No	1,861 (95.8)	443 (23.8)	1,418 (76.2)
Osteoporosis:	Yes	89 (4.6)	54 (60.7)	35 (39.3)
(n=1,942)	No	1,853 (95.4)	426 (23.0)	1,427 (77.0)
Benign prostatic hyperplasia:	Yes	30 (1.6)	13 (43.3)	17 (56.7)
(n=1,930)	No	1,900 (98.4)	462 (24.3)	1,438 (75.7)
Obesity:	Yes	110 (5.7)	38 (34.5)	72 (65.5)
(n=1,943)	No	1,833 (94.3)	443 (24.2)	1,390 (75.8)
Colon cancer:	Yes	17 (0.9)	7 (41.2)	10 (58.8)
(n=1,943)	No	1,926 (99.1)	474 (24.6)	1,452 (75.4)
Breast cancer:	Yes	24 (1.2)	8 (33.3)	16 (66.7)
(n=1,942)	No	1,918 (98.8)	473 (24.7)	1,445 (75.3)
Neurological diseases (excl. dementia):	Yes	20 (1.0)	16 (80.0)	4 (20.0)
(n=1,945)	No	1,925 (99.0)	466 (24.2)	1,459 (75.8)
Dementia:	Yes	23 (1.2)	22 (95.7)	1 (4.3)
(n=1,945)	No	1,922 (98.8)	460 (23.9)	1,462 (76.1)

COPD=chronic obstructive pulmonary disease

Table 2. Increased fall risk according to the demographic, clinical, and psychosocial characteristics of the participants (numerical variables).

Characteristic (n=number of non-missing values)	All participants Median (IQR)	Participants with increased fall risk Median (IQR)	Participants without increased fall risk Median (IQR)
Age (years) (n=1945)	61.8 (42.1, 76.5)	80.5 (69.4, 87.2)	54.3 (38.6, 67.8)
Systolic blood pressure (mmHg) (n=1,930)	130 (120, 140)	130 (120, 141.5)	125 (115, 136.2)
Diastolic blood pressure (mmHg) (n=1,930)	75 (70, 80)	75 (70, 80)	75 (70, 80)
Pain intensity (scale 1-10) (n=1,918)	1 (1, 3)	3 (2, 5)	1 (1, 2)
Self-assessment of current health (scale 1-10) (n=1,932)	8 (5, 9)	5 (4, 7)	8 (6, 9)
Feeling of loneliness (scale 1-10) (n=1,917)	1 (1, 3)	2 (1, 5)	1 (1, 2)
Dependence in daily activities (scale 1-4 in steps of 0.125) (n=1,922)	1 (1, 1)	1.2 (1.1, 1.8)	1 (1, 1)

IQR=interquartile range

3.2 Increased fall risk

The increased fall risk was determined in 482 or 24.8% (95% CI: [22.9, 26.8]) of the participants. For age categories up to 45 years, between 46 and 64 years and aged 65 or more, the proportion of patients with increased fall risk was 2.0% (95% CI: [1.0, 3.5]), 14.1% (95% CI: [11.2, 17.3]) and 46.4% (95% CI: [43.0, 49.8]), respectively.

The multivariate model for fall risk (Table 3 for interpretable coefficients, the whole model is presented in Supplementary Table 2) discriminated the data very well, with AUC=0.938 (bias-corrected 0.930) and pseudo R2=64.0% (bias-corrected 61.0%), and was well calibrated (calibration curve based on the out-of-bag samples with intercept -0.048 and slope 0.917). It showed a statistically significant association of the increased fall risk with higher age (p<0.001), lower systolic blood pressure (p=0.047), poor family function (p=0.016, OR 1.9 with 95% CI [1.1, 3.1]), increased risk of malnutrition (p=0.013, OR 2.1 with 95% CI [1.2, 3.7]), higher number of chronic diseases (p=0.027), higher pain intensity (p<0.001), lower self-assessment of current health (p=0.002), and higher dependence in daily activities (p<0.001). Gender, BMI, diastolic blood pressure, and feeling of loneliness were not significantly associated with the fall risk. Patients with one chronic disease did not have statistically significantly higher fall risk than those without chronic diseases, whereas patients with at least two chronic diseases were more likely to have increased fall risk than those without chronic diseases (two vs. no disease: p=0.023, OR 1.8 with 95% CI [1.1, 3.1]; three or more vs. no disease: p=0.006, OR 2.3 with 95% CI [1.3, 4.1]). Obese patients had higher odds for an increased fall risk than patients with normal BMI, although this was not statistically significant (p=0.133, OR=1.4 with 95% CI for OR [0.9, 2.3]).

The results of the sensitivity analysis showed that the above results are similar to the alternative multivariate model for fall risk where dependence in daily activities was not included as a covariate (Supplementary Table 3 for interpretable coefficients). The only substantial difference is that in the alternative model patients with one chronic disease did have statistically significantly higher fall risk than those without chronic diseases (p=0.040). Although systolic blood pressure was not statistically significant in the alternative model, its p value changed from 0.047 (main model) to 0.058 (alternative model) which is not important. Finally, the nonlinear effect of age was statistically significant in the alternative model while it was not in the main model, but the shape of the effect remains the same (see Supplementary Figure 3).

In Figure 1, the effects of numerical variables are presented graphically as we allowed for non-linear effects. The model showed that age and pain intensity were linearly associated with the log odds for an increased fall risk (left panels), systolic blood pressure and self-assessment of current health were associated non-linearly (middle panels), while diastolic blood pressure and feeling of loneliness were not significantly associated with increased fall risk (right panels). If systolic blood pressure was below about 120, then lower systolic blood pressure was associated with higher odds for an increased fall risk, while there was no apparent effect above 120. The odds for an increased fall risk were similar for a self-assessment of current health below 7, but a higher self-assessment of current health was associated with lower odds for an increased fall risk.

Table 3. Multivariate logistic model for fall risk – interpretable coefficients: sample size n=1474 with 382 (25.9%) with increased fall risk, AUC=0.938 (bias-corrected 0.930), pseudo R2=64.0% (bias-corrected 61.0%), calibration curve based on the out-of-bag samples with intercept -0.048 and slope 0.917, likelihood ratio test p<0.001.

Variable	OR	95% CI	p value
Age			<0.001
Nonlinear			0.157
Gender (female vs. male)	1.08	[0.74, 1.59]	0.672
Body mass index			0.096
Underweight vs. normal	0.70	[0.27, 1.81]	0.472
Overweight vs. normal	0.84	[0.54, 1.29]	0.423
Obese vs. normal	1.43	[0.90, 2.28]	0.133
Systolic blood pressure			0.047
Nonlinear			0.019
Diastolic blood pressure			0.740
Nonlinear			0.611
Poor family function	1.87	[1.12, 3.11]	0.016
Increased risk of malnutrition	2.09	[1.17, 3.73]	0.013
Chronic diseases			0.027
1 disease vs. no disease	1.33	[0.82, 2.15]	0.251
2 diseases vs. no disease	1.83	[1.09, 3.09]	0.023
3 or more diseases vs. no disease	2.25	[1.26, 4.05]	0.006
Pain intensity			<0.001
Nonlinear			0.429
Self-assessment of current health			0.002
Nonlinear			0.001
Feelings of loneliness			0.108
Nonlinear			0.037
Dependence in daily activities with transformation $\log_2$	16.22†	[9.04, 30.83]	<0.001

† OR for increased fall risk when doubling dependence in daily activities
AUC=area under the ROC (receiver operating characteristic) curve, OR=odds ratio, CI=confidence interval

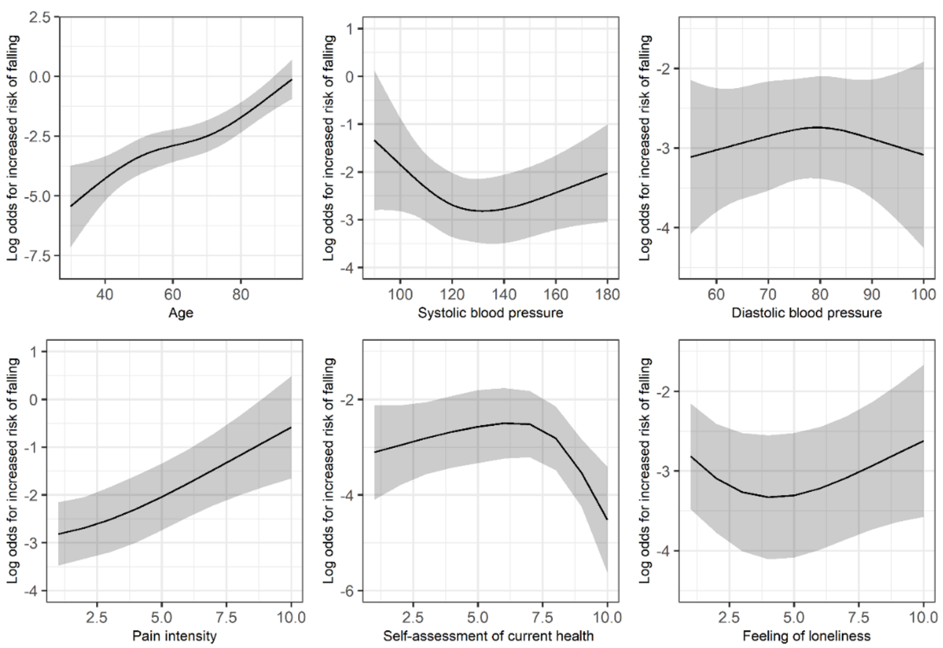

Figure 1. Logarithm of odds for an increased fall risk (black line) with 95% confidence intervals (grey area) in the multivariate logistic model (Table 3).

The figure shows the nonlinear effects of all numerical variables: age and pain intensity (left panels, both variables significant but with non-significant nonlinear effect), systolic blood pressure and self-assessment of current health (middle panels, both variables significant and with significant nonlinear effect), and diastolic blood pressure and feeling of loneliness (right panels, both variables non-significant), where the other variables in the model are fixed to their modes or medians (gender to female, age to 62.7, systolic blood pressure to 130, diastolic blood pressure to 72, self-assessment of current health to 8, and all the others to values indicating a healthy individual).

4 DISCUSSION

4.1 Main findings

According to our study, around one quarter (24.8%, 95% CI: [22.9, 26.8]) of family practice non-attenders living in the community (home-dwelling people) had an increased fall risk. The increased fall risk was significantly associated with higher age, lower systolic blood pressure, poor family function, increased risk of malnutrition, higher number of chronic diseases, higher pain intensity, lower self-assessment of current health, and higher dependence in daily activities. In contrast, gender, BMI, diastolic blood pressure, and feeling lonely were not significantly associated with fall risk.

4.2 Comparison to other studies

Our study is one of the few to assess the fall risk among home-dwelling people and also among young and middle-aged adults. Moreover, previous studies that focused on the younger population assessed the prevalence of actual falls but not the fall risk, as we did in our work. For example, Talbot et al. (5) showed that the prevalence of falls increased with age, from 18% in young adults (20-45 years old), to 21% in the middle-aged (46-65 years old), and 35% in older adults (older than 65 years). In our study, a considerable number of adults (14.1%) between 45 and 65 years old had an increased fall risk. In those aged over 65, almost every second person had an increased fall risk. This is less when compared to fall risk of hospitalised people (9-11), but it is understandable as we focused on home-dwelling patients.

Since we focused on non-attenders, the fall risk cannot be generalised to the general or primary care population as non-attenders have different health issues (24, 25), and having unmet medical needs increases the fall risk (26). Our previous work showed that a considerable proportion of primary care non-attenders had limitations in daily activities (23%) and were at risk of malnutrition (13%) (13, 16). Therefore, the fall risk found in our study might be higher than in general population.

With this work we identified several factors that were associated with the fall risk. For example, patients with the risk of malnutrition had increased fall risk, and here it should be noted that malnutrition is not only associated with weight loss,(27) but also with being overweight and having obesity (16, 28).

Dependence in daily activities increased the fall risk, which was also indicated in other studies (2). The present study showed a non-linear association between the fall risk and self-assessment of current health. Namely, the fall risk was increased, but to a degree that was quite similar for all patients with different levels of dissatisfaction with their own health, whereas for patients with a satisfactory self-assessment of health the fall risk decreased with higher levels of satisfaction. This finding is important and should be further explored.

It has already been shown that chronic patients have an increased fall risk (29). Additionally, patients with multimorbidity of chronic diseases also have increased risks (30, 31), as shown also in the present study, where having one chronic disease was not significant but having more than one was significantly associated with an increased fall risk in comparison to patients without chronic diseases. Although one of the items of the MFS (used to assess the fall risk) is the assessment of the presence of chronic diseases (yes/no), this is only one of six items, and it contributes the least to the final score. Therefore, it is sensible to estimate the association of the number of chronic diseases with the fall risk. In the alternative model (sensitivity analysis), where dependence in daily activities was not included as a covariate (as it depends on items that are related to those of the MFS), having one chronic disease was also significantly associated with increased fall risk. Presumably, dependence in daily activities took over this significance in the main model. To conclude, this study shows that the number of chronic diseases is associated with the fall risk.

Higher levels of pain and lower systolic blood pressure also increased the fall risk, as other studies have already pointed out (31-33). The pathophysiological mechanism of an increased fall risk in people with low blood pressure may partly be due to changes in arterial structure and function, such as vascular stiffness, calcification, collagen deposition and less distensibility of vessels. This may impair auto-regulation of blood pressure and cause falls (34).

Gender was not identified as an important factor for the fall risk in the present study, which is not consistent with earlier research (35) that revealed it to be important when other risk factors were controlled for. The reason for this discrepancy could lie in the different populations studied, as ours included adult patients, not only the elderly as most earlier studies did, and we also focused on primary care non-attenders.

Since the present study focused on primary care non-attenders, the high prevalence of fall risk is worrying. It is a common misconception that people who do not attend primary care visits are healthy and simply do not need healthcare (12). Our study showed the opposite, and that this group has healthcare needs and their non-management could result in increased fall risk. As such, this population might benefit from successful interventions (36, 37).

4.3 Strengths and limitations

The strengths of our study were the large number of participants and high response rate. Moreover, all the health personnel that collected the data went through a standardised education, enabling more reliable data collection. There are, however, several potential limitations. The first is the cross-sectional design, which does not enable detection of causal relations between variables. Secondly, we included patients from only one region of Slovenia. Although this might be a limitation for the generalisability of the results, we can expect that the risk factors for falls identified in our study would be the same in other regions, as the one examined is both the largest and a very diverse region covering different geographical characteristics. This region includes almost a quarter of registered patients in Slovenia, and we were able to include 96% of the non-attenders from it, which adds to the generalisability of the results. An additional limitation could be that the presence of chronic diseases was self-reported. Studies show that self-reporting of chronic diseases is in general reliable (38) when compared to register data, but could differ for some diseases (e.g. depression could be underreported) (39), and this could also be the case in our study. Also associated with the latter is the fact that the difference between self-reported obesity and obesity calculated based using BMI differed in our study. Research shows that a self-reported bias exists that causes an underestimation of being overweight and obese (40), which was evident in our study. Another limitation is that we did not collect data on whether the participants visited private doctors or hospitals instead of their chosen family physician. Therefore, such participants could be unjustifiably labelled as non-attenders. However, according to earlier studies up to one third of people avoid going to see a doctor, due to various personal, social, organisational, financial, and other issues (41, 42). Another limitation is the potential bias in sampling, as the fall risk is considered in non-attenders to primary care while those who had already experienced at least one fall might have seen their family physician, even if only for administrative reasons, and this should be taken into account when interpreting the results.

5 CONCLUSIONS

The results of our study indicate that primary care non-attenders can have unmet health needs that could potentially lead to serious consequences (including disability and death). Other healthcare professionals (in our case, community nurses) could be helpful in managing this specific population of primary care patients. As such, integrated and coordinated care is needed, not only to identify the non-attenders' health needs, but also to better manage their health, especially the factors that were identified to be associated with greater fall risk.
Further studies are needed to address the integrated healthcare interventions that are required to decrease non-attendance with regard to primary care. Moreover, the actual prevalence of falls should be studied in non-attenders, and the risk factors identified.

CONFLICTS OF INTEREST

The authors declare that no conflicts of interest exist.

FUNDING

The study was financed by the Norway Grants and Government Office for Development and European Cohesion Policy in Slovenia (No. 4300-367/2014). RB was partly supported by the Slovenian Research Agency (Methodology for Data Analysis in Medical Sciences, P3-0154). ZKK was partly supported by the Slovenian Research Agency (Research in the Field of Public Health, P3-0339).

ETHICAL APPROVAL

The National Ethics Committee (No. 0120-138/2016-2) approved the study.

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Supplementary Table 1. Comparison of the outcome (fall risk) and demographic characteristics between the subsample used in the multivariate model for fall risk (n=1,474) and the subsample that was omitted from the model on the account of missing values for the covariates in the model (n=471). Note that there were no missing values regarding the outcome or demographic characteristics.

Characteristic	Subsample used in the model (n=1,474)	Subsample omitted from the model (n=471)
Increased fall risk, n (%)	382 (25.9)	100 (21.2)
Gender: female, n (%)	941 (63.8)	289 (61.4)
Age (years), median (IQR)	62.7 (41.6 – 77.6)	60.4 (43.3 – 74.2)

Supplementary Table 2. Multivariate logistic model for fall risk – all coefficients: sample size n=1,474 with 382 (25.9%) with increased fall risk, AUC=0.938 (bias-corrected 0.930), pseudo R2=64.0% (bias-corrected 61.0%), calibration curve based on the out-of-bag samples with intercept -0.048 and slope 0.917, likelihood ratio test p<0.001.

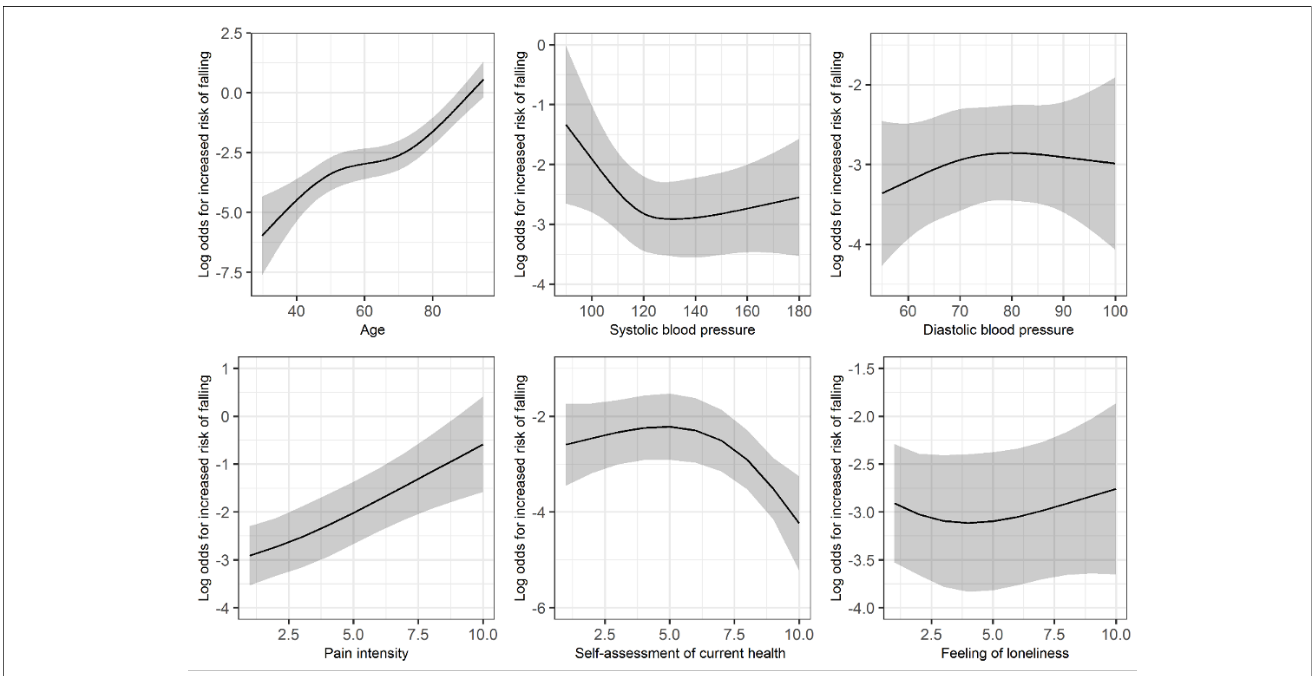
Variable	OR	95% CI	p value
Age			<0.001
Linear term	1.12	[1.02, 1.26]	0.027
Nonlinear term 1	0.85	[0.65, 1.07]	0.177
Nonlinear term 2	1.63	[0.89, 3.12]	0.123
Gender (female vs. male)	1.08	[0.74, 1.59]	0.672
Body mass index			0.096
Underweight vs. normal	0.70	[0.27, 1.81]	0.472
Overweight vs. normal	0.84	[0.54, 1.29]	0.423
Obese vs. normal	1.43	[0.90, 2.28]	0.133
Systolic blood pressure			0.047
Linear term	0.95	[0.90, 1.01]	0.096
Nonlinear term 1	1.08	[0.90, 1.30]	0.386
Nonlinear term 2	0.86	[0.43, 1.74]	0.673
Diastolic blood pressure			0.740
Linear term	1.02	[0.95, 1.09]	0.607
Nonlinear term 1	1.00	[0.81, 1.22]	0.985
Nonlinear term 2	0.95	[0.54, 1.69]	0.861
Poor family function	1.87	[1.12, 3.11]	0.016
Increased risk of malnutrition	2.09	[1.17, 3.73]	0.013
Chronic diseases			0.027
1 disease vs. no disease	1.33	[0.82, 2.15]	0.251
2 diseases vs. no disease	1.83	[1.09, 3.09]	0.023
3 or more diseases vs. no disease	2.25	[1.26, 4.05]	0.006
Pain intensity			<0.001
Linear term	1.12	[0.83, 1.51]	0.448
Nonlinear term 1	1.43	[0.59, 3.51]	0.429
Self-assessment of current health			0.002
Linear term	1.16	[0.88, 1.54]	0.300
Nonlinear term 1	0.87	[0.51, 1.50]	0.619
Nonlinear term 2	0.10	[0.00, 4.35]	0.241
Feelings of loneliness			0.108
Linear term	0.74	[0.56, 0.98]	0.036
Nonlinear term 1	2.89	[1.08, 7.89]	0.037
Dependence in daily activities with transformation $\log_2$	16.22†	[9.04, 30.83]	<0.001

† OR for increased fall risk of a patient that is twice as dependent in daily activities as the other patients
AUC=area under the ROC (receiver operating characteristic) curve, OR=odds ratio, CI=confidence interval

Supplementary Table 3. Sensitivity analysis − Multivariate logistic model for fall risk without covariate dependence in daily activities, showing only interpretable coefficients: sample size n=1,474 with 382 (25.9%) with increased fall risk, AUC=0.910 (bias-corrected 0.900), pseudo R2=57.0% (bias-corrected 53.9%), calibration curve based on the out-of-bag samples with intercept -0.036 and slope 0.922, likelihood ratio test p<0.001.

Variable	OR	95% CI	p value
Age			<0.001
Nonlinear			0.001
Gender (female vs. male)	0.84	[0.59, 1.18]	0.312
Body mass index			0.117
Underweight vs. normal	1.22	[0.52, 2.82]	0.642
Overweight vs. normal	0.75	[0.50, 1.12]	0.158
Obese vs. normal	1.23	[0.80, 1.89]	0.337
Systolic blood pressure			0.058
Nonlinear			0.033
Diastolic blood pressure			0.575
Nonlinear			0.606
Poor family function	1.87	[1.18, 2.96]	0.008
Increased risk of malnutrition	1.86	[1.11, 3.11]	0.018
Chronic diseases			<0.001
1 disease vs. no disease	1.59	[1.02, 2.47]	0.040
2 diseases vs. no disease	2.29	[1.42, 3.72]	0.001
3 or more diseases vs. no disease	3.79	[2.25, 6.46]	<0.001
Pain intensity			<0.001
Nonlinear			0.572
Self-assessment of current health			<0.001
Nonlinear			0.003
Feelings of loneliness			0.596
Nonlinear			0.310

AUC=area under the ROC (receiver operating characteristic) curve, OR=odds ratio, CI=confidence interval



Supplementary Figure 1. Sensitivity analysis − Logarithm of odds for an increased fall risk (black line) with 95% confidence intervals (grey area) in the multivariate logistic model without covariate dependence in daily activities (Supplementary Table 3), where the other variables in the model are fixed to their modes or medians (gender to female, age to 62.7, systolic blood pressure to 130, diastolic blood pressure to 72, self-assessment of current health to 8, and all the others to values indicating a healthy individual).