

PREVALENCE AND INCIDENCE OF FRAILTY AMONG COMMUNITY-DWELLING OLDER ADULTS IN SLOVENIA

RAZŠIRJENOST IN POJAVNOST KRHKOSTI MED STAREJŠIMI ODRASLIMI V SLOVENIJI

Janja JAZBAR¹, Špela PIŠEK¹, Igor LOCATELLI¹, Mitja KOS^{1*}

¹University of Ljubljana, Faculty of Pharmacy, Department of Social Pharmacy, Aškerčeva cesta 7, 1000 Ljubljana, Slovenia

Received: Aug 5, 2020
Accepted: May 27, 2021

Original scientific article

ABSTRACT

Keywords:

frailty, older adults, SHARE survey, prevalence, incidence

Introduction: Frailty is recognized as one of the most important global health challenges as the population is aging. The aim of this study was to evaluate prevalence and incidence of frailty, and associated factors, among the population of older adults in Slovenia compared to other European countries.

Methods: The prevalence and 4-year incidence of frailty among older adults (≥65 years) were evaluated using data from the Survey of Health, Ageing and Retirement in Europe (SHARE). Frailty was defined by the SHARE operationalization of Frailty phenotype. Multiple logistic regression model was used to explore factors associated with frailty.

Results: Age-standardized prevalence (95% CI) of frailty and pre-frailty in Slovenia were 14.9% (13.3-16.5) and 42.5% (39.8-45.2), respectively. Factors (OR, 95% CI) associated with increased frailty in Slovenia included age (75-84 years: 5.03 (3.08-8.22); ≥85 years 21.7 (10.6-44.7) vs. 65-74 years), self-rated health (fair: 4.58 (2.75-7.61), poor: 54.6 (28.1-105.9) vs. excellent/very good/good), number of chronic diseases (1.20 (1.03-1.40)), and polypharmacy (yes: 3.25 (1.93-5.48) vs. no). Female gender and lower education were significantly associated with pre-frailty, but not frailty, in the adjusted model. Independently of these characteristics, age-standardized prevalence of frailty varied among geographical regions. Age-standardized 4-year incidence of frailty and pre-frailty in Slovenia were 6.6% (3.0-10.1) and 40.2% (32.7-47.6), respectively.

Conclusion: Among the Slovenian population of older adults aged 65 years and older, the age-standardized prevalence of frailty is 15% and 4-year incidence of frailty is 7%. Regional differences in Slovenia show the lowest prevalence in central Slovenian regions and the highest in northeastern Slovenian regions.

IZVLEČEK

Ključne besede:

krhkost, starejši odrasli, raziskava SHARE, razširjenost, pojavnost

Uvod: S staranjem populacije postaja sindrom krhkosti vse pomembnejši javnozdravstveni izziv. Raziskav o razširjenosti krhkosti v slovenski populaciji je zelo malo, samo ena opisuje tudi različne dejavnike tveganja, vendar brez upoštevanja sočasnih spremenljivk. Podatkov o pojavnosti krhkosti za Slovenijo zaenkrat še ni. Namen naše raziskave je ovrednotiti razširjenost in pojavnost krhkosti med starejšimi odraslimi v Sloveniji, opredeliti regionalne razlike in ostale pridružene dejavnike, ki so povezani s krhkostjo ter primerjati rezultate z drugimi evropskimi državami.

Metode: Razširjenost in 4-letna pojavnost krhkosti med starejšimi odraslimi, starimi 65 let in več, sta bili ovrednoteni s pomočjo podatkov raziskave o zdravju, procesu staranja in upokojevanju v Evropi (SHARE). Krhkost je bila definirana z metodo fenotipa krhkosti, ki je prilagojena in validirana za uporabo na podatkih SHARE. Za analizo dejavnikov, ki so povezani s krhkostjo, je bil uporabljen model multiple logistične regresije.

Rezultati: Starostno standardizirana razširjenost (95-odstotni interval zaupanja) krhkosti v Sloveniji je 14,9-odstotna (13,3-16,5), razširjenost predkrhkosti pa 42,5-odstotna (39,8-45,2). V Evropi sta ta dva deleža 16,4 % (16,0-16,8) in 44,5 % (43,9-45,2). Dejavniki, ki so povezani s krhkostjo, so starost (75-84 let: 5,03 (3,08-8,22); ≥ 85 let: 21,7 (10,6-44,7) vs. 65-74 let; podana so razmerja obetov in 95-odstotni interval zaupanja), samoocena zdravja (zadovoljivo: 4,58 (2,75-7,61), slabo: 54,6 (28,1-105,9) vs. odlično/zelo dobro/dobro), število kroničnih bolezni (1,20 (1,03-1,40)) in polifarmakoterapija (da: 3,25 (1,93-5,48) vs. ne). Pri naši raziskavi sta ob upoštevanju sočasnih spremenljivk ženski spol in nižja izobrazba značilno povezana s predkrhkostjo, ne pa tudi s krhkostjo. Razširjenost krhkosti statistično značilno variira med različnimi geografskimi regijami Slovenije tudi ob upoštevanju starosti, spola in ostalih dejavnikov. Najnižja starostno standardizirana razširjenost krhkosti je bila zaznana v gorenjski, zasavski in osrednjeslovenski regiji (8,5 %, 10,0 %, 10,3 %), najvišja pa v koroški, podravski in pomurski regiji (21,3 %, 22,7 %, 27,0 %). Starostno standardizirana 4-letna pojavnost krhkosti v Sloveniji je 6,6 % (3,0-10,1), pojavnost predkrhkosti pa 40,2 % (32,7-47,6). V Evropi je starostno standardizirana pojavnost krhkosti 8,3 % (7,5-9,2), predkrhkosti pa 42,3 % (40,7-43,9). Vzorec za oceno pojavnosti je bil premajhen, da bi lahko ovrednotili tudi dejavnike, ki so povezani s pojavnostjo krhkosti.

Zaključek: Starostno standardizirana razširjenost krhkosti v Sloveniji znaša 15 %, 4-letna pojavnost pa 7 %. Regionalne razlike v razširjenosti krhkosti v Sloveniji so precejšnje, z najmanjšo razširjenostjo v osrednjih (približno 10 %) in najvišjo v severovzhodnih regijah (nad 20 %).

*Corresponding author: Tel. + 386 1 4769 686; E-mail: mitja.kos@ffa.uni-lj.si

1 INTRODUCTION

Frailty is recognized as one of the most important global health challenges as the population is aging worldwide (1). Frailty is an age-related syndrome characterized by a “decline in functioning across multiple physiological systems, accompanied by an increased vulnerability to stressors” (2-4). Older adults with frailty are at increased risk of adverse health outcomes and death (2).

The prevalence and incidence of frailty vary among studies due to differences in the methods that define frailty and population used. The prevalence of frailty in community-dwelling older adults is reported to be around 11% (range 4-59%) (2, 5). There are fewer studies reporting the incidence of frailty, but recent meta-analysis found 4.6% overall incidence of frailty (range 1-20%) among non-frail individuals at baseline and with a median follow-up of 3 years (6).

The information on the prevalence of frailty in Slovenia is limited to a few studies. Overall prevalence of frailty among older adults aged 50 years and older was reported in two studies (7, 8). Age-standardized prevalence of frailty in this age range in Slovenia was 7.6% (7.4-7.8) (8). Both studies also reported higher prevalence with age and in women, but no other associated factors were explored. Another study showed the association of several characteristics and frailty, on a smaller convenience sample of older adults from one community health centre (9). No multiple regression model was used in this study (9). To the best of our knowledge, the incidence of frailty in Slovenia has not been published yet.

The aim of this study was to evaluate the prevalence and incidence of frailty among the population of older adults aged 65 years and older in Slovenia and to evaluate factors associated with frailty among Slovenian older adults. Additionally, the aim was to evaluate potential regional differences in Slovenia and compare the results to other European countries. The study results could benefit the development and implementation of frailty management programs in Slovenia.

2 METHODS

2.1 Study design

This study was a retrospective database analysis of the data from the longitudinal Survey of Health, Ageing and Retirement in Europe (SHARE survey). The prevalence of frailty was evaluated in 2015 and the incidence of frailty was evaluated using a 4-year follow-up from 2011 to 2015. The prevalence and incidence were evaluated separately for Slovenia and for Europe.

2.2 Study data

The SHARE survey is a multi-national and multidisciplinary study of over 140,000 people aged 50 years and older. The first wave of the survey started in 2004 (Wave 1), with new waves released approximately every two years. The data from wave 6 (year 2015) and wave 4 (year 2011) were used in the current study. Data from wave 5 (year 2013) were used as a validation study for the incidence of frailty - the results were similar to the results published in this article. A detailed description of the SHARE survey methodology is published elsewhere (10-14).

2.3 Study population

The inclusion criteria for the evaluation of the prevalence were: (i) participants in 2015 SHARE survey, (ii) aged 65 years or older in 2015, and (iii) available data on frailty. The final sample of older adults for the evaluation of the prevalence was 2,286 for the Slovenia and 37,471 for the Europe (Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Italy, Luxembourg, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland).

The inclusion criteria for the evaluation of the incidence were: (i) participants in 2011 and 2015 SHARE survey, (ii) aged 65 years or older in 2011, (iii) available data on frailty in 2011 and 2015 SHARE survey, and (iv) non-frail in 2011. The final sample of older adults for the evaluation of the incidence was 294 for the Slovenia and 6,902 for the Europe (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Italy, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland).

2.4 Frailty measures

Frailty was defined by the Frailty phenotype, which is one of the two most-widely used methods for defining frailty syndrome (2, 3) and is also used in Slovenian practice within comprehensive geriatric assessment (15). The measurement of frailty based on frailty phenotype consists of five physical components: shrinking, weakness, exhaustion, slowness, and low levels of physical activity (3). In the current study we used the previously published and validated scale of frailty phenotype from SHARE data (16, 17); details are presented in Appendix A. Study participants were classified into the following groupings: (i) non-frail (robust) if none of the components were present; (ii) pre-frail if one or two of the components were present; and (iii) frail if three to five components were present.

2.5 Statistical analysis

The prevalence was defined as the proportion of older adults with pre-frailty or frailty. The incidence was defined as the proportion of new cases of older adults with pre-frailty or frailty in 2015 among non-frail older adults at

baseline in 2011. The 95% confidence intervals were also presented. The prevalence and incidence were stratified by the following variables: gender, age groups (65-74 years, 75-84 years and ≥ 85 years); highest educational level completed (primary, secondary, tertiary); self-rated health (excellent, very good, good, fair, poor); polypharmacy (taking at least 5 different drugs per typical day; no, yes), number of chronic diseases (0-1; ≥ 2), country (for the European sample) and regions (for the Slovenian sample). The variable polypharmacy was only available in 2015, therefore this variable could not be used for the analysis of the incidence. Age standardization was used to present the prevalence of frailty and pre-frailty by countries and Slovenian regions. The 2013 European standard population was used (18). A multiple logistic regression model was used to evaluate factors associated with the prevalence of frailty and pre-frailty in the Slovenian and European sample. Variable self-rated health was categorized in three groups, because some categories had no frequencies

for frailty ((i) excellent/very good/good, (ii) fair, (iii) poor). A variable number of chronic diseases was included in the model as a scale variable. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were presented. A multiple logistic regression model for the incidence was not performed due to small sample size.

3 RESULTS

3.1 The prevalence of frailty

The prevalence (95% CI) of frailty in Slovenia and Europe were 14.2% (12.7-15.6) and 15.4% (14.8-15.9), respectively (Table 1). The corresponding prevalence of pre-frailty (95% CI) were 41.8% (39.8-43.8) for Slovenia and 44.4% (43.6-45.2) for Europe. The characteristics of the prevalence for Slovenia and Europe are very similar. The prevalence was higher in women and it increased with age. Older adults with higher education were less exposed to frailty. The

Table 1. The prevalence of pre-frailty and frailty in Slovenia and Europe.

Variable	Sample size ^a		Pre-frailty Prevalence % (95% CI)		Frailty Prevalence % (95% CI)	
	Slovenia	Europe	Slovenia	Europe	Slovenia	Europe
Overall	2,286	37,471	41.8 (39.8-43.8)	44.4 (43.6-45.2)	14.2 (12.7-15.6)	15.4 (14.8-15.9)
Gender						
Male	990	16,833	38.2 (35.2-41.2)	42.2 (41.5-42.9)	11.8 (9.8-13.8)	12.0 (11.5-12.5)
Female	1,296	20,638	44.6 (41.9-47.3)	46.2 (45.6-46.9)	16.0 (14.0-18.0)	18.1 (17.6-18.6)
Age group						
65-74 years	1,300	21,006	38.5 (35.8-41.1)	41.5 (40.9-42.2)	6.4 (5.1-7.7)	8.2 (7.8-8.6)
75-84 years	770	12,834	45.8 (42.3-49.4)	48.5 (47.7-49.4)	22.2 (19.3-25.1)	20.3 (19.6-21.0)
≥ 85 years	216	3,631	47.7 (41.0-54.3)	46.5 (44.9-48.2)	32.4 (26.2-38.6)	39.6 (38.0-41.2)
Highest educational level						
primary	863	17,371	48.1 (44.8-51.4)	47.5 (46.8-48.3)	21.3 (18.6-24.1)	21.4 (20.8-22.0)
secondary	1,076	12,258	39.7 (36.8-42.6)	42.7 (41.8-43.5)	11.0 (9.1-12.8)	11.0 (10.5-11.6)
tertiary	341	7,228	32.8 (27.9-37.8)	40.1 (39.0-41.3)	6.5 (3.8-9.1)	7.8 (7.2-8.4)
Self-rated health						
excellent	58	1,828	20.7 (10.3-31.1)	24.7 (22.7-26.6)	/ ^b	1.4 (0.9-2.0)
very good	148	5,237	22.3 (18.2-26.4)	30.4 (29.1-31.6)	/ ^b	1.9 (1.5-2.2)
good	954	13,332	34.8 (31.8-37.8)	43.9 (43.1-44.8)	4.0 (2.7-5.2)	5.6 (5.2-6.0)
fair	723	12,459	54.1 (50.4-57.7)	54.7 (53.8-55.6)	13.8 (11.3-16.3)	19.8 (19.1-20.5)
poor	402	4,604	46.5 (41.6-51.4)	41.8 (40.3-43.2)	46.3 (41.4-51.1)	52.6 (51.2-54.1)
Polypharmacy						
no	1,524	21,620	41.6 (39.1-44.1)	45.3 (44.7-46.0)	10.1 (8.6-11.6)	10.4 (10.0-10.8)
yes	477	10,442	48.2 (43.7-52.7)	48.4 (47.4-49.3)	32.9 (28.7-37.1)	32.0 (31.1-32.9)
Number of chronic diseases						
0-1	903	15,506	35.1 (32.0-38.2)	38.9 (38.1-39.7)	7.6 (5.9-9.3)	7.1 (6.7-7.5)
≥ 2	1,381	21,949	46.2 (43.6-48.8)	48.3 (47.6-49.0)	18.4 (16.4-20.4)	21.2 (20.7-21.7)

^aSum of N for specific variable may be smaller than total N due to missing data.

^bThere were no frail older adults in Slovenia with excellent or very good self-rated health.

prevalence of frailty in older adults with polypharmacy or multiple chronic diseases was two to three times higher than in older adults without polypharmacy or multiple chronic diseases.

Age-standardized prevalence of frailty and pre-frailty in Slovenia compared to other European countries is presented in Table 2. Slovenia was rated 7th among the 17 countries, with Switzerland having the lowest prevalence of frailty (6.8% (5.5-8.1)). Regional differences in the age-standardized prevalence of frailty and pre-frailty in Slovenia are presented in Table 3 and Figure 1. The regions with the highest prevalence of frailty were the northeastern regions Koroška (21.3%), Podravska (22.7%), and Pomurska (27.0%). The prevalence in these regions was more than twice as high compared to the regions in central Slovenia with the lowest prevalence of frailty.

Table 2. Age-standardized prevalence of pre-frailty and frailty across European countries. The countries are listed from the lowest to the highest prevalence of frailty.

Country	Age-standardized prevalence of Frailty (95% CI)	Age-standardized prevalence of Pre-frailty (95% CI)
Switzerland	6.8 (5.5-8.1)	41.0 (37.9-44.0)
Sweden	8.4 (7.3-9.5)	41.5 (39.1-43.9)
Denmark	10.3 (8.8-11.9)	38.2 (35.3-41)
Germany	11.4 (9.9-13)	39.9 (37.4-42.5)
Luxembourg	13.1 (10.3-16)	45.5 (40.5-50.6)
Czech Republic	14.8 (13.3-16.4)	43.6 (41.2-46)
Slovenia	14.9 (13.3-16.5)	42.5 (39.8-45.2)
Austria	15.4 (13.7-17.2)	36.9 (34.2-39.5)
Belgium	16.4 (15-17.9)	44.7 (42.3-47.2)
France	16.7 (15-18.4)	45.6 (42.8-48.5)
Estonia	17.7 (16.2-19.2)	53.1 (50.5-55.6)
Spain	18.7 (17.2-20.2)	47.2 (44.8-49.6)
Greece	20.2 (18.4-22)	47.7 (45-50.4)
Italy	21.7 (19.9-23.5)	48.3 (45.8-50.8)
Croatia	22.4 (19.4-25.4)	45.1 (41.2-49)
Portugal	27.1 (23.4-30.7)	45.5 (41.1-49.9)
Poland	27.5 (23.9-31.1)	48 (43.5-52.5)
Average	16.4 (16.0-16.8)	44.5 (43.9-45.2)

Table 3. Age-standardized prevalence of pre-frailty and frailty across geographical regions in Slovenia. The regions are listed from the lowest to the highest prevalence of frailty.

Slovenian region	Age-standardized prevalence of Frailty (95% CI)	Age-standardized prevalence of Pre-frailty (95% CI)
Gorenjska/Upper Carniola	8.5 (4.6-12.4)	38.7 (30.3-47.1)
Zasavska/Central Sava	10.0 (3.1-16.8)	32.9 (19.7-46.1)
Osrednjeslovenska/Central Slovenia	10.3 (7.2-13.3)	39.8 (34.1-45.5)
Jugovzhodna Slovenija/Southeast Slovenia	11.6 (6.3-17.0)	44.3 (33.5-55.0)
Notranjsko-kraška/Littoral-Inner Carniola	12.0 (4.1-19.8)	35.3 (20.2-50.4)
Spodnjeposavska/Lower Sava	13.3 (6.3-20.3)	49.2 (35.4-62.9)
Obalno-kraška/Coastal-Karst	14.8 (8.2-21.5)	40.6 (29.0-52.2)
Goriška Gorizia	17.0 (10.0-23.9)	44.2 (33.1-55.3)
Savinjska/Savinja	19.5 (13.8-25.2)	44.6 (36.1-53.1)
Koroška/Carinthia	21.3 (12.2-30.4)	43.2 (31.4-55.1)
Podravska/Drava	22.7 (16.9-28.4)	41.7 (34.3-49.1)
Pomurska/Mura	27.0 (16.6-37.4)	46.9 (34.8-58.9)
Average	14.9 (13.3-16.5)	42.5 (39.8-45.2)

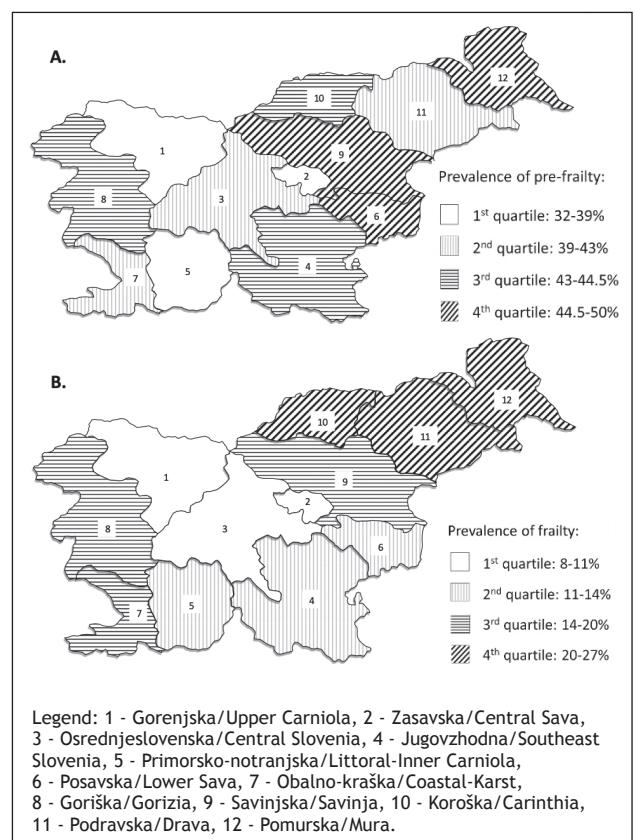


Figure 1. Age-standardized prevalence of pre-frailty (A) and frailty (B) across Slovenian geographical regions.

3.2 Factors associated with frailty

Factors associated with pre-frailty and frailty in the adjusted model are presented in Table 4. The results for gender differences in Slovenia did not reach statistical significance (OR 1.39; 95% CI 0.89-2.19), although significant differences were shown for Europe. Age had a significant impact on frailty, with high adjusted-odds ratios for the 75-84-year and ≥ 85 -year age groups compared to the 65-74-year age group for both Europe and Slovenia. A higher educational level was significantly associated with lower adjusted odds of frailty in Europe, but the results for Slovenia were not statistically significant. Polypharmacy was associated with higher odds of frailty even after adjustment for number of chronic diseases and other cofactors (OR (95% CI): 2.89 (2.59-3.22) for Europe and 3.25 (1.93-5.48) for Slovenia). Also, the number of chronic diseases was significantly associated with increased odds of frailty. After adjusting for all included variables, regional differences showed increased odds (OR, 95% CI) for frailty in the following regions: Podravska (5.03, 2.00-

12.6), Pomurska (4.44, 1.44-13.7), Koroška (3.95, 1.33-11.7), Spodnje-posavska (3.37, 1.03-11.0), and Savinjska (3.11, 1.19-8.15), compared to the reference region with the lowest prevalence (Gorenjska).

3.3 The incidence of frailty

The 4-year incidence (95% CI) of frailty was 4.4% (2.1-6.7) in Slovenia and 5.4% (4.9-5.9) in Europe (Table 5). The 4-year incidence of pre-frailty (95% CI) was 37.8% (32.3-43.3) and 39.2% (38.0-40.4) in Slovenia and Europe, respectively. All included variables have a similar association to the incidence of frailty as to the prevalence of frailty. The incidence was increased in female gender and older age groups, and decreased with higher educational level. Older adults with poorer self-rated health at baseline had increased incidence of frailty. The incidence of frailty was higher in older adults with more chronic diseases.

Age-standardized 4-year incidence of frailty in Slovenia and Europe were 6.6% (3.0-10.1) and 8.3% (7.5-9.2),

Table 4. Factors associated with pre-frailty and frailty in Slovenia and Europe.

Variable	Pre-frailty		Frailty	
	Slovenia	Europe	Slovenia	Europe
	Adjusted OR ^a (95% CI)	Adjusted OR ^b (95% CI)	Adjusted OR ^a (95% CI)	Adjusted OR ^b (95% CI)
Gender				
Male	reference	reference	reference	reference
Female	1.46 (1.16-1.85)*	1.36 (1.29-1.43)*	1.39 (0.89-2.19)	1.79 (1.61-1.97)*
Age group				
65-74 years	reference	reference	reference	reference
75-84 years	1.65 (1.28-2.12)*	1.60 (1.51-1.69)*	5.03 (3.08-8.22)*	3.07 (2.76-3.40)*
≥ 85 years	3.06 (1.93-4.85)*	3.41 (3.03-3.84)*	21.7 (10.6-44.7)*	15.9 (13.5-18.8)*
Highest educational level				
primary	reference	reference	reference	reference
secondary	0.71 (0.55-0.91)*	0.83 (0.77-0.88)*	0.88 (0.54-1.43)	0.67 (0.59-0.75)*
tertiary	0.51 (0.35-0.73)*	0.76 (0.70-0.82)*	0.92 (0.45-1.89)	0.52 (0.45-0.60)*
Self-rated health				
excellent/very good/good	reference	reference	reference	reference
fair	2.47 (1.93-3.16)*	2.34 (2.20-2.49)*	4.58 (2.75-7.61)*	6.12 (5.47-6.85)*
poor	7.63 (4.75-12.26)*	6.57 (5.68-7.60)*	54.6 (28.1-105.9)*	62.6 (52.3-74.9)*
Polypharmacy				
no	reference	reference	reference	reference
yes	1.72 (1.23-2.40)*	1.58 (1.47-1.69)*	3.25 (1.93-5.48)*	2.89 (2.59-3.22)*
Number of chronic diseases				
	1.14 (1.04-1.25)*	1.13 (1.11-1.15)*	1.20 (1.03-1.40) [#]	1.22 (1.18-1.26)*

^aVariables used in the adjusted model: gender, age group, highest educational level, self-rated health, polypharmacy, number of chronic diseases, geographical region. Nagelkerke R square=0.266 (pre-frailty); 0.670 (frailty). Omnibus test $p < 0.001$.

^bVariables used in the adjusted model: gender, age group, highest educational level, self-rated health, polypharmacy, number of chronic diseases, country. Nagelkerke R square = 0.208 (pre-frailty); 0.646 (frailty). Omnibus test $p < 0.001$.

* $p < 0.01$

[#] $p = 0.019$

respectively. Age-standardized 4-year incidence of pre-frailty was 40.2% (32.7-47.6) in Slovenia and 42.3% (40.7-43.9) in Europe. National and regional differences in the age-standardized incidence of frailty and pre-frailty are not shown, because the sample size for each country and each region was too small.

4 DISCUSSION

There is little data on the prevalence and incidence of frailty in Slovenia, wherefore the present study provides further knowledge of the characteristics of frailty in Slovenia, also comparing the results to other European countries.

The age-standardized prevalence of frailty in Slovenia in our study was 14.9% (95% CI: 13.3-16.5), which is similar to the European average prevalence of 16.4 (95% CI 16.0-16.8) in our study. In Slovenia, 42.5% (39.8-45.2) of older adults were pre-frail, comparable to the 44.5% (43.9-45.2) of pre-frail older adults in Europe. These results are in accordance with other published literature on the prevalence of frailty, although the results vary greatly

depending on the age range, settings and frailty measure used. A meta-analysis (19) published in 2018 reported the pooled prevalence of frailty 17.4% (14.4-20.7). When including only studies for the Fried frailty phenotype method, the pooled prevalence was 12.7% (10.9-14.5) (19). Another study (8) on SHARE survey data reported overall standardized prevalence of frailty 7.7% (7.5-8.0) among the population of people aged 50 years and older. This suggests that the prevalence is almost double when including only older adults age 65 years and older.

Our study confirms the differences between European countries published in other studies, with smaller frailty prevalence in Switzerland and northern European countries and higher frailty prevalence in southern and eastern European countries (7, 8). The age-standardized prevalence of frailty in Slovenia in our study is lower than in many other European countries, included in this study. We used age-standardization to enable better comparison of the prevalence between countries, and the logistic regression model confirmed significant differences between countries using age, sex, and other potential confounding variables in the model. However, the possibility of residual confounding or possible methodological differences in

Table 5. The incidence of pre-frailty and frailty in Slovenia and Europe.

Variable	Sample size*		Pre-frailty Prevalence % (95% CI)		Frailty Prevalence % (95% CI)	
	Slovenia	Europe	Slovenia	Europe	Slovenia	Europe
Total	294	6902	37.8 (32.3-43.3)	39.2 (38.0-40.4)	4.4 (2.1-6.7)	5.4 (4.9-5.9)
Gender						
Male	141	3426	30.5 (22.9-38.1)	36.2 (34.6-37.8)	5.0 (1.4-8.5)	4.9 (4.2-5.7)
Female	153	3476	44.4 (36.6-52.3)	42.3 (40.6-43.9)	3.9 (0.8-7.0)	6.0 (5.2-6.7)
Age group						
65-74 years	209	5031	36.4 (29.8-42.9)	35.8 (34.5-37.1)	1.9 (0.1-3.8)	3.4 (2.9-3.9)
75-84 years	79	1716	40.5 (29.7-51.3)	48.3 (45.9-50.6)	10.1 (3.5-16.8)	9.9 (8.5-11.3)
≥85 years	6	155	50.0 (10.0-90.0)	52.3 (44.4-60.1)	16.7 (0.0-46.5)	22.6 (16-29.2)
Highest educational level						
primary	77	2646	51.9 (40.8-63.1)	44.0 (42.1-45.9)	6.5 (1.0-12.0)	7.8 (6.8-8.8)
secondary	146	2540	36.3 (28.5-44.1)	36.3 (34.5-38.2)	3.4 (0.5-6.4)	4.1 (3.4-4.9)
tertiary	70	1571	24.3 (14.2-34.3)	35.3 (32.9-37.6)	4.3 (0.0-9.0)	3.4 (2.5-4.3)
Self-rated health						
excellent	23	650	30.4 (11.6-49.2)	24.2 (20.9-27.4)	4.3 (0.0-12.7)	1.5 (0.6-2.5)
very good	57	1529	35.1 (22.7-47.5)	33.2 (30.9-35.6)	3.5 (0.0-8.3)	2.8 (2.0-3.6)
good	129	2942	40.3 (31.8-48.8)	38.9 (37.2-40.7)	1.6 (0.0-3.7)	4.6 (3.8-5.3)
fair	76	1628	35.5 (24.8-46.3)	49.8 (47.4-52.2)	9.2 (2.7-15.7)	9.9 (8.4-11.3)
poor	9	149	55.6 (23.1-88.0)	57.7 (49.8-65.7)	11.1 (0.0-31.6)	18.1 (11.9-24.3)
Number of chronic diseases						
0-1	167	3742	37.1 (29.8-44.4)	36.0 (33.5-36.5)	4.2 (1.2-7.2)	4.0 (3.4-4.6)
≥2	127	3160	38.6 (30.1-47.1)	44.2 (42.5-45.9)	4.7 (1.0-8.4)	7.2 (6.3-8.1)

*Sum of N for specific variable may be smaller than total N due to missing data.

study samples from different countries should be taken into account. Nevertheless, our results are in accordance with some other results reporting relatively good health, quality of life and lifestyle measures in Slovenia compared to other European countries (17, 18), e.g. lower prevalence of older adults with multiple chronic diseases, lower out-of-pocket expenses for health-care, lower prevalence of smoking, and good nutritional habits (17-19) among older adults in Slovenia.

The age-standardized prevalence of frailty was unequal across different geographical regions of Slovenia (Figure 1). This study is the first to report regional differences in frailty in our country. Age-standardized prevalence of frailty was the highest in northeastern Slovenian regions, where the prevalence was above 20%. The lowest frailty prevalence was around 10% and was found in central Slovenian regions. Multiple logistic regression model showed statistically significant association between geographical regions and prevalence of frailty, independent of other cofactors. The results are statistically significant even after adjustment for age, education, and other characteristics that might influence these differences. These findings are in agreement with other studies that showed worse health indicators in northeastern Slovenian regions (20). The regional differences have already been recognized and addressed in national health programs in recent years (21).

Factors associated with frailty prevalence in Slovenia were age, geographical region, self-rated health, number of chronic diseases, and polypharmacy. In addition to the listed variables, also gender and education were significantly associated with pre-frailty in Slovenia. One other research (9) explored factors associated with frailty in Slovenia on a sample of 143 older adults from one region of Slovenia. This study reports increased frailty with age, female gender, people with chronic diseases and multiple medications, lower education, living alone, unhealthy diet, less exercise and not being socially active. No adjustment or multiple analysis was performed in that study (9). Another study of 40 individuals aged 55 years and older from one region of Slovenia showed significant association between frailty and self-reports of poor health after controlling for age and gender (22). In our study, female gender was associated with higher odds of pre-frailty, but not frailty, although frailty prevalence was higher in women than men (adjusted OR 1.39; 95% CI 0.89-2.19). This might be due to smaller sample size for frailty prevalence compared to pre-frailty prevalence, but further studies are needed to explore this finding. Age was significantly associated with pre-frailty and frailty in Slovenia, with a marked increase in the adjusted odds ratio in ≥ 85 years age group. Older adults with higher levels of education have a lower prevalence of frailty, which is in accordance with other published literature (3, 17). Nonetheless, in

Slovenia only the association to pre-frailty was significant, but not the association to frailty, after adjusting for other cofactors. Older adults with frailty report poorer self-rated health compared to non-frail older adults. There were no participants with excellent or very good self-rated health among frail older adults in Slovenia. Older adults with more chronic diseases and polypharmacy have higher odds for frailty and pre-frailty. The association between polypharmacy and frailty remains statistically significant after adjustment for number of chronic diseases and other cofactors. The association between polypharmacy and frailty was confirmed in a systematic review (23), but the causal relationship remains unclear. Some longitudinal studies suggest the independent influence of polypharmacy on frailty risk (23, 24) and further research is necessary to evaluate the possible benefits of reducing polypharmacy in frail older adults. It would also be interesting to explore the association between nutrition, physical activity and frailty among Slovenian older adults in further studies, since these factors are suggested as effective interventions in frailty (25).

The incidence of frailty is not well described at the population level as is the prevalence of frailty. The recent systematic review and meta-analysis (6) found great variation in frailty incidence not only due to differences in settings, age groups, and frailty method used, but also different time of follow-ups and different transitions between frailty states. In this meta-analysis (6) the pooled incidence of frailty among non-frail individuals at baseline over a median follow-up of 3 years was 4.6%. The overall 4-year incidence of frailty in our study was 5.4% (4.9-5.9) for Europe, and 4.4% (2.1-6.7) for Slovenia. The incidence of frailty and pre-frailty in our study increased with age, lower levels of education and a higher number of chronic diseases. Interestingly, non-frail older adults that reported poorer self-rated health at baseline were at increased risk of frailty after a 4-year follow-up. Unfortunately, the sample size in this case was too small to enable analysis of regional differences in the incidence of frailty.

Our results place Slovenia among countries with lower frailty prevalence; nevertheless, the overall prevalence of frailty will likely increase in the following years mainly due to population aging (26). Current science describes frailty as reversible and preventable syndrome, wherefore early frailty identification is essential part of frailty management (26, 27). Nevertheless, the management of frailty in clinical practice remains challenging due to the heterogeneity of the clinical manifestation of frailty, lack of standard definition of frailty and limited evidence on the effective strategies to manage frailty (28, 29). Current guidelines in frailty management at individual level recommend appropriate physical activity and nutrition, and managing polypharmacy or potentially inappropriate medication use, implemented within individual patient-

tailored approach such as comprehensive geriatric assessment (1, 28-31). Examples of frailty management at the public health level include increasing awareness of frailty among health practitioners and general population as well as screening for frailty (28). Our results suggest priority groups based on geographical regions, age groups and other characteristics. However, future research is needed regarding the health, economic and humanistic outcomes of various strategies in frailty management (28). The strengths of our study include using a large multi-national and multidisciplinary database that enabled evaluation of regional differences in Slovenia and analysis of other factors associated with frailty in our country. Using one data source also facilitated relevant comparison of Slovenian data to other European countries. Furthermore, the most validated method of defining frailty was used, namely the Frailty phenotype. Several potential confounding factors were accounted for in the multiple regression analysis, nevertheless other potential cofactors might be interesting to explore in relation to frailty in Slovenia, e.g. nutritional habits and physical activity. Another limitation is the small sample size for the incidence analysis, therefore regional differences and other associated factors for frailty incidence in Slovenia could not be explored. The SHARE survey population does not include hospitalized patients in the study, which should be noted when interpreting the results of our study.

5 CONCLUSIONS

Among the population of older adults aged 65 years and older in Slovenia, 14% are frail and 42% are pre-frail. During a 4-year follow-up, 4% of non-frail older adults become frail and 38% become pre-frail. Factors associated with increased frailty in Slovenia are age, self-rated health, number of chronic diseases and polypharmacy. Female gender and education are significantly associated with pre-frailty in Slovenia, but not frailty per se. There are significant differences in frailty and pre-frailty across geographical regions of Slovenia, with the lowest prevalence in central Slovenian regions (around 10%) and the highest frailty prevalence in north-eastern Slovenian regions (above 20%).

ACKNOWLEDGEMENTS

This paper uses data from SHARE Waves 4, 5, and 6 (DOIs: 10.6103/SHARE.w4.700, 10.6103/SHARE.w5.700, 10.6103/SHARE.w6.700), see Börsch-Supan et al. (2013) for methodological details.

The SHARE data collection has been funded by the European Commission through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-

CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N°211909, SHARE-LEAP: GA N°227822, SHARE M4: GA N°261982) and Horizon 2020 (SHARE-DEV3: GA N°676536, SERISS: GA N°654221) and by DG Employment, Social Affairs & Inclusion. Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, HHSN271201300071C), and from various national funding sources is gratefully acknowledged (see www.share-project.org).

CONFLICTS OF INTEREST

The authors declare that no conflict of interest exist.

FUNDING

This work was financially supported by the Slovenian Research Agency, Grant No. P1-0189.

ETHICAL APPROVAL

The study data are part of the survey of health, ageing and retirement in Europe (SHARE). The SHARE survey is subject to continuous ethics review. Wave 4, 5 and 6 were reviewed and approved by the Ethics Council of the Max Planck Society. In addition, the country implementations of SHARE were reviewed and approved by the respective ethics boards whenever this was required.

REFERENCES

- Dent E, Morley JE, Cruz-Jentoft AJ, Woodhouse L, Rodriguez-Manas L, Fried LP, et al. Physical frailty: ICFSR international clinical practice guidelines for identification and management. *J Nutr Health Aging.* 2019;23(9):771-87. doi: 10.1007/s12603-019-1273-z.
- Hoogendijk EO, Afilalo J, Ensrud KE, Kowal P, Onder G, Fried LP. Frailty: implications for clinical practice and public health. *Lancet.* 2019;394(10206):1365-75. doi: S0140-6736(19)31786-6.
- Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci.* 2001;56(3):M146-56. doi: 10.1093/gerona/56.3.m146.
- Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. *Lancet.* 2013;381(9868):752-62. doi: 10.1016/S0140-6736(12)62167-9.
- Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. *J Am Geriatr Soc.* 2012;60(8):1487-92. doi: 10.1111/j.1532-5415.2012.04054.x.
- Ofori-Asenso R, Chin KL, Mazidi M, Zomer E, Ilomaki J, Zullo AR, et al. Global incidence of frailty and prefrailty among community-dwelling older adults: a systematic review and meta-analysis. *JAMA Netw Open.* 2019;2(8):e198398. doi: 10.1001/jamanetworkopen.2019.8398.

7. Romero-Ortuno R, Fouweather T, Jagger C. Cross-national disparities in sex differences in life expectancy with and without frailty. *Age Ageing*. 2014;43(2):222-8. doi: 10.1093/ageing/aft115.
8. Manfredi G, Midao L, Paul C, Cena C, Duarte M, Costa E. Prevalence of frailty status among the European elderly population: findings from the Survey of Health, Aging and Retirement in Europe. *Geriatr Gerontol Int*. 2019;19(8):723-9.
9. Kozina G. Establishing frailty in the elderly in the home setting: bachelor thesis. Ljubljana: University of Ljubljana, 2019.
10. Börsch-Supan A. Survey of health, ageing and retirement in Europe (SHARE) Wave 6. Release version: 7.0.0. SHARE-ERIC. Data set. 2019. doi: 10.6103/SHARE.w6.700.
11. Ageing in Europe - supporting policies for an inclusive society. Accessed July 10th, 2020 at: file:///C:/Users/janjat/Downloads/10.1515_9783110444414.pdf.
12. Borsch-Supan A, Brandt M, Hunkler C, Kneip T, Korbmayer J, Malter F, et al. Data resource profile: the Survey of health, ageing and retirement in Europe (SHARE). *Int J Epidemiol*. 2013;42(4):992-1001. doi: 10.1093/ije/dyt088.
13. Börsch-Supan A. Survey of health, ageing and retirement in Europe (SHARE) Wave 4. Release version: 7.1.0. SHARE-ERIC. Data set. 2020. doi: 10.6103/SHARE.w4.710.
14. Opinion of the ethics council of the Max Planck society on the SHARE-Project. Accessed July 10th, 2020 at: http://www.share-project.org/fileadmin/pdf_documentation/MPG_Ethics_Council_SHARE_overall_approval_14.06.2018_en_.pdf.
15. Gabrijelčič Blenkuš M, et al. Perspektiva: Krhkost. *Javno Zdravje*. 2017;1(1):92-127.
16. Theou O, Brothers TD, Mitnitski A, Rockwood K. Operationalization of frailty using eight commonly used scales and comparison of their ability to predict all-cause mortality. *J Am Geriatr Soc*. 2013;61(9):1537-51. doi: 10.1111/jgs.12420.
17. Santos-Eggimann B, Cuenoud P, Spagnoli J, Junod J. Prevalence of frailty in middle-aged and older community-dwelling Europeans living in 10 countries. *J Gerontol A Biol Sci Med Sci*. 2009;64(6):675-81. doi: 10.1093/gerona/64(6):675-81.
18. Revision of the European standard population. Accessed July 10th, 2020 at: <https://ec.europa.eu/eurostat/documents/3859598/5926869/KS-RA-13-028-EN.PDF/e713fa79-1add-44e8-b23d-5e8fa09b3f8f>.
19. Siriwardhana DD, Hardoon S, Rait G, Weerasinghe MC, Walters KR. Prevalence of frailty and prefrailty among community-dwelling older adults in low-income and middle-income countries: a systematic review and meta-analysis. *BMJ Open*. 2018;8(3):e018195. doi: 10.1136/bmjopen-2017-018195.
20. Health inequalities in Slovenia. Accessed July 10th, 2020 at: https://www.euro.who.int/__data/assets/pdf_file/0008/131759/Health_inequalities_in_Slovenia.pdf.
21. The strategic approach to health inequalities in the Pomurje region and Slovenia. Accessed July 10th, 2020 at: https://www.nijz.si/sites/www.nijz.si/files/uploaded/the_strategic_approach_to_health_inequalities_in_the_pomurje_region_and_slovenia.pdf.
22. Vidovic M, Sharron G, Crews DE. Correlates of frailty among aging residents of Upper Selska valley villages under Ratitovec mountain. *Coll Antropol*. 2015;39(2):297-306.
23. Gutierrez-Valencia M, Izquierdo M, Cesari M, Casas-Herrero A, Inzitari M, Martinez-Velilla N. The relationship between frailty and polypharmacy in older people: a systematic review. *Br J Clin Pharmacol*. 2018;84(7):1432-44. doi: 10.1111/bcp.13590.
24. Gnjidic D, Hilmer SN, Blyth FM, Naganathan V, Cumming RG, Handelsman DJ, et al. High-risk prescribing and incidence of frailty among older community-dwelling men. *Clin Pharmacol Ther*. 2012;91(3):521-8. doi: 10.1038/clpt.2011.258.
25. Gabrovec B, Veninsek G, Samaniego LL, Carriazo AM, Antoniadou E, Jelenc M. The role of nutrition in ageing: a narrative review from the perspective of the European joint action on frailty - ADVANTAGE JA. *Eur J Intern Med*. 2018;56:26-32. doi: 10.1016/j.eurj.2018.03.022.
26. Kwak D, Thompson LV. Frailty: past, present, and future. *Sports Med Health Sci*. 2021;3(1):1-10. doi: 10.1016/j.smhs.2020.11.005.
27. Morley JE, Vellas B, van Kan GA, Anker SD, Bauer JM, Bernabei R, et al. Frailty consensus: a call to action. *J Am Med Dir Assoc*. 2013;14(6):392-7. doi: 10.1016/j.jamda.2013.03.022.
28. Dent E, Martin FC, Bergman H, Woo J, Romero-Ortuno R, Walston JD. Management of frailty: opportunities, challenges, and future directions. *Lancet*. 2019;394(10206):1376-86. doi: 10.1016/S0140-6736(19)31785-4.
29. Cesari M, Calvani R, Marzetti E. Frailty in older persons. *Clin Geriatr Med*. 2017;33(3):293-303. doi: 10.1016/j.cger.2017.02.002.
30. Walston J, Buta B, Xue QL. Frailty screening and interventions: considerations for clinical practice. *Clin Geriatr Med*. 2018;34(1):25-38. doi: 10.1016/j.cger.2017.09.004.
31. Nwadiugwu MC. Frailty and the risk of polypharmacy in the older person: enabling and preventative approaches. *J Aging Res*. 2020;2020:6759521. doi: 10.1155/2020/6759521.

Appendix A. Variables used to define Frailty phenotype from SHARE data.

Frailty phenotype defined by SHARE survey data

Shrinking: What has your appetite been like in the last month? No diminution in desire for food=0; Diminution in desire for food=1. If an uncodable response: "So, have you been eating more or less than usual?" More=0; Neither more nor less=0; Less=1

Weakness: Handgrip strength measured by dynamometer. Men (BMI≤24 and strength≤29=1; BMI 24.1-26 and strength≤30=1; BMI 26.1-28 and strength≤30=1; BMI>28 and strength≤32=1). Women (BMI≤23 and strength≤17=1; BMI 23.1-26 and strength≤17.3=1; BMI 26.1-29 and strength≤18=1; BMI>29 and strength≤21=1).

Exhaustion: In the last month, have you had too little energy to do the things you wanted to do? No=0; Yes=1

Slowness: Please tell me whether you have any difficulty [expected to last more than 3 months] walking 100 m or ... climbing one flight of stairs without resting. No difficulties=0; Difficulty with either task=1

Low levels of physical activity: How often do you engage in activities that require moderate level of energy such as gardening, cleaning the car, or going for a walk? Once a week or more often=0; One to three times a month=1; Hardly ever, or never=1