A Roadmap of Aging in Russia: The Prevalence of Frailty in Community-Dwelling Older Adults in the St. Petersburg District—The "Crystal" Study

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OBJECTIVES: To categorize the health problems of older Russians and identify the number of frail older adults using different approaches.

DESIGN: Cross-sectional study.

SETTING: The Kolpino district of St. Petersburg.

PARTICIPANTS: A random sample of 611 community-dwelling adults aged 65 and older was selected from a population-based register and stratified into two age groups (65–74, $\geq$75).

MEASUREMENTS: Anthropometry, medical history, nutritional status, Physical Performance Battery, activities of daily living, grip strength, spirometry, renal function, 15-item Geriatric Depression Scale, Mini-Mental State Examination, and sense of coherence.

RESULTS: The female:male ratio was 2.5:1; 19% were malnourished or at risk for malnutrition, and 78.6% presented with one to three chronic pathologies, with no differences according to age or sex. Problems with hearing (60.7%), vision (89.5%), and incontinence (40.9%) were highly prevalent. Moreover, 25.9% of the younger group (65–74) and 42.5% of the older group ($\geq$75) were found to be at risk for depression. Mild to severe cognitive impairment was found in 34.5% of the participants, and 14.4% of those aged 65 to 74 and 33.0% of those aged 75 and older reported dependence in daily living activities.

The prevalence of frailty assessed using different models varied from 21.1% to 43.9%. The Fried model revealed the strongest associations with the frailty outcomes (dependence and performance). No significant differences between the sexes were found in either age group (P = .82), although the percentage of frail women increased with age (P = .001).

CONCLUSION: The findings emphasize the need for attention and resources to be shifted from disease-oriented to functional approaches in the older Russian population. The population studied is consistent with the Fried model, in which one in five older adults can be labeled as frail. **J Am Geriatr Soc 59:980–988, 2011.**

Key words: frailty; comprehensive geriatric assessment; depression; Russia

Currently, Russia faces three important transitions: political, economic, and demographic.[1] Public health authorities are facing many new challenges because of the demographic changes; the Russian population will become older in the next 15 years[2] and is expected to shrink by 12% because of a high mortality rate and a low fertility rate. At the same time, as a result of rising life expectancy, the elderly population (aged $\geq$65) in Russia is expected to increase from 12% in 2000 to 18% in 2025.[2] Currently, 13.3% of the entire Russian population and 14.8% of those people living in the St. Petersburg district are aged 65 and older.[3]

Russia's cardiovascular disease (CVD) death rate is as high as 829 per 100,000 (2007)—one of the world's highest—and life expectancy at birth in 2007 in Russia has fallen below 68 years.[3,4] These changes have resulted in a growing population of elderly survivors of the CVD epidemic and have generated, from a scientific perspective, a distinct epidemiological context in which to study aging.

Some reports available in the Russian literature describe the healthcare needs of older adults,[5–8] although these reports do not provide a comprehensive, reliable, and clear picture of the health status of older adults in different domains. The current study is the first epidemiological study in Russia to use a comprehensive geriatric assessment (CGA) to investigate the health status of older adults.

The term "frailty" is used to describe the condition of the specific group of older people who "exhibit great medical complexity and vulnerability" and require special

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attention.[9] As many as 30 criteria have been proposed to identify or predict frailty in older adults.[10] These criteria have been included in different frailty models based on different conceptual and operational definitions. Researchers such as Fried,[11] Steverink and Slaets,[12] and Puts[13] have developed and validated some of the most popular models.

The aims of the current study were to present a picture of the health status of community-dwelling older adults in the St. Petersburg district, to identify groups of people with immediate health needs who could benefit from geriatric prevention strategies, and to determine which of the frailty models is the most applicable and informative for the Russian situation.

METHODS

The "Crystal" (Хрусталь) is a prospective cohort study of community-dwelling individuals aged 65 and older living in the Kolpino district of St. Petersburg. The primary care clinic (Policlinic no. 95) serves a population of 58,000 inhabitants based on a territorial concept of administration. Of that population, 10,986 are aged 65 and older. The population of older adults was first stratified according to age into two groups: 65 to 74 and 75 and older. A random sample was selected from each group: 462 from the first group and 452 from the second.

Selected persons were invited to participate by telephone. Some people who were unable to come to the Policlinic were examined at home. The local ethics committee of the Medical Academy for Postgraduate Studies approved the study, and informed consent was obtained from all respondents. Fourteen nurses were trained as clinical research assistants during 3 half-day training sessions to familiarize them with the questionnaires and test procedures. All research data were collected from March to December 2009.

Details of past and current medical problems were collected based on anamnesis or information that was present in the medical records. Information on angina pectoris, myocardial infarction, arrhythmias, peripheral artery disease, stroke, obstructive pulmonary disease or asthma, diabetes mellitus, cancer, osteoarthritis and rheumatoid arthritis, incontinence, and vision and hearing decline was systematically documented.

Nutritional status was evaluated using the Mini Nutritional Assessment (MNA) questionnaire[14–16] and body mass index (BMI). Weight was measured using a stationary calibrated medical scale at the Policlinic or by a calibrated bathroom scale at home. The cutoff value[13] used in the analysis for BMI was 23 kg/m^2. A MNA score between 17.0 and 23.5 was interpreted as at risk for malnutrition, and a score less than 17.0 was an indicator of frank malnutrition.

Laboratory tests included hemoglobin, blood sedimentation test (BSt), creatinine, and C-reactive protein (CRP). The following normal reference ranges for each laboratory test were used: hemoglobin (venous blood), 130 to 170 g/L for men and 120 to 150 g/L for women; BSt, 2 to 10 mm/h for men and 2 to 15 mm/h for women; creatinine, 53 to 106 μmol/L for men and 44 to 88 μmol/L for women; and CRP, 0 to 5 mg/L.

The Physical Performance Battery, which includes walking speed, rising from a chair, putting on and taking off a cardigan, and maintaining balance in a tandem stance has been used and described in detail in several studies[17,18] and has been shown to be a reliable and valid measure of physical functioning. The overall score for the four performance tests ranges from 0 to 14. The cutoff value was defined as the lowest quartile of the total score.

The Barthel Index of activities of daily living[19] was used to determine the baseline level of functioning and consequently degree of independence. The cutoff for minimal dependency was defined as a score of less than 95.[20]

The grip strength test was used to measure the maximum isometric strength of the hand and forearm muscles. The test was conducted using a carpal dynamometer (DK-50, Nizhni Tagil, Russian Federation) according to the standard protocol for the procedure in the Groningen Elderly Tests.[21] The maximum reading (kg) from three attempts for each hand was recorded separately, and the average of the left and right scores was calculated and analyzed. The cutoff value for indicating poor strength was the lowest quartile of the average score.

Renal function was estimated using the Modification of Diet in Renal Disease formula.[22] A glomerular filtration rate (GFR) greater than 60 mL/min indicates normal renal function, 45 to 60 mL/min signifies minimal decline of renal function, 30 to 44 mL/min represents moderate decline, and 15 to 29 mL/min indicates severe decline.[23]

Spirometry was performed to assess respiratory function according to the American Thoracic Society/European Respiratory Society criteria. Two portable microspirometers (MIR Spirobank, Rome, Italy) were used for the procedure. Four research nurses were trained to perform spirometry for all study participants. A pilot study was conducted to test the reproducibility of the results between trained nurses and the reliability of the procedure.[24] Reproducibility reached 68.2%, and reliability was 59.1%. For the analysis, forced expiratory volume in 1 second (FEV_1) and peak expiratory flow (L/min) with a cutoff at the lowest quintile were used.

The 15-item Geriatric Depression Scale (GDS-15) was used to screen for depressive symptoms. A person with a sum score greater than 5 is considered to be at risk for depression.[25,26]

The Mini-Mental State Examination (MMSE) was used to determine cognitive impairment.[27] The cutoff value for cognitive ability is 24, but it is useful to study the degree of impairment. Therefore, participants were classified into four categories (25–30, normal mental status; 21–24, mild cognitive impairment; 10–20, moderate cognitive impairment; and 0–9, severe cognitive impairment).

The Sense of Coherence scale is based on the Antonovsky salutogenic theory, which proposes that the way in which people view their life has a positive influence on their health. It was developed to clarify how people are able to stay healthy and has been shown to be a valid, reliable, and cross-culturally applicable instrument for measuring health.[28–30] The cutoff value for indicating a poor protective health effect was defined as the value of the lowest quartile.

Frailty Models

Fried and colleagues developed a phenotypic definition of frailty based on identifiable physical aspects,[11] but the general concept of frailty goes beyond physical factors to encompass psychological and social dimensions as well, including cognitive status, social support, and sensorial deficiencies. In Europe, generally more-comprehensive frailty models are advocated, so it was decided to also test two different well-documented approaches as "prototypes" for many other models. As a prototype of a more-comprehensive model, the approach that Puts and colleagues advocated in their excellent study was chosen.[13] As a prototype of an approach based on a clinical tool (that was designed as a simpler, easier-to-use questionnaire), the Groningen Frailty Indicator (GFI) was selected.[12]

The Fried model comprises five well-known criteria,[11] which were used as the baseline for choosing and adjusting the available criteria to approximate the model as much as possible. Muscle weakness was defined as the lowest quintile of the average grip strength in both hands adjusted for sex and BMI. The answer and the relevant question (Q13) in the GDS-15 was substituted for exhaustion or fatigue. Less physically active was defined as a self-reported low level of daily physical activity. Slow gait speed was defined as the lowest quintile for walking speed adjusted for sex and height. A MNA score of 23.5 or less was substituted for weight loss. Fried and colleagues, in their original assessment of the prevalence of the frail phenotype, used a MMSE score less than 18, Parkinson's disease, and stroke as exclusion criteria. Prevalence of frailty according to that model was calculated with and without these exclusion criteria. Individuals were considered frail if three or more of the listed characteristics were present. Those with no characteristics present were considered robust, and the intermediate group with one or two characteristics was defined as prefrail.

The Steverink-Slaets model in the format of the GFI[12,31] is a questionnaire that targets eight dimensions: mobility, physical fitness, vision, hearing, nourishment, morbidity, cognition, and psychosocial. It was developed as a screening instrument. A score greater than 5 identifies a person as frail, a score less than 4 as robust, and a score of 4 or 5 as prefrail.

The Puts model is based on nine frailty markers: body weight, peak expiratory flow, cognitive functioning, vision capacity, hearing capacity, incontinence, sense of mastery, depressive symptoms, and physical activity.[13] In the current analysis, some of the markers were modified, some were retained as in the original model, and one (physical activity) was omitted because there was no equivalent. In addition, based on the authors' conceptual approach to frailty, two biological markers were added: anemia and low estimated GFR (eGFR). The markers retained from the original model were BMI less than 23.0 kg/m^2, a MMSE score less than 24, poor vision and hearing, and incontinence. The GDS-15, rather than the Center for Epidemiologic Studies Depression Scale, was used to measure depression. The lowest quintile of FEV_1 was substituted for the lowest quintile of peak expiratory flow. The lowest quintile of sense of coherence was substituted for the lowest quintile of mastery. Frailty was defined as the presence of three or more frailty markers, participants with one or two markers were considered prefrail, and those with no markers were classified as robust.

Statistical analysis was performed using SPSS v. 18 (SPSS, Inc., Chicago, IL) and MedCalc version 11.2 (http://www.medcalc.be). Proportions, medians, means, and standard deviations were calculated for the descriptive analysis.

The Student *t*-test was used to test the significance of the differences in means. Regression analysis was performed to test the relationship between the frailty variables and the models. Logistic regression was used with the Barthel Index (cutoff value) as a dichotomous outcome variable, and linear regression was used with performance test scores as a continuous outcome variable.

RESULTS

Six hundred eleven adults aged 65 to 91 were examined. The response rate was 66.2% of younger participants (65–74) and 67.9% in the older group ($\geq$75). To test for sampling bias, those who agreed to participate in the study and those who were invited but did not participate were compared, and no significant difference was found in sex and age distribution (data not shown). The number of women was 2.5 times as high as the number of men. The women had a mean age of 75.7 ± 6.1 and the men of 73.6 ± 5.3 ($P < .001$) (Figure 1).

A summary of the health status of the study participants is presented in Table 1.

Nutritional assessment identified 11 (1.8%) participants with frank malnutrition and 106 (17.3%) at risk of malnutrition. No age or sex differences were found for these variables. Mean BMI was 27.2 ± 4.4 kg/m^2 for men and 29.2 ± 5.1 kg/m^2 for women.

Fifty-nine (9.7%) of the participants had no declared pathology, and two (0.3%) had six of the nine chronic illnesses studied, which was the greatest number of chronic illnesses observed per participant; 480 (78.6%) reported one to three pathologies, and 274 (44.8%) had two to three CVDs. No significant sex or age-group differences were found in the number of comorbidities ($P = .47$).

A high prevalence of hearing (60.7%) and vision (89.5%) impairments and urinary incontinence (40.9%) was observed. Younger men were more likely to have hearing problems than younger women ($P = .04$), whereas there was no difference between the sexes in the older group ($P = .15$), although there was a significant decline in hearing

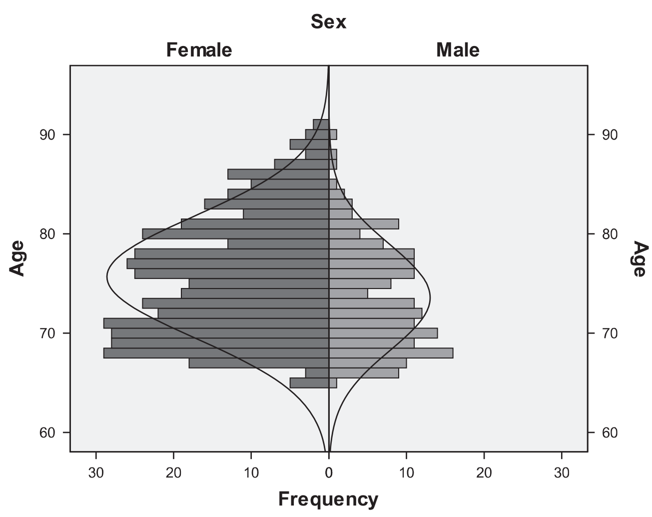

Figure 1. Age and sex distribution of the study population.

Table 1. Health Characteristics of Older Adults in the Kolpino District According to Age Group and Sex

Characteristic	Aged 65–74		Aged ≥75	
	Male, n = 100 (32.8%)	Female, n = 205 (67.2%)	Male, n = 73 (23.9%)	Female, n = 233 (76.1%)
Demographic				
Age, mean ± SD	69.7 ± 2.4	70.2 ± 2.3	78.8 ± 3.2	80.5 ± 2.4*
Response rate, %	59.5	70.1	61.3	70.3
Clinical				
Body mass index, kg/m^2, mean ± SD	27.6 ± 4.6	29.9 ± 4.9*	26.6 ± 4.1	28.6 ± 5.1*,†
Mini Nutritional Assessment score, n (%)				
<17	1 (1.0)	3 (1.5)	3 (4.1)	4 (1.7)
17–23.5	16 (16.0)	31 (15.1)	11 (15.1)	48 (20.6)
>23.5	83 (83.0)	171 (83.4)	59 (80.8)	181 (77.7)
Morbidity, number of chronic pathologies, n (%)				
0–1	34 (34.0)	80 (39.0)	30 (41.1)	80 (34.3)
2–3	50 (50.0)	101 (49.3)	39 (53.4)	105 (49.3)
>3	16 (16.0)	24 (11.7)	4 (5.5)	38 (16.2)
Morbidity, number of cardiovascular diseases, n (%)				
0–1	48 (48.0)	114 (55.6)	37 (50.7)	112 (48.1)
2–3	45 (45.0)	87 (42.4)	33 (45.2)	109 (46.7)
>3	7 (7.0)	4 (2.0)	3 (4.1)	12 (5.2)
Hearing impairment, n (%)	61 (61.0)	98 (47.8)*	56 (76.7)†	156 (67.0)†
Vision impairment, n (%)	88 (88.0)	178 (86.8)	63 (86.3)	218 (93.6)*,†
Incontinent, n (%)	21 (21.0)	83 (40.5)*	27 (37.0)†	119 (51.1)*,†
Mental				
Geriatric Depression Scale, score, n (%)				
0–5	80 (80.0)	146 (71.2)	49 (67.1)	127 (54.5)
6–15	20 (20.0)	59 (28.8)	24 (32.9)	106 (45.5)†
Mini-Mental State Examination score, n (%)				
25–30	83 (83.0)	161 (78.5)	38 (52.1)†	118 (50.6)†
21–24	9 (9.0)	31 (15.1)	20 (27.4)†	65 (27.9)†
10–20	8 (8.0)	12 (5.9)	13 (17.8)	45 (19.3)†
0–9	0	1 (0.5)	2 (2.7)	5 (2.1)
Dependence				
Barthel Index <95, n (%)	14 (14.0)	30 (14.6)	21 (28.8)†	80 (34.3)†
Physical Performance Battery				
6-meter walk, seconds, median (IQR)	10.0 [8.0–14.0]	10.0 [8.0–15.0]	11.0 [9.0–15.0]	13.0 [9.5–17.0]
Rise from a chair five times, seconds, median (IQR)	13.0 [10.0–17.0]	13.0 [10.0–18.0]	15.0 [12.0–20.0]	15.0 [10.0–22.5]
Put on and take off a cardigan, seconds, median (IQR)	9.5 [7.0–12.0]	10.0 [7.5–12.0]	11.0 [8.0–15.0]	10.0 [8.0–15.0]
Maintain balance, n (%)				
Not able	10.0 (10.0)	27 (13.2)	23 (31.5)†	101 (43.3)†
6–9 seconds	44 (44.0)	63 (30.7)*	25 (34.2)	79 (33.9)
≥10 seconds	46 (46.0)	115 (56.1)	25 (34.2)	53 (22.7)†
Cutoff for the lowest quartile of the total score of Physical Performance Battery (maximum 14)	7	7	5	5
Grip strength, kg, mean ± SD	25.9 (7.9)	14.3 (4.9)*	19.7 (7.9)†	11.2 (4.6)*,†
Renal function, Modification of Diet in Renal Disease formula, glomerular filtration rate (mL/min), n (%)				
>60	87 (88.8)	166 (85.6)	61 (84.7)	164 (71.3)*,†
45–60	8 (8.2)	21 (10.8)	7 (9.7)	57 (24.8)*,†
30–44	3 (3.1)	4 (2.1)	3 (4.2)	8 (3.5)
15–29	0	3 (1.5)	1 (1.4)	1 (0.4)
Spirometry				
Forced expiratory volume in 1 second, L, mean ± SD	2.78 ± 0.67	2.01 ± 0.49*	2.26 ± 0.68	1.66 ± 0.48*
Peak expiratory flow, L/s, mean ± SD	7.11 ± 2.11	5.12 ± 1.37*	5.65 ± 2.07	4.07 ± 1.32*
Sense of coherence, mean ± SD	65.6 ± 9.9	63.1 ± 9.6*	66.7 ± 12.3	63.5 ± 11.3*
Anemia, n (%)	19 (19.0)	30 (14.9)	18 (24.7)	51 (21.9)†

* Significant differences ($P < .05$) between the sexes within the age group.
† Significant differences ($P < .05$) between the age groups within the sexes.
SD = standard deviation.

with age in men ($P=.04$) and women ($P<.001$). Older women were more likely to have vision problems than older men, but no difference between the sexes was found in the younger age group ($P=.91$). Greater levels of vision impairment with older age were observed only in women ($P=.02$). For incontinence, a difference between men and women was observed in both age groups; the prevalence increased with age ($P=.03$), and it occurred primarily in women. Some 12.9% of participants aged 65 to 74 and 22.5% of those aged 75 and older were anemic ($P=.003$), and there was no difference between the sexes in either age group. A high CRP level was found in 15.9% of participants, and 47.1% had a high BSt.

One-quarter (25.9%) of those aged 65 to 74 and 42.5% of those aged 75 and older were identified as being at risk for depression, and there was no difference between sexes in either age group ($P=.10$). Risk of depression significantly increased with age only in women ($P<.001$). The MMSE revealed that 20.5% of the elderly had mild cognitive impairment, 12.8% had moderate impairment and 1.3% had severe impairment, without any significant sex differences. Cognitive impairment considerably declined with age ($P<.001$).

With respect to functional status, 14.4% of the younger group and 33.0% of the older group reported dependence in their activities of daily living. No sex differences were observed ($P=.72$). Dependence increased with age.

It was found that 12.5% of participants had impaired renal function (eGFR < 60 mL/min per 1.73 m^2). In the older group, women were more likely to have impaired renal function than men ($P=.02$).

The level of sense of coherence of the participants was moderate, without age group differences, but men had a higher score. The reliability (Cronbach alpha coefficient) of the total scale score was 0.7.

The overall picture of the older community-dwelling Russians examined in this study could be described as follows. Two-thirds were female, and they had a mean age of 75.1 ± 5.9, a BMI of 28.6 ± 4.9 kg/m^2, and normal nutritional status. They had, on average, 2.0 ± 1.3 diseases and were more likely to have one or two cardiovascular comorbidities. One-quarter of the population had anemia, 34.2% had undiagnosed depression, and 14.1% had moderate to severe cognitive impairment. One-quarter were dependent on others in at least one activity of daily living. Average grip strength was 15.7 ± 7.8 kg, and half had problems with maintaining balance. In terms of social adaptation, they had moderate levels on the sense of coherence scale.

Table 2 shows the results of the application of the different models for identifying frailty in elderly Russians. The overall prevalence of frailty was 21.1% using the Fried model, 32.6% using the Steverink-Slaets model, and 43.9% using the Puts model and of prefrailty was 65.5%, 24.7%, and 42.9%, respectively.

Only 74 older adults (12.1%) were identified as frail according to all three models. Taking the Fried model as a reference, 65.9% and 72.9% of the cases of frailty matched in the Steverink-Slaets model and the Puts model, respectively, whereas neither of the other two models defined 21 cases classified as frail according to the Fried model.

Table 3 shows the results of the regression analyses regarding frailty outcomes for the models tested. The Fried model has the strongest associations with dependence and performance. All of the criteria of the Fried model were significantly associated with dependence, whereas only four of eight criteria of the Steverink-Slaets model and three of nine criteria of the Puts model demonstrated this level of association. In addition, all of the parameters of the Fried model combined explain 57.4% of the variance in the scores of the performance test battery, whereas only four of eight variables of the Steverink-Slaets model contribute to 46% of the variance, and only four of nine variables of the Puts model contribute to 39.6% of the variance of the performance scores.

DISCUSSION

The current study analyzed an older Russian population using a comprehensive range of assessment tools. It found a high prevalence of mental problems; 25.4% of elderly men and 37.7% of women had a depressive disorder. No other study could be found in the available Russian literature that used the same GDS-15 questionnaire. In a population-based study in Arkhangelsk, only one question was used to determine depression: "Do you have long periods (two weeks or more) during which you feel sad, blue or depressed (yes/no)?" A prevalence of depression of 19.9% for men and 41.3% for women was reported in participants aged 60 and older.[6]

Mild to severe cognitive impairment (MMSE score < 25) was found in 34.5% of participants. No appropriate research in Russia was found for comparison, although a few studies have assessed cognition using the MMSE or other instruments. The first study was conducted at the end of the last century on the population in one of the districts of Moscow. A prevalence of cognitive impairment of 10.4% in individuals aged 60 and older was found.[7] One hundred thirty-two neurologists working in primary health care conducted another study, named "Prometheus," in 2004/05 in 33 cities of the Russian federation. The study population was comprised of individuals aged 60 and older who visited a neurologist at the Policlinic. Altogether, 3,210 adults were tested, and the study reported a prevalence of cognitive impairment (cutoff was MMSE < 25) of 25%.[8]

The current study found that 17.3% of community-dwelling older adults were at risk of malnutrition, and 1.8% were malnourished. However, the mean BMI was within the range of 25 to 29 kg/m^2 in both age groups and in both sexes, which tells us that many older adults are overweight. It is not clear whether this effect is a cohort effect. Longitudinal and cross-sectional studies have been used to relate changes in BMI to age. BMI increases with age.[32] In aging men, the percentage of fat mass increases initially and then levels off or decreases. Such change has been attributed to an accelerated decrease in lean mass, along with an initial increase and a later decrease in fat mass.[33] Intramuscular and visceral fat tend to increase with aging, whereas subcutaneous fat declines.[34] Women generally show a similar pattern.[33] This may be a matter of "sarcopenic obesity";[35] an additional body composition study needs to be conducted to clarify these findings.

International data indicate a prevalence of malnutrition, as assessed by the MNA, of 1% to 5% in community-dwelling elderly persons,[36] a range that is concordant with the current results. The prevalence of being at risk for

Table 2. Prevalence of Frailty in the Kolpino District in Russia as Defined According to Different Models

Parameter	Aged 65–74 Male	Aged 65–74 Female	Aged ≥75 Male	Aged ≥75 Female
Fried criteria for frailty, n (%)				
Muscle weakness (lowest quintile of the average grip strength in both hands adjusted for sex and BMI)	13 (13.0)	23 (11.2)	18 (24.7)	61 (26.2)†
Exhaustion, fatigue (Question 13 of GDS-15)	52 (52.0)	114 (55.6)	49 (67.1)	172 (73.8)†
Less physically active (self-reported low level of daily physical activity)	40 (40.0)	82 (40.0)	30 (41.1)	122 (52.4)†
Slow gait (lowest quintile of gait speed adjusted for sex and height)	26 (26.0)	36 (17.6)	10 (13.7)	37 (15.9)
Malnutrition (Mini Nutritional Assessment score ≤23.5)	17 (17.0)	34 (16.6)	14 (19.2)	52 (22.3)
Fried model groups according to sex and age, n (%)				
Robust	16 (16.0)	42 (20.5)	13 (17.8)	26 (11.2)†
Prefrail	68 (68.0)	136 (66.3)	39 (63.4)	142 (60.9)
Frail	16 (16.0)	27 (13.2)	14 (19.2)	65 (27.9)†
Fried model groups in the whole study population, n (%)				
Robust	97 (15.9)			
Prefrail	385 (63.0)			
Frail	129 (21.1)			
Fried model groups in the study population adjusted for MMSE score < 18, Parkinson's disease, and stroke, n (%)				
Robust	81 (16.6)			
Prefrail	319 (65.5)			
Frail	87 (17.9)			
Steverink–Slaets model, Groningen Frailty Indicator according to variable, n (%)				
Mobility	0	4 (2.0)	7 (9.6)†	4 (1.7)*
Physical fitness	40 (40.0)	82 (40.0)	30 (41.1)	122 (52.4)†
Vision	30 (30.0)	69 (33.7)	19 (26.0)	109 (46.8)*,†
Hearing	21 (21.0)	40 (19.5)	18 (24.7)	83 (35.6)†
Nourishment	13 (13.0)	25 (12.2)	9 (12.3)	38 (16.3)
Morbidity	23 (23.0)	49 (23.9)	25 (34.2)	76 (32.6)
Cognition	33 (33.0)	105 (51.2)*	39 (53.4)†	156 (67.0)*,†
Psychosocial	71 (71.0)	165 (80.5)	52 (71.2)	189 (81.1)
Total score for groups				
Robust	60 (60.0)	110 (53.7)	30 (41.1)†	61 (26.2)*,†
Prefrail	30 (30.0)	32 (15.6)*	23 (31.5)	66 (28.3)†
Frail	10 (10.0)	63 (30.7)*	20 (27.4)†	106 (45.5)*,†
Total score for whole population:				
Robust	261 (42.7)			
Prefrail	151 (24.7)			
Frail	199 (32.6)			
Extended Puts model according to variable, n (%)				
BMI < 23 kg/m^2	12 (12.0)	15 (7.3)	14 (19.2)	31 (13.4)
Lowest quintile peak expiratory flow (lowest quintile forced expiratory volume in 1 second), L	19 (19.0)	40 (19.5)	14 (19.2)	46 (19.7)
MMSE score < 24	12 (12.0)	26 (12.7)	29 (39.7)†	93 (39.9)†
Poor vision	30 (30.0)	69 (33.7)	19 (26.0)	109 (46.8)*,†
Poor hearing	21 (21.0)	40 (19.5)	18 (24.7)	83 (35.6)†
Incontinence	21 (21.0)	83 (40.5)*	27 (37.0)†	119 (51.3)*,†
Lowest quintile mastery (lowest quintile Sense of Coherence)	13 (13.0)	35 (17.1)	13 (17.8)	50 (21.5)
Depression, Centers for Epidemiologic Studies Depression Scale score > 16 (GDS > 5)	20 (20.0)	59 (28.8)	24 (32.9)	106 (45.5)†
Anemia	19 (19.0)	30 (14.9)	18 (24.7)	51 (21.9)†
Renal function deficiency, estimated glomerular filtration rate ≤ 60 mL/min	11 (11.2)	28 (14.4)	11 (15.3)	66 (28.6)*,†
Total score				
Robust	26 (26.0)	35 (17.1)	10 (13.7)	10 (4.3)*,†
Prefrail	48 (49.0)	102 (49.8)	29 (39.7)	83 (35.6)†
Frail	26 (29.0)	68 (33.2)	34 (46.6)†	140 (60.1)†
Total score for whole population				
Robust	81 (3.3)			
Prefrail	262 (42.9)			
Frail	268 (43.9)			

* Significant differences ($P < .05$) between the sexes within the age group.
† Significant differences ($P < .05$) between the age groups within the sexes.
BMI = body mass index; GDS = Geriatric Depression Scale; MMSE = Mini-Mental State Examination.

Table 3. Frailty Models Compared According to Their Outcomes

Parameter	Results of Statistical Analysis: Association with Dependency (Outcome Variable: Barthel Index < 95) Odds Ratio (95% Confidence Interval)	Results of Statistical Analysis: Association with Physical Ability (Outcome Variable: Total Score of the Performance Tests) R Coefficient, Beta
Fried model	6.44 (4.21–9.85)	0.567
Muscle weakness (lowest quintile of the average grip strength in both hands)	2.61 (1.62–4.18)	– 0.149
Exhaustion, fatigue (Question 13 from GDS-15)	1.76 (1.09–2.83)	– 0.127
Less physically active (self-reported low level of daily physical activity)	3.52 (2.28–5.43)	– 0.299
Slow gait (lowest quintile of range for walking speed)	1.97 (1.16–3.35)	0.260
Weight loss (Mini Nutritional Assessment score ≤23.5)	2.74 (1.71–4.39)	– 0.219
Steverink–Slaets model	3.88 (2.63–5.73)	0.461
Mobility	0.14 (0.04–0.46)	0.165
Physical fitness	3.09 (2.01–4.75)	– 0.367
Nourishment	2.49 (1.48–4.17)	
Morbidity		– 0.082
Cognition	2.09 (1.32–3.31)	– 0.032
Puts model	4.67 (3.10–7.02)	0.403
Lowest quintile peak expiratory flow (lowest quintile forced expiratory volume in 1 second), L		– 0.114
Mini-Mental State Examination score < 24	2.64 (1.63–4.29)	– 0.146
Incontinence	4.97 (3.07–8.04)	– 0.120
Depression, Centers for Epidemiologic Studies Depression Scale score > 16 (GDS > 5)	2.61 (1.60–4.23)	– 0.207
Anemia	2.24 (1.31–3.85)	– 0.100
Renal function deficiency, estimated glomerular filtration rate ≤60 mL/min	2.01 (1.17–3.42)	

All variables entered into the table had a significant ($P < .05$) effect on the model.
GDS = Geriatric Depression Scale.

malnutrition in similar populations is estimated at approximately 10%,[14] a rate that is lower than the rate in the current study population.

The current results emphasize the need for a reallocation of attention and resources of healthcare professionals away from disease-oriented thinking toward more-functional thinking. Social and environmental factors and the economic instability of the past 20 years could be influencing the high prevalence of depression in older adults. This prevalence may also represent a cohort effect; these individuals are survivors of World War II who were approaching the age of 45 when perestroika started and may have faced difficulties managing the new economic situation. In addition, they are survivors of the CVD epidemic that affects middle-aged adults, especially men. Nevertheless, the data are original and interesting because none of these individuals were taking any antidepressants or benefiting from any particular mental healthcare program.

This study showed that the reported prevalence of frailty in older adults depends on the model used. One of the differences can be attributed to the scores for particular criteria. Scores on the self-reported level of daily physical activity and high levels of exhaustion contributed to the high prevalence of frailty in the Fried model; high scores on psychosocial markers were of primary importance for the Steverink-Slaets model; and incontinence, poor vision, and depression were important markers in the Puts model.

In this population, prevalence ranged from 21.1% according to the Fried criteria to 43.9% according to the Puts model. These figures are high but still comparable with international data. When Fried and colleagues first tested their hypothesis of frailty and established "frailty" characteristics, they showed that 7% of community-dwelling people aged 65 and older had three or more criteria and 46% had none.[11] However, they excluded a large group of individuals from the analysis: those with a history of Parkinson's disease, stroke, or a MMSE score less than 18; those taking levodopa, donepezil, or antidepressants; those receiving active therapy for a malignancy; those who were wheelchair-bound in the home; and those who were likely to move out of the recruitment area within the next 3 years or were unable to complete a baseline assessment.[9,11] Applying only half of these exclusion criteria reduced the prevalence of frailty in the current study population to 17.9%.

The Survey of Health, Ageing and Retirement in Europe revealed important regional differences in the prevalence of frailty in community-dwelling people aged 65 and older based on the Fried definition.[37] Frailty was particularly prevalent in Spain (27.3%) and to a lesser extent in Italy (23.0%), whereas Sweden (8.6%) and Switzerland (5.8%) had a low prevalence of frailty. The level of prefrail people varied from 50.9% in Italy to 34.6% in Germany. The current prevalence figures are concordant with these findings, but the percentage of prefrail people in the current study is higher. Another study in the United Kingdom that evaluated community-dwelling persons aged 64 to 74 reported a frailty level of 4.1% for men and 8.5% for women.[38] A similar study in France revealed a prevalence of frailty of 7% (4.3% of men and 8.7% of women).[39]

Using the Steverink-Slaets model, the prevalence of frailty in the current study population was 32.6% overall (GFI score $\geq$6): 38.6% in women and 17.4% in men. In the Netherlands, the GFI (cutoff score $\geq$4) detected 46.3% frailty in community-dwelling people aged 70 and older: 39.3% in men and 51.3% in women.[40] Taking into account age and cutoff differences, the results are similar.

The prevalence of frailty as assessed using the Puts model was 43.9%. The original data of Puts and associates describe the prevalence of frailty in terms of static and dynamic indices.[13] Of people aged 65 and older, 36.5% were frail in the static sense and 42.2% in the dynamic sense. The overall outcome of self-reported functioning in the study of Puts and colleagues showed that 45.4% were frail in the static sense and 45.8% in the dynamic sense. Thus, it seems that the current data are concordant with the original findings, despite a slightly different methodological approach.

The group of prefrail individuals merits special attention. The highest level of prefrail status was defined according to the Fried model (65.5%), followed by the Puts model (42.9%), and lastly the Steverink-Slaets model (24.7%). The figures are high but relevant because this group is probably easier to restore to a robust status. The findings also have significant implications for a country like Russia, with limited primary healthcare expenditures.

This study has several limitations. First, a cross-sectional study is not adequate for a frailty analysis because this phenotype is more dynamic than static. The prognostic significance of the different frailty indicators and models will become clear after the follow-up data are analyzed, although the analysis already provides a better understanding of the health status of older adults in Russia. Second, data concerning the medical status of older adults are largely based on self-reports and to a lesser extent on information present in the medical files. Third, the tested frailty models were modified by using proxies for some of the original indicators. Nevertheless, the prevalence of frailty was within the ranges reported in other, similar studies. Fourth, the findings can be generalized to the whole population of St. Petersburg only with caution. The Kolpino district represents one of the 18 districts of the city. The inner-city population of St. Petersburg might be different from the population in the other districts, although these results represent a case study of the situation in other regions of Russia with a similar industrial historical background.

CONCLUSION

This is the first epidemiological study in Russia of the health and functional status of community-dwelling older adults.

This study contributes to a better understanding of the imminent healthcare needs of elderly Russians. Several frailty models were used to identify the one that was the most consistent with the studied population.

Two findings emerge from this study. First, within the particular epidemiological context, which has an exceptionally high CVD mortality, a prevalence of frailty was identified that is largely comparable with that reported in other populations. Second, the incidence of comorbidity appeared to be the same in both age groups, which could mean that this cohort of people aged 65 and older could be classified according to clinical status as stable and that the attention of healthcare providers should shift primarily to its functional and mental status.

More research is needed to understand in detail the characteristics of frail and prefrail older adults and to identify the prognostic value of the different frailty markers in this population.

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