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Распространенность синдрома старческой астении и его влияние на функциональный статус в зависимости от используемой диагностической модели: результаты исследования «Хрусталь»

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Введение. Распространенность синдрома старческой астении зависит от используемых для ее выявления моделей, возраста, экономической ситуации, социального статуса, а также доли мужчин и женщин в исследуемой популяции. Диагностическая ценность различных моделей синдрома старческой астении в разных популяциях неодинакова.

Цель исследования — оценить распространенность синдрома старческой астении при использовании четырех разных диагностических моделей и их чувствительность для выявления лиц, зависимых от посторонней помощи.

Материалы и методы. Случайная выборка из 611 людей в возрасте от 65 лет и старше. Использованные модели: модель «Возраст не помеха», Остеопоротический индекс старческой астении (SOF Frailty Index, Study of Osteoporotic Fractures Frailty Index), Гронингенский индикатор хрупкости, модель Л. Фрид. Оцениваемые параметры: нутритивный статус, анемия, функциональный статус, депрессия, деменция, хронические заболевания, сила сжатия, уровень физического функционирования.

Результаты. Распространенность синдрома старческой астении, выявленного с помощью фенотипических моделей, составила от 16,6 до 20,4 %, с помощью моделей накопления дефицитов — 32,6 %. Синдром старческой астении вне зависимости от модели был ассоциирован с увеличением распространенности основных гериатрических синдромов: недержания мочи, снижения слуха и зрения, снижения уровня физического функционирования, мальнутриции и риска развития недостаточности питания, снижения когнитивных функций и развития зависимости от посторонней помощи ($p < 0,05$). Отрицательная прогностическая значимость моделей «Возраст не помеха», SOF Frailty Index и Гронингенского опросника хрупкости для выявления лиц, зависимых от посторонней помощи, была 86–90 %.

Заключение. Распространенность синдрома старческой астении в зависимости от примененной модели составила 16,6–32,6 %. Диагностические модели «Возраст не помеха», SOF Frailty Index и Гронингенский индикатор хрупкости обладают высокой отрицательной прогностической значимостью для выявления лиц со сниженным функциональным статусом. Вне зависимости от модели синдром старческой астении тесно связан с повышением частоты основных гериатрических синдромов.

Ключевые слова: распространенность; пожилые; синдром старческой астении; индекс Бартел; гериатрический синдром; зависимость от посторонней помощи.

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The prevalence of frailty, measured with different diagnostic tools, and autonomy decline: Results of the Crystal study

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INTRODUCTION: Frailty prevalence differs across different population depending on the models used to assess, age, economic situation, social status, and the proportion of men and women in the study. The diagnostic value of different models of frailty varies from population to population.

OBJECTIVES: To assess the prevalence of frailty using 4 different diagnostic models and their sensitivity for identifying persons with autonomy decline.

MATERIAL AND METHODS: A random sample of 611 people aged 65 and over. Models used: the Age is not a blocking factor model, the SOF Frailty Index, the Groningen Frailty Indicator, L. Fried model. Covariates: nutritional status, anemia, functional status, depression, dementia, chronic diseases, grip strength, physical function.

RESULTS: The prevalence of the Frailty Phenotype ranged from 16.6 to 20.4% and the Frailty Index was 32.6%. Frailty, regardless of the used models was associated with an increase in the prevalence of the geriatric syndromes: urinary incontinence, hearing and vision loss, physical decline, malnutrition and the risk of malnutrition, low cognitive functions and autonomy decline ($p < 0.05$). The negative predictive value (NPV) of the Age is not a blocking factor model, the SOF Frailty Index, the Groningen Frailty Indicator for identifying individuals with autonomy decline was 86–90%.

CONCLUSION: The prevalence of frailty depended on the operational definition and varied from 16.6 to 32.6%. The Age is not a blocking factor model, the SOF Frailty Index, the Groningen Frailty Indicator, L. Fried model can be used as screening tools to identify older patient with autonomy decline. Regardless of the model used, frailty is closely associated with an increase in the prevalence of major geriatric syndromes.

Keywords: prevalence; older adults; frailty; Barthel index; geriatric syndrome; autonomy decline.

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INTRODUCTION

The aging process is accompanied by a gradual decrease in the physiological reserve of the body, but this decrease is accelerated significantly with the development of frailty [1]. The risk factors for frailty development include age, sociodemographic factors, cancer, endocrine diseases, dementia, polypharmacy, depression, low physical activity level, and malnutrition [2].

Currently, more than 50 different models are used in various studies to diagnose frailty. All models can be presented as three groups: phenotype frailty models, deficit-accumulation frailty index (FI) or the cumulative deficit models, and self-reported questionnaires [3].

Depending on the model, age, economic situation, social status, and gender proportion in the study population, a different prevalence of frailty is revealed. According to a meta-analysis published in January 2021, the prevalence of frailty in people aged 50 years and older in 62 countries of the world is 12% when estimated using phenotypic models and 24% using deficiency accumulation models. The prevalence of pre-frailty reaches 46% for the frailty phenotype and 49% for FI. The prevalence of frailty was highest in Africa and lowest in Europe [4].

There are few works focused on the study of frailty prevalence in the Russian population. In a study conducted in 2014–2015, the prevalences of frailty and pre-frailty diagnosed using the phenotypic models were 8.9% and 61.3%, respectively, and according to the deficiency accumulation model, these were 4.2% and 45%, respectively [5].

Screening for frailty in older patients is mainly aimed to identify those who need a comprehensive geriatric assessment and develop a treatment and follow-up plan based on it, aimed at maintaining and restoring their ability to self-care and independence from outside help in everyday life, as well as improve the quality of life and decrease mortality. There are currently more than 50 such questionnaires with different sensitivities to the detection of frailty models, and diagnostic values differ in various populations [3]. Thus, our study aimed to assess the prevalence of frailty when using various diagnostic approaches and assess their sensitivity for identifying older patients with autonomy decline and in need of comprehensive geriatric assessment.

MATERIALS AND METHODS

Study design. The Crystal study was conducted in St. Petersburg City polyclinic No. 95 in 2009 [7].

Study participants aged 65 years and older were randomly recruited (n = 611).

The *main study parameters* included the following:

I. Frailty

Four diagnostic models were used to detect frailty, namely, the phenotypic model of L. Fried, the Groningen Frailty Indicator (GFI), the Study of Osteoporotic Fractures Frailty Index (Study of Osteoporotic Fractures (SOF) index), and the Age is not a blocking factor model.

1. The phenotypic model of L. Fried includes an assessment of five criteria [6], namely, unintentional weight loss, rapid fatigue, decreased walking pace, general asthenia (weakness gripping force), and slowness poor endurance and energy [7]. Participants were considered frail if three or more of the above criteria were present pre-frail if one or two criteria were present and robust if they had none of the criteria.
2. The self-reported questionnaire GFI [8], consisting of 15 questions, assesses 7 areas, namely, physical activity level, autonomy decline degree in everyday life (decrease in basic and instrumental mobility), physical fitness, sensory impairment, nourishment, morbidity, cognition, and psychosocial. Participants in the study who scored more than 5 points were regarded as having frailty, and those who scored 4–5 points were regarded as having pre-frailty.
3. The SOF index includes an assessment of 3 parameters [9], namely, unintentional decrease in body weight by 6 kg during the recent 6 months or 3 kg over the recent 3 months, inability to stand up from the chair 5 times without using the hands, and low level of physical activity. Low level of physical activity was defined based on a self-reported level of daily physical activity following the question "How would you rate your physical activity by a scale of 0 to 10?" in GFI [10].
4. Model Age is not a blocking factor. According to the clinical guidelines for frailty, all study participants were interviewed using the Age is not a blocking factor scale at the first stage of diagnostics [2]. The Age is not a blocking factor scale consists of seven questions assessing the presence of such geriatric syndromes as cognitive decline, depression, sensory deficiency, urinary incontinence, weight loss, fall-related injuries, and difficulty moving around the house or outside [2]. Those who scored more than 3 points were tested to determine the physical functioning level [10]. Study participants who scored only 0–2 points or 4–5 points on the questionnaire and 10 points or more on the test for assessing the physical functioning level were classified as strong. Study participants who scored only 5 points or more or 4–5 points on the questionnaire and 7 points or less on the test for assessing the physical functioning level were assigned to the frailty category. Those who scored 4–5 points on the questionnaire and 8–9 points on the test for assessing the physical functioning level were assigned to the pre-frailty group.

II. Low autonomy

The Barthel index was used to determine of autonomy decline [11]. Study participants who scored less than 95 points were considered dependency for outside help.

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Additional covariates

The grip strength was assessed using a DK-50 mechanical hand dynamometer (Nizhniy Tagil Medical Instrumental Plant, Russia) in decanewtons (daN). Dynamometer DK-50 is registered in the State Register of Measuring Instruments with the No. 9817-85 and has a registration certificate No. FSR 2008/02239 as a medical equipment product. The measurements were conducted according to the protocol of the Groningen Fitness Test for the Elderly [8]. After obtaining the measurement data, muscle strength was converted from daN to kilograms (1 daN = 1.02 kg). A low grip strength was diagnosed when the grip strength decreased below the 90th centile, which is characteristic of persons of the same sex and age [12].

Low physical function levels were determined using the short physical performance battery (SPPB). The cut-off value was set as less than 8 points [2].

The cognitive function level was assessed using the Mini-Mental State Examination. The cut-off value was set as less than 24 points [2].

Emotional status was assessed using the Geriatric Depression Scale-15. Depression was diagnosed with a test score of 5 or more [2].

Data on comorbidities were collected based on study participant interviews and medical record analysis.

The Mini Nutritional Assessment was used to study the nutritional status. Study participants who scored less than 17.5 points were assigned to the malnutrition group, whereas those who scored 17–23.5 were assigned to the risk of malnutrition group. For those who scored more than 23.5 points, the normal nutritional status was registered [2].

The laboratory tests, including a general (clinical) blood test and C-reactive protein measurement, were used. Anemia was diagnosed when the hemoglobin level was lower than 120 g/L in women and lower than 130 g/L in men.

Statistical analyses. To assess intergroup differences, chi-square test, proportion comparison test, and Receiver Operating Characteristic (ROC) Curve Analysis were used to determine the sensitivity and specificity of diagnostic models for identifying older patients with autonomy decline. The kappa statistics coefficient was used to assess the inter-expert agreement for diagnostics of frailty using four models. Kappa statistics of 0.81–1 were considered to correspond to a high level of agreement, 0.61–0.80 to a good level, 0.41–0.60 to an average level, 0.21–0.40 to an insignificant level, and lower than 0.21 to a bad level. A *p*-value of 0.05 was considered a critical significance limit.

Basic statistical calculations were performed using the SPSS 26.0 (SPSS Inc., Chicago, IL, USA) and MedCalc 19.5.3 (MedCalc Software Ltd) programs.

Table 1. The prevalence of frailty using various frailty models

Таблица 1. Распространенность синдрома старческой астении при использовании различных моделей для ее диагностики

Participants' condition depending on the model applied	Total population (*n* = 611)
Age is not a blocking factor, *n* (%)	
No frailty symptoms	395 (65.0)
Pre-frailty	50 (8.2)
Frailty	163 (26.8)
Groningen Frailty Indicator, *n* (%)	
No frailty symptoms	261 (42.7)
Pre-frailty	151 (24.7)
Frailty	199 (32.6)
L. Fried model, *n* (%)	
No frailty symptoms	90 (15.5)
Pre-frailty	373 (64.1)
Frailty	119 (20.4)
SOF Frailty Index, *n* (%)	
No frailty symptoms	192 (28.5)
Pre-frailty	335 (54.9)
Frailty	83 (16.6)

Note. SOF, Study of Osteoporotic Fractures.

RESULTS OF THE STUDY

The prevalence of frailty in the population of the Crystal study participants varied, depending on the model applied for diagnosing frailty, from 16.6% (*n* = 83) in the case of the SOF Frailty Index phenotypic model to 32.6% (*n* = 199) in the case of the GFI of deficiency accumulation (Table 1). In general, when using the cumulative deficit models, the proportion of study participants with frailty was 12.7% higher than when using phenotype frailty models (95% CI: 8.0–17.3%) ($p < 0.0001$).

The largest number of study participants without signs of frailty was revealed when using the Age is not a blocking factor model (65.0%, *n* = 395), the smallest when using L. Fried's model (15.5%, *n* = 90).

The kappa statistics was maximum when using the cumulative deficit models, namely, the GFI and Age is not a blocking factor questionnaire, and amounted to 0.49 (95% CI 0.43–0.54), and it was the minimum (0.08) when using the the Age is not a blocking factor model and L. Fried model (95% CI 0.047–0.10). When comparing 2 phenotype models of frailty (L. Fried and SOF Frailty Index models), the kappa statistics was also low at only 0.18 (95% CI 0.15–0.21). The kappa statistics between the SOF Frailty Index and the GFI was 0.31 (95% CI 0.25–0.38), and between the SOF Frailty Index and the Age is not a blocking factor model was 0.21 (95% CI 0.16–0.26).

Clinical and demographic characteristics of study participants with and without frailty diagnosed using various frailty models

Frailty, regardless of the model used for diagnostics, was associated with an increase in the prevalence of the main geriatric syndromes, such as urinary incontinence, decreased hearing and vision loss, physical decline functioning level, malnutrition and the risk of malnutrition, cognitive decline functions, and the need dependency for outside help ($p < 0.05$). Regardless of the diagnostic model used, there were no statistically significant differences in the prevalence of chronic diseases and such geriatric syndromes as decreased cognitive functions, depression, decreased compression force, and difficulty in performing tasks due to decreased visual acuity or hearing in the presence of frailty (Table 2). There were also no differences in the prevalence of low physical function levels among study participants with frailty diagnosed using the SOF Frailty Index, the GFI, and L. Fried model ($p > 0.05$; Table 2). However, a low physical function level was registered significantly more often in patients with frailty diagnosed using the Age is not a blocking factor model than when applying other models ($p > 0.05$; Table 2). This is because one of the criteria for diagnosing frailty, according to this model, is a decrease in SPPB test scores lower than 8. Differences between the four models were revealed in the prevalence of malnutrition,

Table 2. Health characteristics of the study participants with frailty using various frailty models

Таблица 2. Клинико-демографические показатели участников исследования с синдромом старческой астении, диагностированным с использованием различных диагностических моделей

Parameters	Age is not a blocking factor (*n* = 163)	Groningen Frailty Indicator (*n* = 199)	L. Fried model (*n* = 119)	SOF Frailty Index (*n* = 83)
Age	78.1 ± 6.1	77.2 ± 6.3	76.7 ± 5.8	77.7 ± 5.7
Myocardial infarction, *n* (%)	23 (14.1)	18 (15.1)	18 (15.1)	18 (21.7)
Diabetes mellitus, *n* (%)	31 (19.0)	37 (18.6)	13 (10.9)	14 (16.9)
Atrial fibrillation, *n* (%)	59 (36.2)	74 (37.2)	39 (32.8)	21 (25.3)
New cases of atrial fibrillation, *n* (%)	13 (15.7)	13 (11.3)	6 (9.0)	4 (10.8)
Acute cerebrovascular accident, *n* (%)	30 (18.4)	36 (18.1)	24 (20.2)	19 (22.9)
Chronic obstructive pulmonary disease, *n* (%)	50 (30.7)	59 (29.6)	37 (31.1)	22 (26.5)
Cancer, *n* (%)	14 (3.5)	9 (4.5)	5 (4.2)	5 (6.0)
Barthel index < 95, *n* (%)	90 (55.2)	82 (41.2)	50 (42.0)	40 (48.2)
Urinary incontinence, *n* (%)	124 (76.1)*	122 (61.3)*	58 (48.7)	44 (53.0)
Hearing loss, *n* (%)	117 (71.8)	131 (65.8)	73 (61.3)	49 (59.0)
Difficulty performing daily routine tasks associated with hearing loss dependency, *n* (%)	70 (42.9)	85 (42.7)	42 (35.3)	26 (31.3)
Reduced vision loss, *n* (%)	154 (94.5)	187 (94.0)	108 (90.8)	75 (90.4)
Difficulty performing daily routine tasks associated with vision loss, *n* (%)	90 (55.2)	119 (59.8)	61 (51.3)	39 (47.0)
MNA ≤ 23.5, *n* (%)	67 (41.1)	70 (35.2)	42 (35.3)	52 (62.7)*
Anemia, *n* (%)	38 (23.6)	38 (19.3)	35 (29.4)*	29 (35.8)*
C-reactive protein > 5, *n* (%)	36 (24.5)	32 (18.7)	17 (15.9)	20 (26.0)
MMSE				
30–28, *n* (%)	34 (20.9)	32 (16.1)	21 (17.6)	10 (12.0)
27–24, *n* (%)	54 (33.1)	73 (36.7)	50 (42.0)	30 (36.1)
<23, *n* (%)	75 (46.0)	94 (47.2)	48 (40.3)	43 (51.8)
Subjective complaints about cognitive decline, *n* (%)	146 (89.6)*	171 (85.9)*	77 (64.7)	52 (62.7)
SPPB < 8, *n* (%)	154 (94.5)*	121 (60.8)	69 (58.0)	59 (71.1)
Low grip strength, *n* (%)	45 (53.6)	55 (48.2)	30 (44.8)	22 (59.5)
Depression, *n* (%)	129 (79.1)	149 (74.9)	85 (71.4)	67 (80.7)

Note. SOF, Study of Osteoporotic Fractures; MMSE, Mini-Mental State Examination; MNA, Mini Nutritional Assessment; SPPB, short physical performance battery. * $p < 0.05$.

anemia, urinary incontinence, and subjective complaints of cognitive decline (Table 2).

The prevalence of anemia was higher in patients with frailty diagnosed using the phenotype frailty models ($p > 0.05$). Among study participants with frailty who were identified using deficiency accumulation indices, urinary incontinence and subjective complaints of decreased cognitive functions were registered more often.

The highest incidence of malnutrition or the risk of malnutrition was revealed in patients with frailty diagnosed using the SOF Frailty Index ($p < 0.05$; Table 2). In this group, malnutrition was recorded 27.5% more often than when using the GFI (95% CI 14.7%–39.0%; $p < 0.0001$), 21.6% more often than when using the questionnaire Age is not a blocking factor model (95% CI 8.4–33.6; $p < 0.005$), and 27.4% more often than when using L. Fried model (95% CI 13.4%–40.0%; $p < 0.0001$; Table 2).

Sensitivity of diagnostic models for identifying the study participants with low autonomy

The GFI questionnaire had the greatest sensitivity in identifying participants with dependency on outside help in the study. Its sensitivity was 77.4% (95% CI 68.2–84.9), specificity 66.9% (95% CI 61.8–71.8), area under the curve (AUC) 0.72 (95% CI 0.69–0.76), positive predictive value (PPV) 41.2% (95% CI 36.9–45.6), and negative predictive value (NPV) 90.8% (95% CI 87.3–93.4). The lowest sensitivity for identifying research participants with autonomy decline was recorded for the L. Fried model. Its sensitivity was 70.4% (95% CI 58.4–80.7), specificity 10.4% (95% CI 4.6–19.5), AUC 0.40 (95% CI 0.32–0.49), PPV 42.0% (95% CI 38.0–56.4), and NPV 27.5% (95% CI 15.3%–44.6%). The sensitivity and specificity of the SOF Frailty Index, the Age is not a blocking factor model, and the GFI questionnaire were comparable ($p > 0.05$). The NPVs of the Age is not a blocking factor model and SOF Frailty Index were 86.5% (95% CI 83.9–88.9) and 89.6% (95% CI 85.7–92.5), respectively.

DISCUSSION

In our study, the prevalence of frailty, identified using phenotypic models, ranged from 16.6% to 20.4%, and it was 32.6% if identified using deficiency accumulation models, which was comparable to the data of other studies conducted in similar age and other characteristics of samples [13, 14]. Nevertheless, the prevalence of frailty diagnosed using all diagnostic approaches was higher in our study than in a study conducted in Moscow in 2014–2015 [5]. These differences are related to the fact that the Moscow study of frailty only considered patients who could independently consult a doctor at a polyclinic, whereas the Crystal study included patients who did not even leave the apartment.

The revealed differences in the prevalence of frailty diagnosed using deficiency accumulation models and phenotypic models are due to a different approach to diagnostics. The phenotype frailty models assess the physical function of the older adults, and according to the concept proposed by L. Fried, in this case, frailty may not be associated with the presence of concomitant chronic diseases or disability [6]. Deficiency accumulation models used in our study in frailty diagnostics, in addition to physical function, also consider such geriatric symptoms as urinary incontinence, sensory deficiency, decreased cognitive functions, and impaired depression status, as well as malnutrition and decreased functional status, which explains the higher prevalence of frailty in the application of this approach.

Frailty is associated with autonomy decline and a high risk of mortality in older adults. That is why to plan effectively the amount of medical care required for older patients, one should know not only the true prevalence of frailty but also the sensitivity of diagnostic tests to identify patients with various geriatric syndromes and autonomy decline. According to a review published at the end of 2020 and which included 5 systematic reviews, frailty, regardless of the diagnostic model used in the study, increases the probability of functional decline and the development of other geriatric syndromes, and also increases by 1.5–2 times the risk of all-cause mortality at 5-10 years follow-up among community dwelling older adults aged 65 years and over [15–17]. According to meta-analyses, frailty increases the risk of autonomy decline by 1.6–2.0 times, the risk of low physical function level and fall-related injuries associated with falling by 1.2–2.8 times, the risk of hospitalizations by 1.2–1.8 times, and the risk of developing dementia by 1.33 times [16, 17]. These data confirm the results of our study, which showed that frailty, regardless of the diagnostic model used, was associated with an increase in the prevalence of geriatric syndromes such as urinary incontinence, hearing loss, vision loss impairment, malnutrition, decreased cognitive function, depression, decreased low grip strength, and physical functioning level. At the same time, according to another meta-analysis, screening for frailty detection and development of an individual treatment and follow-up plan significantly reduce the number of total hospital bed days, decrease the risk of Hospital Readmission, mortality, and impairment of cognitive functions, and reduce of autonomy decline and risk of decreased physical functioning levels [18]. Accordingly, instruments with high sensitivity are required to detect quickly and accurately the signs of frailty and decrease in the functional status.

In this regard, it is worth mentioning the possibility of using these models to identify individuals with autonomy and cognitive decline. In our study, the GFI had the highest NPV for identifying participants with dependency (90.8%). The results obtained are most likely related to the fact

that the questionnaire itself contains six questions that allow identifying older patients who are unable to dress independently, go to the toilet, do shopping, and have difficulties in performing everyday tasks due to hearing and vision impairment [8]. However, it is important to note that the NPV of the Age is not a blocking factor and SOF Frailty Index models were also high at 86.5% and 89.6%, respectively, so that all 3 models can be used to identify older participants with low autonomy. In addition, according to the results of our early studies [7], older patients aged 65 years and older who are at risk of cognitive decline and depression development can be effectively identified using the L. Fried model [7].

Thus, any of these models can be used in the study population as a screening tool.

A possible limitation of our study is that within the framework of this work, the influence of the studied models on mortality and the prognosis of a decrease in cognitive functions, physical and autonomy decline was not assessed.

The strengths of this study consisted in the fact that we examined a random sample from a population of people over 65 years old who lived in one of the districts of St. Petersburg. The study involved even those patients who usually do not come to visit a doctor at a polyclinic, which enabled us to assess more objectively the capabilities of these models to detect patients with frailty, major geriatric syndromes, and low autonomy.

CONCLUSIONS

1. The prevalence of frailty diagnosed using phenotypic models ranged from 16.6% to 20.4%, and it was 32.6% if diagnosed using deficiency accumulation models.
2. The diagnostic models Age is not a blocking factor, SOF Frailty Index, and GFI have a high NPV (86%–90%); therefore, they can be used as screening tools for identifying persons with reduced functional status in the population who need low autonomy.
3. Regardless of the model used for diagnostics, frailty is closely associated with an increase in the frequency of major geriatric syndromes.

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