

Coexistence of frailty syndrome and the level of health behaviors in elderly patients with chronic obstructive pulmonary disease

Współwystępowanie zespołu kruchości a poziom zachowań zdrowotnych u pacjentów w podeszłym wieku z przewlekłą obturacyjną chorobą płuc

Anna Górka¹ , Katarzyna Szwamel² , Antonina Kaczorowska² , Agata Mroczek² , Mariusz Panczyk³ 

¹Women's Internal Medicine Department, Independent Public Healthcare Center, Kępno, Poland
Head of the Department: Ewa Łopińska MD

²Institute of Health Sciences, University of Opole, Opole, Poland
Head of the Institute: Prof. Henryk Kozłowski PhD

³Department of Education and Research in Health Sciences, Faculty of Health Science, Medical University of Warsaw, Warsaw, Poland
Head of the Department: Prof. Joanna Gotlib MD, PhD

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Słowa kluczowe: zachowania zdrowotne, starzenie się, przewlekła obturacyjna choroba płuc, zespół słabości.

Abstract

Introduction: The acceleration of the aging rate of the population, the associated risk of frailty syndrome and the increase in the number of people living with chronic obstructive pulmonary disease (COPD) mean that future health policy should focus on activities in the field of health promotion, enhancing health behavior, and maintaining or improving the functional fitness of aging people.

Aim of the research: To analyze the coexistence of frailty syndrome and the severity of health behaviors in elderly patients with COPD as well as established factors determining the severity of health behaviors.

Material and methods: A hundred COPD patients (mean age: 72.82 ±8.31 years) hospitalized in the Independent Public Healthcare Center in Kępno, Poland were examined. The COPD Assessment Test (CAT), mMRC Dyspnea Severity Scale, Tilburg Frailty Index (TFI), and Health Behavior Inventory were used.

Results: Ninety-two percent had frailty syndrome. The mean value of the TFI index was 9.31 ±2.97. A group of 53% had high intensity, 35% had average intensity, and 11% had low intensity of health behaviors. The strongest positive predictors of health behaviors were the presence of two or more chronic diseases in addition to COPD itself (β std = 0.42; $p < 0.001$) and higher results obtained on the CAT scale (β std = 0.38; $p < 0.001$). The severity of most health behaviors decreased with the duration of COPD, while the severity of health practices increased with age.

Conclusions: Health promotion and health education activities should be aimed at those COPD patients who have been ill for a long period of time as well as at younger patients.

Streszczenie

Wprowadzenie: Przyspieszenie tempa starzenia się populacji, związane z tym ryzyko występowania zespołu słabości oraz wzrost liczby osób żyjących z przewlekłą obturacyjną chorobą płuc (POChP) powodują, że przyszłe kierunki polityki zdrowotnej powinny się skupiać na działaniach z zakresu promocji zdrowia, potęgowaniu zachowań prozdrowotnych, utrzymaniu lub poprawie sprawności funkcjonalnej starzejących się ludzi.

Cel pracy: Analiza współwystępowania zespołu kruchości oraz nasilenia zachowań zdrowotnych u pacjentów w wieku podeszłym z POChP, jak również ustalenie czynników determinujących nasilenie zachowań zdrowotnych.

Materiał i metody: Zbadano 100 pacjentów z rozpoznaniem POChP (średnia wieku: 72,82 ±8,31 roku) hospitalizowanych w Samodzielnym Publicznym Zakładzie Opieki Zdrowotnej w Kępnie, Polska. Zastosowano *Test oceny POChP* (CAT), *Skalę nasilenia Dyspnea* mMRC, wskaźnik kruchości Tilburga (TFI), Inwentarz Zachowań Zdrowotnych.

Wyniki: Spośród 100 uczestników badania 92% miało zespół kruchości. Średnia wartość wskaźnika TFI wynosiła 9,31 ±2,97. W grupie 53% ankietowanych miało wysokie, 35% – przeciętne, a 11% – niskie nasilenie zachowań zdrowotnych. Najsilniejszymi predyktorami pozytywnymi zachowań zdrowotnych były: obecność dwóch lub większej liczby chorób przewlekłych poza samym POChP (β std = 0,42, $p < 0,001$) oraz wyższe wyniki uzyskane przez badanych w skali CAT (β std = 0,38, $p < 0,001$). Wraz z czasem trwania POChP zmniejszało się nasilenie większości zachowań zdrowotnych, natomiast wraz z wiekiem wzrastał poziom nasilenia praktyk zdrowotnych.

Wnioski: Działaniami z zakresu promocji zdrowia i edukacji zdrowotnej należy objąć szczególnie tych pacjentów z POChP, którzy chorują przez długi czas, jak również pacjentów młodszych.

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Introduction

Chronic obstructive pulmonary disease (COPD) is one of the most common diseases of the respiratory system in the 21st century and its main cause is smoking [1]. COPD is prevalent in the elderly population, with a high impact on their quality of life, morbidity, and mortality [2]. According to the World Health Organization (WHO) COPD caused 3.23 million deaths in 2019 and is the third leading cause of death worldwide [3]. Data from 65 countries published showed that in 2019 the global prevalence of COPD among people aged 30–79 years was between 7.6% and 10.3%, which translates to 292.0 to 391.9 million sick people [1]. Other data obtained using Geographic Information System maps show that the global prevalence of COPD is 13.1%. The mean prevalence of COPD was estimated at 12.4% in Europe, 13.9% in Africa, 13.2% in America, 13.5% in Asia and 11.6% in Oceania [4]. It is estimated that about 2 million people in Poland suffer from COPD [5]. The peak incidence of COPD is at the age of 65+. The COPD incidence rate for men living in Poland is 929.1/100 thousand, and for women 513.6/100 thousand [6]. Many global studies partially confirm the greater prevalence of COPD among men, although data from developed countries more and more often show equal numbers of women and men. This is likely a reflection of changing smoking patterns – in the past it was mostly men who smoked cigarettes. Currently, in countries such as the USA, Sweden and Denmark, the number of women smoking is increasing [7].

Chronic obstructive pulmonary disease (COPD) is a devastating lung disease. In COPD there is overproduction of mucus, restriction of airflow through the respiratory tract due to obstruction of bronchi and bronchioles, pulmonary distension and emphysema, gas exchange disturbances and, consequently, the development of pulmonary hypertension [8]. In addition to lung dysfunction, COPD patients, especially the elderly, have systemic comorbidities including asthma, diabetes, cardiovascular disease (cardiac arrhythmias, hypertension, ischemic heart disease), anxiety, depression, cognitive impairment, sarcopenia and frailty [7, 9–11].

The progressive aging process of the human body increases the risk of the so-called frailty syndrome (FS), weakness or exhaustion of reserves [12, 13]. Frailty has been defined as a complex clinical syndrome associated with vulnerability to adverse health outcomes [11]. According to the WHO, frailty is “a clinically recognizable state in which the ability of older people to cope with everyday or acute stressors is compromised by an increased vulnerability brought by age-associated declines in physiological reserve and function across multiple organ systems” [14]. The best known concept is so-called physical frailty, which includes such patient features as: unintentional weight loss (10 lbs in the past year), self-reported exhaustion,

weakness (grip strength), slow walking speed, and low physical activity [15]. The available literature also includes the concepts of psychosocial frailty, cognitive frailty and nutritional frailty [16]. Despite the fact that no single universal definition of frailty has been developed so far, many authors agree that the frailty syndrome increases the risk of disability, institutionalization and death [17, 18]. According to Uchmanowicz *et al.*, adverse outcomes of frailty are patient rehospitalization, level of self-care, mortality, patient morbidity, and deterioration of patients’ quality of life [19, 20]. Lahousse *et al.* claim that COPD is associated with frailty. These authors suggest that frailty – in addition to COPD severity and comorbidities – identifies those COPD patients at high risk of mortality [21]. A positive aspect is the fact that this syndrome is considered to be a dynamic process with frequent transitional stages (pre-frail, frailty, complications of frailty syndrome) that can be modified [16, 22, 23].

In the face of an aging society, the WHO gives priority to preventing the occurrence of the frailty syndrome, adapting health care to the difficulties of old age and maintaining independence. It becomes extremely important to initiate preventive and intervention measures both in the frailty syndrome and in the preceding condition as early as possible, and they consist of many elements that should be encouraged. It is important for healthcare professionals to communicate the most important behavioral information that can reduce the risk of FS. The first element that seniors should remember is to follow the principles of healthy eating, taking into account the consumption of protein-containing products, where the daily consumption for the elderly is 1.2–1.5 g/kg body weight, which reduces the emergence of problems resulting from age, namely sarcopenia or osteoporosis. It is also worth taking care of the presence of whole grains as well as fruit and vegetables. Additionally, the diet should be varied to prevent nutrient deficiencies [24]. Then, a key role is also played by daily physical activity, which can be carried out in the form of walks, bicycle trips or even social meetings. Elderly people, in addition to the aforementioned aerobic exercises, are also recommended to perform strength and stretching training, which has a positive effect on increasing strength and muscle mass. Additionally, gymnastics allows one to maintain physiological ranges of motion, which ensures proper body posture and movement [25]. The next steps are mainly related to monitoring one’s health by avoiding the occurrence of infections [26].

The acceleration of the aging rate of the population, the associated risk of the frailty syndrome and the increase in the number of people with COPD mean that future health policy directions should focus on activities in the field of health promotion, enhancing health behaviors, and maintaining or improving the functional fitness of elderly people.

Aim of the research

The main aims of the study were to: (1) analyze the coexistence of the frailty syndrome and the severity of health behaviors in elderly patients with chronic obstructive pulmonary disease, as well as (2) determine factors determining the severity of health behaviors in these patients.

Material and methods

Study design and setting

The research was carried out at the Independent Public Healthcare Institution in Kępno, in the Women's Internal Medicine Division and Men's Internal Medicine Division in the period from September 2020 to March 2021. The study was conducted in accordance with the principles of the Helsinki Declaration. The research was approved in writing by the director of the facility as well as the Bioethics Committee at Opole Medical School (approval number 58/PI/2020). The guidelines of STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) were followed.

Participants

In our study, we used a non-probabilistic sampling method. The available data show that the number of hospitalizations in Poland due to COPD (J43, J44) is approximately 43,134 annually. These hospitalizations are generated by 35,957 patients, of whom 86% (30,923) are people over 65 [27]. With a confidence level of 95%, a margin of error of 5%, $p = 50\%$, the minimum study sample was set at 384 subjects. The criteria for including participants in the study were: over 60 years of age, logical contact with the patient, hospitalization at the Independent Public Healthcare Center in Kępno in the Internal Medicine Department, diagnosed chronic obstructive pulmonary disease and consent to the study by the participant. Patients not meeting the above criteria were excluded from the study. Initially, 147 patients hospitalized in the internal medicine ward during the study period consented to participate in the study. When completing the questionnaires, 12 patients reported problems with seeing the text, 15 questionnaires were not returned by the patients and 20 were filled in incorrectly. Ultimately, the questionnaires obtained from 100 respondents were analyzed.

Data sources/measurement

The study was carried out by the method of a diagnostic survey, using the questionnaire technique, using the questionnaires described below.

The COPD Assessment Test (CAT) is a short, patient-administered questionnaire that was developed for comprehensive assessment of the severity of COPD

through individual analysis of the factors affecting the deterioration of the patient's health. The elements to be assessed are symptoms such as coughing, sputum retention, chest tightness and shortness of breath, as well as performing simple everyday activities, feeling safe outside the home environment, sleep quality and the patient's energy to act. Patients rate the symptoms of COPD in the range of 0 to 5 points, where 0 to 10 points indicates a mild clinical impact, 11 to 20 points indicates a moderate clinical impact, 21–30 points indicates a severe clinical impact and 31–40 points indicates a very severe clinical impact. The CAT test can also be used to easily estimate the risk of disease exacerbation [28–31].

The Modified Medical Research Council scale (mMRC) is a self-rating tool to measure the degree of disability that breathlessness imposes on day-to-day activities on a scale from 0 to 4. Symptoms occurring in the current situation are analyzed and they influence the patient's dyspnea level. Elements such as strenuous exercise, brisk walking, walking pace and dyspnea at rest are taken into account. The determination of one of the five given grades by the participants of the study allows for the interpretation of the result, where 0 suggests the presence of dyspnea during the period of intense exercise, and 4 means the presence of dyspnea at rest [28, 29].

The Tilburg Frailty Indicator (TFI) is a standardized research tool for assessment of the frailty syndrome. The original version was developed by Dr. Robbert JJ Gobbens [32], while the Polish adaptation was made by Dr. hab. Izabella Uchmanowicz [33]. The analysis includes two parts – the first relates to socio-demographic factors, while the second relates to the characteristic features of fragility. In addition, the second part includes an assessment of physical as well as mental and social determinants. Patients answering 8 questions in the field of physical health provide useful information on, among other things, the occurrence of visual, hearing and walking difficulties (0–8 points). The next 4 questions concern the psychological domain, where the presence of memory problems, low mood, nervousness and the ability to cope with problems can be determined (0–4 points). The last component is a social domain with 3 questions about relationships and social support, as well as living alone (0–3 points). The described second part of the frailty index contains eleven items, where the answer is “yes” or “no”, while in the remaining four questions the categories of answers are “yes”, “no” or “sometimes”. If you answer in the affirmative, i.e. “yes” or “sometimes”, you get 1 point, while answering “no” will give you 0 points. The score for total frailty ranges from 0 to 15 and an individual is considered frail if the total TFI score is five or higher. The maximum scores refer to the highest level of frailty. The TFI is valid and reproducible for assessment of frailty syndrome among a Polish population.

Cronbach's α reliability coefficients of the instrument ranged from 0.68 to 0.72 [32, 33].

The Health Behavior Inventory (HBI) is a tool by Zygryd Juczyński. The analysis covers 24 statements which can be used to determine the level of health behaviors undertaken by patients. They are assessed in four categories, i.e. proper eating habits, health practices, positive mental attitude and preventive behavior undertaken. Health behavior analysis is based on a five-point scale. For each of the 24 statements, the participants write down the appropriate number of points denoting the frequency of performing specific health-shaping activities, where 1 point means "almost never", and 5 points means "almost always". The result ranges from 24 to 120 points, and the higher the sum of points, the greater the intensity of the undertaken health behaviors. Additionally, they are also calculated for each of the four categories of activities undertaken by calculating the average number of points in a given group. Results in sten 1–4 mean low, results in sten 5–6 average, and results in sten 7–10 mean high intensity of health behaviors [34].

The authors' self-prepared questionnaire included questions about sociodemographic and health data (Table 1). We also asked our patients about their self-assessment of their knowledge of COPD. We constructed this question on the basis of a five-point Likert scale (possible answers "very bad", "bad", "average", "good", "very good").

Statistical analysis

For the analysis of quantitative variables, the mean, standard deviation, median and quartiles were calculated. In turn, the analysis of qualitative variables was carried out by calculating the number and percentage of occurrences of each value. The comparison of the values of quantitative variables in two groups was performed using the Mann-Whitney test. The comparison of the values of quantitative variables in three or more groups was performed using the Kruskal-Wallis test. If statistically significant differences were detected, post-hoc analysis was performed using Dunn's test to identify statistically significantly different groups. Correlations between quantitative variables were analyzed using Spearman's rank correlation. A significance level of 0.05 was adopted in the analysis; therefore all p -values below 0.05 were interpreted as showing significant relationships. The analysis was performed in the R software, version 4.0.5.

A multivariate linear regression model with stepwise progressive input of predictors into the model was tested. The factors that influence the intensity of pro-health behaviors to the greatest extent were searched for. The estimation of the regression model parameters was performed using the least squares method. The validation of the model parameters was tested on a 10-fold cross-validation. Standardized re-

gression coefficients (β std) were determined together with 95% confidence intervals (CI).

Results

Participants

The mean age of the participants was 72.82 (SD = 8.31). More than half of the respondents were men (53%), married persons constituted 59%, those with primary education 78%. The mean duration of COPD was 10.32 years (SD = 6.08). The mean number of COPD exacerbations in the last 12 months was 2.18 (SD = 0.83). The number of hospitalizations in the last 12 months was 1.49 (SD = 0.72). The mean duration of cigarette smoking was 32.59 years (SD = 8.27). The number of drugs/pills taken permanently daily was 4.06 (SD = 1.62). The largest percentage of respondents, 42%, had 2 mMRC dyspnea, and the smallest, 8%, had grade 4. According to the CAT questionnaire, the largest group of respondents, 47%, had severe symptoms, and the smallest group, 9%, had mild COPD symptoms (Table 1). A group of 46% rated their knowledge of COPD as "good", 38% as "average", 14% as "bad" and only 2% as "very good".

Data relating to frailty syndrome

Ninety-two (92%) out of 100 participants had the frailty syndrome. The TFI total mean score was 9.31. Detailed data on the occurrence of the frailty syndrome are presented in Table 2.

Health behaviors level

The group of 53% of respondents had high intensity, 36% had medium intensity and 11% had low intensity of health behaviors. The highest mean value was obtained for the indicator of positive mental attitude (3.91 ± 0.35). The lowest average index was related to proper eating habits (3.09 ± 0.71) (Table 3).

Determinants of health behaviors undertaken by elderly people with COPD and frailty syndrome

The patient's age was significantly positively correlated with health practices, so the older the age, the higher was the level of health practices ($p < 0.001$). Duration of the disease significantly and negatively correlated with general health behaviors ($p = 0.013$), proper eating habits ($p = 0.006$), preventive behaviors ($p = 0.003$) and positive mental attitude ($p < 0.001$), so the longer the disease lasted, the lower was the intensity of this type of behavior. The CAT test correlated positively with each type of health behavior, so the greater the severity of symptoms, the greater the severity of each type of behavior. The overall result of TFI significantly negatively correlated with the general index of health behaviors ($p = 0.009$), proper eat-

Table 1. Descriptive characteristics of the participants (sociodemographic and clinical) ($n = 100$)

Variables		<i>n</i>	%
Gender	Male	53	53
	Female	46	46
	No data	1	1
Age [years]	55–60	1	1
	61–65	25	25
	66–70	16	16
	71–75	17	17
	76–80	20	20
	81–85	14	14
	86–90	7	7
Marital status	Married	59	59
	Unmarried	3	3
	Separated/divorced	0	0
	Widower	38	38
Education	Primary	78	78
	Secondary/vocational	22	22
	University	0	0
Socioeconomic status	Very bad	1	1
	Low	1	1
	Middle	24	24
	Upper-middle	72	72
	Upper	2	2
Household income in PLN	≤ 600 PLN	0	0
	601–900 PLN	1	1
	901–1200 PLN	7	7
	1201–1500 PLN	4	4
	1501–1800 PLN	10	10
	1801–2100 PLN	23	23
	> 2101 PLN	55	55
Clinical data on the state of health			
Symptoms with COPD*		<i>n</i>	%
	Cough	66	66
	Mucus (sputum) production	39	39
	Breathing difficulty	95	95
	Chest tightness	67	67
	Wheezing	58	58
mMRC (Modified Medical Research Council) Dyspnea Scale	mMRC 0	10	10
	mMRC 1	24	24
	mMRC 2	42	42
	mMRC 3	16	16
	mMRC 4	8	8
CAT Test	Mild clinical impact (0–10 points)	9	9
	Moderate clinical impact (11–20 points)	28	28
	Severe clinical impact (21–30 points)	47	47
	Very severe clinical impact (31–40 points)	16	16

Table 1. Cont.

Variables		<i>n</i>	%
COPD duration [years]	0–5	23	23
	6–10	47	47
	11–15	16	16
	16–20	8	8
	21–25	2	2
	26–30	4	4
Smoker	Yes	27	27
	No	73	73
Number of cigarette packets smoked per day	Less than a pack a day	20	74
	1-2 packages a day		
	More than 2 packages a day		
	1–2 packets a day	7	26
	More than 2 packets a day	0	0
Smoking duration [years]	7	1	4
	20	1	4
	25	2	7
	28	1	4
	30	10	37
	35	4	15
	40	5	19
	45	3	11
Number of COPD exacerbation episodes during 12 months	1	23	23
	2	40	40
	3	33	33
	4	4	4
Number of hospitalizations in the last 12 months	0	1	1
	1	59	59
	2	29	29
	3	9	9
	4	1	1
	Not reported	1	1
Contact with chemicals and dust at work	Yes	18	18
	No	80	80
	Not reported	2	2
Chronic diseases	Hypertension	71	71
	Diabetes	28	28
	Coronary artery disease	35	35
	Diseases of the thyroid gland	12	12
	Osteoporosis	5	5
	Depression	5	5
	Other	5	5
BMI [kg/m ²]	Normal 18.5–24.99	21	21
	Overweight 25.0–29.99	48	48
	Class 1 obesity 30.0–34.99	29	29
	Class 2 obesity 35.0–39.99	2	2

**Percentages do not add up to 100 as it was a multiple choice question.

Table 2. Frailty syndrome data

TFI – number of points		Interpretation		n	%				
0–4		No frailty syndrome		5	5				
5 and more		Frailty syndrome		92	92				
–		Missing data		3	3				
Tilburg Frailty Indicator	Value range	N	Missing data	M	SD	Mdn	Min.	Max.	Q3
TFI total score	0–15	97	3	9.31	2.97	9	3	14	12
TFI: physical domain	0–8	98	2	3.72	2.02	4	0	7	5
TFI: psychological domain	0–4	99	1	2.88	1.11	3	0	4	4
TFI: social domain	0–3	100	0	2.7	0.7	3	0	3	3

M – mean, *SD* – standard deviation, *Mdn* – median, *Q1* – first quartile, *Q3* – third quartile, *min.* – minimum, *max.* – maximum, *TFI* – Tilburg Frailty Indicator.

Table 3. Health behaviors of the respondents

HBI – number of points		Interpretation		n	%				
Female	Male								
24–77	24–71	Low		11	11				
78–91	72–86	Medium		36	36				
92–120	87–120	High		53	53				
Health Behavior Inventory (HBI)	N	M	SD	Mdn	Min.	Max.	Q1	Q3	
Proper eating habits (PEH)	100	3.09	0.71	3	1.33	4.67	2.67	3.67	
Preventive behavior (PB)	100	3.89	0.57	4	2.67	4.83	3.5	4.33	
Positive mental attitude (PMA)	100	3.91	0.35	4	3	4.5	3.67	4.17	
Health practices (HP)	100	3.75	0.46	3.83	2.67	4.67	3.5	4.04	

M – mean, *SD* – standard deviation, *Mdn* – median, *Q1* – first quartile, *Q3* – third quartile.

Table 4. Correlation coefficients between health behaviors and selected variables

The Health Behavior Inventory (HBI)	Duration of COPD	Age	CAT	TFI's overall result
Overall result HBI	$r = -0.248, p = 0.013^*$	$r = 0.121, p = 0.229$	$r = 0.573, p < 0.001^*$	$r = -0.264, p = 0.009^*$
Proper eating habits (PEH)	$r = -0.271, p = 0.006^*$	$r = 0.046, p = 0.647$	$r = 0.561, p < 0.001^*$	$r = -0.224, p = 0.028^*$
Preventive behavior (PB)	$r = -0.297, p = 0.003^*$	$r = 0.073, p = 0.471$	$r = 0.546, p < 0.001^*$	$r = -0.199, p = 0.051$
Positive mental attitude (PMA)	$r = -0.384, p < 0.001^*$	$r = -0.024, p = 0.81$	$r = 0.293, p = 0.003^*$	$r = 0.022, p = 0.829$
Health practices (HP)	$r = 0.046, p = 0.649$	$r = 0.359, p < 0.001^*$	$r = 0.479, p < 0.001^*$	$r = -0.476, p < 0.001^*$

r – Spearman's correlation coefficient, *CAT* – COPD Assessment Test, *TFI* – Tilburg Frailty Indicator.

ing habits ($p = 0.028$) and health practices ($p < 0.001$), so the greater the severity of the frailty syndrome, the lower the severity of this type of behavior (Table 4).

Next, it was decided to investigate how the individual COPD symptoms affect health behavior. Sputum expectorants had a significantly higher overall HBI ($p = 0.031$) and proper eating habits ($p = 0.024$) compared to those who did not expectorate. Patients

who experienced wheezing had a higher overall index of health behaviors ($p < 0.001$), preventive behaviors ($p < 0.001$), health practices ($p = 0.001$), and proper eating habits ($p < 0.001$). All types of health behaviors were significantly more pronounced in those who experienced cough ($p \leq 0.05$) and those who experienced dyspnea ($p \leq 0.05$) (Table 5). The general index of health behaviors was significantly more pro-

Table 5. Health behaviors and COPD symptoms

Health Behavior Inventory	Cough		P-value	Coughing up phlegm		P-value	Dyspnea		P-value	Chest tightness		P-value	Wheezing		P-value
	No (N = 34)	Yes (N = 66)		No (N = 61)	Yes (N = 39)		No (N = 5)	Yes (N = 95)		No (N = 33)	Yes (N = 67)		No (N = 42)	Yes (N = 58)	
HBI	M ± SD 80.68 ±10.33	91.47 ±9.38	< 0.001*	85.78 ±11.3	90.97 ±9.67	0.031*	72.6 ±5.41	88.6 ±10.58	0.003*	88.36 ±9.81	87.53 ±11.52	0.953	82.63 ±10.39	91.55 ±9.81	< 0.001*
	Mdn	93		87	93		73	90		87	90.55		81.5	93	
	Q1–Q3	73.25– 88.75	86.25– 97.75	78.26– 95	86– 96.5		71–74	81.5– 96		82–98	79–95		77.25–89	88.25– 97.75	
PEH	M ± SD 2.57 ±0.56	3.36 ±0.63	< 0.001*	2.96 ±0.7	3.3 ±0.69	0.024*	2.33 ±0.37	3.13 ±0.71	0.013*	3.16 ±0.69	3.06 ±0.73	0.427	2.74 ±0.67	3.34 ±0.64	< 0.001*
	Mdn	2.58	3.5	3	3.33		2.33	3		3.33	3		2.73	3.5	
	Q1–Q3	2.17– 2.83	3–3.67	2.5–3.5	2.83– 3.83		2.17– 2.5	2.67– 3.67		2.83– 3.67	2.5– 3.67		2.17–30	2.83– 3.67	
PB	M ± SD 3.53 ±0.56	4.07 ±0.49	< 0.001*	3.79 ±0.62	4.03 ±0.46	0.053	3.13 ±0.36	3.92 ±0.55	0.004*	3.94 ±0.52	3.86 ±0.59	0.614	3.6 ±0.53	4.09 ±0.5	< 0.001*
	Mdn	3.5	4.17	3.83	4.17		3.17	4		3.83	4		3.67	4.17	
	Q1–Q3	3.17– 3.83	3.83–4.5	3.33– 4.33	3.75– 4.42		3–3.17	3.5– 4.42		3.67– 4.5	3.33– 4.25		3.21– 3.83	4–4.5	
PMA	M ± SD 3.77 ±0.41	3.98 ±0.29	0.016*	3.85 ±0.38	4 ±0.28	0.054	3.53 ±0.18	3.93 ±0.35	0.008*	3.91 ±0.3	3.91 ±0.37	0.702	3.85 ±0.35	3.95 ±0.35	0.062
	Mdn	3.83	4	3.83	4		3.67	4		3.83	4		3.83	4	
	Q1–Q3	3.38–4 4.17	3.83– 4.17	3.67– 4.17	3.83– 4.17		3.33– 3.67	3.82– 4.17		3.67– 4.17	3.67– 4.17		3.67– 4.12	3.83– 4.17	
HP	M ± SD 3.58 ±0.44	3.83 ±0.45	0.005*	3.7 ±0.44	3.82 ±0.49	0.142	3.1 ±0.35	3.78 ±0.44	0.004*	3.71 ±0.41	3.77 ±0.49	0.376	3.58 ±0.45	3.86 ±0.44	0.001*
	Mdn	3.67	4	3.83	3.83		3.17	3.83		3.83	3.83		3.67	4	
	Q1–Q3	3.33 –3.83	3.67– 4.17	3.33–4 4.17	3.67– 4.17		2.83– 3.33	3.5– 4.17		3.5–4	3.5– 4.17		3.33–4	3.67– 4.17	

M – mean, SD – standard deviation, Mdn – median, Q1 – first quartile, Q3 – p – Mann-Whitney test *statistically significant relationship (p < 0.05). HBI – general indicator of health behaviors, PEH – proper eating habits, PB – preventive behavior, PMA – positive mental attitude, HP – health practices.

Table 6. Regression model for the severity of health-related behaviors in patients with COPD and frailty syndrome

Variable	Level	<i>b</i>	<i>β</i> std	–95% CI	+95% CI	<i>t</i>	<i>P</i> -value
Intercept		9.38				5.031	< 0.001
Smoking		–1.91	–0.48	–0.62	–0.34	–6.816	< 0.001
Presence of 2 or more chronic diseases in addition to COPD		2.08	0.42	0.21	0.63	3.910	< 0.001
SUM_CAT		0.18	0.38	0.23	0.53	5.023	< 0.001
Independence in activities		0.59	0.16	0.01	0.30	2.133	0.036
Gender	F (ref.)						
	M	0.84	0.24	0.11	0.36	3.825	< 0.001
Treatment for other chronic diseases		–2.15	–0.39	–0.60	–0.18	–3.729	< 0.001
Level of knowledge about COPD	Low (ref.)						
	Medium	–0.28	–0.05	–0.18	0.07	–0.847	0.399
	High	1.03	0.21	0.06	0.35	2.749	0.007
BMI		–0.16	–0.16	–0.30	–0.02	–2.290	0.024
Education	P (ref.)						
	S	0.71	0.17	0.03	0.31	2.380	0.019

*β*std – standardized regression coefficient, 95% CI – confidence interval, *p* – statistical significance, CAT – COPD Assessment Test, BMI – body mass index, F – female, M – male, P – primary education, S – secondary education.

nounced in subjects with degrees of dyspnea 0 and 3 than in subjects with degree 2 on the mMRC scale ($p = 0.011$). Proper eating habits were more pronounced in subjects with grade 3 than in subjects with grades 2 and 4 ($p = 0.017$). Preventive behaviors were significantly more intense than in subjects with grade 0, 1 and 3 than in subjects with grade 2 ($p = 0.005$). Health practices were significantly more intense in subjects with grades 3 and 4 than in subjects with grades 1 and 2 ($p = 0.005$).

Regression analysis for health behaviors

The model is statistically significant $F_{(10,89)} = 18.529$, $p < 0.001$, explains a total of nearly 64% ($R^2_{skoryg} = 0.639$) of the variance of the dependent variable (severity of health behaviors) with a standard estimation error of 2.14.

The strongest positive predictors were the presence of two or more chronic diseases in addition to COPD and higher results obtained by the subjects on the CAT. On the other hand, the strongest negative predictors were smoking and the need for treatment due to other chronic diseases (Table 6).

Discussion

COPD is a significant threat to the health of the community and is one of the major health problems in Poland and in the world. The key role in improving the health condition of the population in this re-

gard is prevention and health promotion. Therefore, the priority is to know the risk factors and eliminate them, as well as to develop proper habits regarding a healthy lifestyle. It is also becoming important to encourage health behaviors, which makes it possible to limit the number of exacerbations and the progression of the disease. It is of particular importance in the case of elderly people, most of whom show exhaustion of physiological reserves, and consequently, difficulties in functioning in everyday life [35].

Analysis of the coexistence of the frailty syndrome in patients with COPD

One of the goals of our study was to analyze the coexistence of the frailty syndrome in elderly patients with COPD. We found that the percentage of people with the frailty syndrome was high, 92%. The overall TFI score correlated significantly negatively with the general index of health behaviors, proper eating habits and health practices. Thus, it can be concluded that the greater the severity of the frailty syndrome is, the lower is the severity of health-related behaviors.

The studies available in the literature confirm the prevalence of the frailty syndrome among seniors with COPD, but the percentage of frail people in the studies varies. Thus, Kennedy *et al.* used the Conceptual Model of the Fried Frailty Phenotype to define frail persons among COPD patients. In this group only 6% of patients were frail and 60.5% pre-frail [36]. In a Korean study, 35.5% of COPD patients were frail

and 37.4% pre-frail, while the significant predictors of frailty were the stage of COPD and the perceived pain and discomfort [37]. Zhang *et al.* examined the prevalence of the frailty syndrome using several scales in seniors ($n = 302$, Me = 69 years) with stable COPD. The percentage of frail subjects ranged from 51% to 64.2% depending on the scale used. The frailty syndrome in this study was significantly associated with older age, more comorbidities, worse functional status, and more COPD symptoms as measured by CAT or mMRC [38]. In a study by Luo *et al.* using the Fried Frailty Phenotype, the percentage of frail subjects was 49.8%. The frailty syndrome contributed to more frequent occurrence of acute exacerbations of COPD and more frequent hospitalizations of the respondents during the year [39]. In turn, Kusonose *et al.* assessed the incidence of frailty in patients with stable COPD using the Total Kihon Checklist Score. Here, the frail percentage was 21.5% and the pre-frail 30.4%. Frailty was significantly correlated with patient-reported outcomes [40]. The Polish authors Uchmanowicz *et al.* examined the prevalence of the frailty syndrome in elderly COPD patients using the same scale that we used in our own study, namely the Tilburg Frailty Indicator (TFI). The frailty syndrome was found in 75.5% of respondents [41]. In a Spanish study of patients hospitalized for acute exacerbations of COPD, the frailty syndrome was measured using the Reported Edmonton Frail Scale (REFS). Mild frailty was found in 19.4% of the respondents, moderate frailty in 17.5% and severe frailty in 18.4%. Participants with moderate-to-severe frailty at hospital admission had significantly more exacerbations in the previous year, a higher comorbidity burden, worse respiratory disability (MRC) and a higher number of dependencies [42]. A Brazilian study assessed the incidence of frailty through the Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight (FRAIL) scale. The prevalence of frailty and pre-frailty among the subjects enrolled was 50.3% and 35.3% respectively. Frailty scores were correlated with CAT and MRC [43]. As can be concluded from the above, the percentages of people with the frailty syndrome among COPD patients differ from study to study, which is most likely due to the methodology of the study, i.e. the scale used in the study. It should be noted, however, that in our study we obtained a result similar to the Uchmanowicz study conducted in the Polish population using the same tool. It is also worth paying attention to the fact that the TFI tool can only be used to determine the presence of the frailty syndrome; it does not give the possibility to determine the pre-frailty state. However, TFI is the best screening instrument to use in public health because of the multidimensional structure, being quick and easy to use, and accurate risk prediction of adverse outcomes of frailty [44]. Therefore, we decided to use this tool in our study.

The level of health behaviors in elderly patients with chronic obstructive disease and frailty syndrome

The next goal of our research was to evaluate and analyze the severity of health behaviors in elderly patients with COPD. When assessing the undertaken health behaviors, the activities in the field of health practices, including habits related to physical activity, recreation or sleep, as well as weight control and restriction of tobacco smoking, were taken into account. Another element was prophylactic behavior, which included obtaining information about health and disease, regular medical examination and compliance with medical recommendations. On the other hand, with reference to proper eating habits, the type of consumed food was verified. Positive mental attitude, on the other hand, included an analysis of avoiding such negative feelings as anger, anxiety, depression, avoiding too strong emotions and tensions as well as positive thinking and leading a regulated family life [34]. High intensity of health behaviors was found in 53% of respondents, average in 36% and low in 11%. The highest score was obtained in the category of positive mental attitude, 3.91, and preventive behavior, 3.89, and the lowest in the category of proper eating habits, 3.09. The patient's age was significantly positively correlated with health practices, so the older the age was, the higher was the level of proper health practices. Kropornicka *et al.*, who examined 100 people with COPD using HBI, obtained similar results as in their own research regarding positive mental attitude as much as regarding proper eating habits. In the studied group, positive mental attitude was rated the highest (4.34), while the lowest results were obtained in terms of proper eating habits (3.94) [45]. In our group positive mental attitude also was rated the highest (3.91) and proper eating habits was rated the lowest (3.09). In the study by Grochowska *et al.*, patients with COPD presented a moderate level of health behavior. The respondents assessed different areas of health-related behaviors differently than in their own research. They cared most about proper eating habits and disease prevention, and the least about health practices, i.e. their lifestyle. Smokers showed worse health behaviors in comparison to non-smokers, which is confirmed by the results of our own research [46].

Factors determining the severity of health behaviors

One of the key results obtained by us was the fact that the longer patients had COPD, the lower was the severity of most health-related behaviors. This result is surprising. In principle, it can be assumed that with increasing duration of the disease, patients should have greater knowledge about it and greater self-awareness of the importance of pro-health behav-

iors and should demonstrate a higher level of self-care, especially since COPD is a chronic disease of a progressive nature. Meanwhile, in our study, we obtained the opposite result. It calls for health promotion and pro-health education, especially for those long-term COPD patients.

In our study, we obtained another interesting result. Using correlation analysis, we found that the greater the severity of COPD-related symptoms was, the higher was the severity of each type of health behavior. The CAT test correlated positively with each type of health behavior. It is likely that increased severity of COPD symptoms, such as coughing, sputum retention, chest tightness and shortness of breath, as well as difficulties in performing daily activities, poorer sleep quality and less energy to act, motivate the patient to engage in health-related behaviors. Especially coughing and feeling short of breath, as well as wheezing, had a positive effect on health behaviors. Regression analysis confirmed that the results obtained by the respondents on the CAT scale were a strong positive predictor of health behaviors. We also found that the strongest positive predictor of the severity of health-related behaviors was the presence of two or more chronic diseases (apart from COPD itself). Presumably, such positive behavior of a patient with multiple diseases may result from his fear for his own life and health. On the other hand, the strongest negative predictors of the severity of health-related behaviors were smoking and the need for treatment due to other chronic diseases.

Generalisability

COPD is a significant health problem both in Poland and in the world, and its monitoring indicates a clear increase in incidence. Therefore, the priority is to improve health by developing proper habits related to a healthy lifestyle. An important role in this respect is to engage in pro-health behaviors, especially in the elderly with coexisting frailty syndrome, because such action may lead to a reduction in the number of exacerbations and the progression of the disease.

Limitations of the study

The study was somewhat limited by the small sample size and the fact that all patients were recruited from one hospital. However, it should be noted that the research was conducted during the difficult period of the COVID-19 pandemic. In turn, the strength of the study is the use of as many as five research tools, including 4 standardized tools, as well as conducting a regression analysis in relation to health-related behaviors. The above actions certainly contribute to greater objectivity of the obtained results. In the future, we are planning a similar multicenter study on a larger group of COPD patients.

Conclusions

The vast majority of elderly patients with COPD also have coexisting frailty syndrome. The greater the severity of frailty syndrome, the lower was the severity of health-related behaviors. Therefore, these patients require special support from healthcare professionals in order to prevent flare-ups. The severity of most health behaviors decreased with the duration of COPD, while the severity of health practices increased with age. Therefore, there is a need to extend activities in the field of health promotion and health education, especially to those patients with COPD who are ill for a long period of time, as well as younger patients. Awareness of the presence of two or more chronic diseases in addition to COPD itself, and a greater severity of COPD-related symptoms, as reflected in higher scores on the CAT scale, turned out to be the strongest positive predictors of health-related behavior.

Conflict of interest

The authors declare no conflict of interest.

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Address for correspondence:

Katarzyna Szwamel PhD
Institute of Health Sciences
University of Opole
68 Katowicka St
45-060 Opole, Poland
Phone: +48 605513431
E-mail: k.szwamel@interia.pl