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**RELATIONSHIP BETWEEN FOOD INSECURITY FOR VARIABLE REASONS, PHYSICAL ACTIVITY AND SELECTED HEALTH SITUATIONS AMONG OLDER ADULTS IN POLAND: A CROSS-SECTIONAL STUDY**

**S u m m a r y**

**Background.** As humans age, their level of physical activity declines, and the incidence of health problems and disability increases. In addition, the elderly experience food insecurity. The aim of the study was to establish the relationship between food insecurity for variable reasons, the level of physical activity and the incidence of metabolic diseases and those leading to loss of mobility. The study was conducted among 760 people aged 65 and older in late 2018 and early 2019 in two regions of Poland. Questions on food security were adapted based on the HFSS questionnaire and those on demographic characteristics, physical activity and selected health situations from the KomPAN questionnaire. Reasons for food insecurity were identified based on a principal component analysis (PCA). Ward's hierarchical classification of variables and logistic regression analysis were used to assess the relationship between variables. A chi-square test was used to verify differences between variables. A value of  $p < 0.05$  was considered the threshold for significance.

**Results and conclusion.** Based on the PCA analysis, two factors were identified to describe the reasons for food insecurity. The first factor was termed 'economic-social' reasons and the second one 'spatial-health' reasons. The first factor was associated with moderate or high physical activity, a health situation that was the same as or better than that of a person's peers, a normal body weight or lower prevalence of obesity and the absence of metabolic diseases and diseases that lead to loss of mobility. The second factor was associated with low or moderate physical activity, a health situation that was the same as or worse than that of a person's peers, being overweight or obese, having at least one metabolic disease and having diseases leading to loss of mobility. The study confirmed that the 'economic-social' reason for food insecurity is more prominent in people with a higher level of physical activity and better health, while the 'spatial-health' reason is more prominent in people with a lower level of physical activity and poorer health.

**Keywords:** food insecurity, older adults, physical activity, BMI, metabolic diseases, impaired mobility

## Introduction

Virtually all countries in the world are experiencing a trend toward an increase in the proportion of older people and an increase in their lifespan [8]. The results of the National Census of Population and Housing in Poland in 2021 revealed that the share of the population in the post-working age group (60/65 years and older) accounted for 22.8 % [30]. Although life extension is a positive development, it results in an increase in the number of elderly people at risk of various diseases and disabilities [49]. This situation is conditioned by several common factors.

The first one is a poor diet and related medical conditions [5, 54], such as overweight and obesity [4], metabolic syndrome [37] or malnutrition [20, 35].

The second one is low physical activity, which, like poor nutrition, results in metabolic diseases [11,70], but also in a loss of mobility [10]. Physical activity in the elderly can lead directly to healthier aging, a higher quality of life and reduction of cognitive impairment [15, 56]. Indirectly, physical activity in this subpopulation reduces the value of BMI, reducing the risk of metabolic diseases [53]. With age, there is a progressive loss of mobility, resulting in a higher risk of disability and mortality, as well as a reduction in quality of life and poorer psychosocial health [41, 57]. Reduced mobility can be related to both low physical activity [10] and chronic diseases, especially diseases of the musculoskeletal, nervous and cardiovascular systems [17, 36].

The third factor is the result of restrictions on physical and economic accessibility to food, which reduces food security for the elderly. The risk of food insecurity among the elderly is significant [27, 43] and its consequences are visible in their state of health [7].

The general health of the population in Poland deteriorates with age [28, 65]. A recent population-based study of this group (PolSenior2) indicated that not only age, but also other socio-demographic factors and functional status in basic and complex daily activities determine a health status. Lower education, widowhood, residence in eastern regions of Poland and a worse functional status are determining factors behind a worse health status [65]. No such differentiation was shown on the basis of gender or place of residence. Only earlier Polish studies reported that such a situation was more common among women than men and among rural residents than urban residents [6].

Maintaining well-being and health is a major challenge among the elderly [39]. In the context of a population growth in this group of people, it becomes necessary to identify and assess risk factors for quality of life and a health status [44, 52, 68]. Therefore, in order to develop conceptual models related to the health of the elderly, it is necessary to seek interdependencies and links between health and all of its determinants, especially because public health initiatives to improve the health of the population to date have been related to the prevention or treatment of chronic diseases without considering food security measures [47]. In planning such health-related conceptual

models, one should not forget about food security, as it is known to be related to physical activity levels [18, 46], nutritional status, the presence of malnutrition [26, 34–55] and chronic non-communicable (metabolic) diseases [19, 22, 34]. The relationship of food security to diseases leading to a loss of mobility and to self-assessed health remains debatable [18].

While the available studies have focused their attention on selected determinants of food security separately, the knowledge of the interrelationships between these factors is still insufficient in terms of both objective and subjective indicators. The use of a factor analysis allows for a more holistic view of perceptions of food insecurity among people who are highly vulnerable to it due to their characteristics (e.g. older age, a low socioeconomic status, low physical activity, a loss of health). The results will also allow for a more comprehensive application of strategies to improve the quality of life of older people [25].

Although the relationships among food security, physical activity levels [18, 46] and factors related to the health of the elderly [18, 19, 22, 26, 34, 42, 55] are known, there is a lack of research assessing the relationship between the causes for food insecurity and factors related to physical activity and health. To fill the gap in scientific research into the causes for food insecurity among the elderly and their relationship to physical activity and the incidence of metabolic diseases and those leading to a loss of mobility, it was hypothesized that reasons for food insecurity, such as long distances from home to food procurement sites and impaired food procurement associated with a loss of mobility, are more related to low physical activity, the incidence of metabolic diseases and diseases leading to a loss of mobility than reasons related to a lack of financial resources or a lack of social support. In this context, the aim of the study was to search for a link between food insecurity for various reasons, the level of physical activity and the incidence of metabolic diseases and those that lead to a loss of mobility.

## **Materials and methods of study**

### *Study design and sample*

This cross-sectional study was conducted in two regions of Poland, among people aged 65 and older, in late 2018 and early 2019. These regions are characterized by high cultural and economic diversity. In 2019, the Śląskie region reported a high Gross Domestic Product (GDP) at 102.3 % of medium GDP per capita, while the Świętokrzyskie region has the lowest GDP at 71.6 % of medium GDP per capita [29]. The study used arbitrary sampling, i.e. all senior citizen clubs in the Świętokrzyskie and Śląskie regions were asked to participate in the survey. The study also used a non-probabilistic sampling technique, i.e. snowball method sampling. The choice of the sampling methods aided in 1. the ability to reach a larger group of respondents, 2. increasing the dis-

persion of the research sample, 3. recruiting reluctant people for the study, 4. increasing the economic efficiency of the study and 5. the use of references from known individuals rather than a known researcher in recruiting a research group. As a result, 1,150 questionnaires were distributed to 16 senior citizen clubs in both regions of Poland. Those who agreed to participate in the study were asked to distribute the questionnaire among their friends. Inclusion criteria for the study were age 65 and over, living in the community and representing a variety of households (living alone, with a partner or with family). The criterion for exclusion from the survey was to represent a household in which the survey had already been conducted, i.e. based on the following assumption: one surveyed person representing one household. A total of 798 questionnaires were collected, of which 36 were eliminated due to non-response. The final study sample consisted of 760 people. Demographic characteristics of the sample are shown in Table 1. The study was conducted in accordance with the Declaration of Helsinki [72]. Informed consent was obtained from all participants to participate in the study.

Table 1. Characteristics of the study sample

Tabela 1. Charakterystyka badanej próby

Characteristics / Charakterystyka		N*=760	%
Gender / Płeć	Women / Kobiety	527	69.3
	Men / Mężczyźni	233	30.7
Age / Wiek	65-74 years / 65-74 lata	531	69.9
	75 years and older / 75 lat i więcej	229	30.1
Place of residence Miejsce zamieszkania	Village / Wieś	244	32.1
	A city having fewer than 100,000 inhabitants / Miasto poniżej 100 000 mieszkańców	122	16.1
	A city having over 100,000 inhabitants / Miasto powyżej 100 000 mieszkańców	394	51.8
Region / Region	Świętokrzyskie	443	58.3
	Śląskie	317	41.7

Objaśnienia / Explanatory notes:

\*N – number of respondents / liczba respondentów

### Questionnaire

A proprietary survey questionnaire was used for the study, with questions assessing food insecurity in households of the elderly adapted based on the USDA's recommended (U.S. Department of Agriculture) HFSS questionnaire (U.S. Household Food Security Survey Module) [32]. Questions on demographic characteristics, physical activity and selected health situations were adapted based on a Polish questionnaire to study dietary habits and beliefs (KomPAN) [38]. To assess food insecurity in the last

month in a respondent's household, four questions were asked about 1. food shortage concerns (Have you been worried that the food in your place of residence will run out or has run out during the past month?), 2. the lack of basic food products (Did basic foodstuffs, e.g. bread, butter, milk, eggs etc., in your place of residence run out in the last month?), 3. the need to change the size or frequency of meals (Did the size or frequency of your meal intake decrease during the past month?) and 4. the need to skip meals (Did you have to skip any meals during the past month?). Each of these questions was considered for four reasons, i.e. 1. a lack of financial resources, 2. living too far from the food procurement place (a store, mall, bazaar, food bank or welfare center where free food is offered), 3. a lack of social support (from family, friends or social welfare centers) and 4. difficult food acquisition related to a loss of mobility (mobility problem, disability). The occurrence of food insecurity situations, taking into account the reasons for this insecurity, was assessed on a nominal dichotomous scale (YES/NO).

To describe the study group, questions (and answers) were asked about

1. Demographic characteristics: gender (women/men), age (65 ÷ 74 years / 75 years and older), place of residence (village/ city having fewer than 100,000 inhabitants/city having over 100,000 inhabitants), region (świętokrzyskie / śląskie);
2. Physical activity: low (more than 70 % of the time during the day in a sitting or lying position), medium (About 50 % of the time during the day in a sitting/lying position and about 50 % of the time during the day on the move), high (more than 70 % of the day on the move or performing physical work involving heavy exertion);
3. Health situation: an assessment of a health status (lower than that of peers / the same as that of peers/better than that of peers), declared presence of metabolic diseases, e.g. hypertension, diabetes, dyslipidaemia and atherosclerotic diseases, obesity (yes/no) – if so, how many diseases at the same time (1/2/3 or more), declared presence of diseases leading to a loss of mobility (yes/no) and declared body weight and height, based on which the BMI was calculated. BMI categories were assigned according to World Health Organization guidelines: normal weight ( $18.50 \leq \text{BMI} \leq 24.99 \text{ kg/m}^2$ ), overweight ( $25.00 \leq \text{BMI} \leq 29.99 \text{ kg/m}^2$ ), obesity ( $\text{BMI} \geq 30.00 \text{ kg/m}^2$ ) [71].

### *Statistical analysis*

Counts and percentages were used to describe qualitative variables (categories). A chi-square test was used to verify differences between categories of variables [61].

Data on the identified root causes of food insecurity based on factor analysis using a principal component analysis (PCA) were taken from a previously authored publication entitled: "Food insecurity in the households of the Polish elderly: diversity in

the perception of its causes by demographic and socioeconomic characteristics" [23]. PCA used 16 variables to describe the causes for food insecurity included in the study (four reasons for each of the four situations describing food insecurity). Components with an eigenvalue of one were used to determine the number of factors and test scree plot. Two components (factors) were extracted and rotated using a Varimax transformation. Variables with factor loadings of at least 0.50 were included. Data in the analysis was confirmed by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's sphericity test. The KMO value was found to be 0.892, and Bartlett's test was significant at  $p < 0.0001$ . The percentage of the total variance explained (%) was 61.0. The percentage of the total variance explained (%) by factors 1 and 2 was 249.9 and 11.1. As a result of the dicentyl division of the eigenvalues of the factors that emerged, two categories of factors were described: a lower dicentyl (low – cause of low importance) and an upper dicentyl (high – cause of high importance). Cluster analysis using Ward's hierarchical classification of variables and logistic regression analysis were used to assess the relationship between categories of factors (low and high importance of reasons for food insecurity) and physical activity and selected health situations [62]. Odds ratio (OR) values were calculated at the 95% confidence level. The reference group (OR = 1.00) was the lower dicentyl and all categories of variables characterizing the study group. A p-value of less than 0.05 was considered significant for all tests.

The statistical analysis was performed using STATISTICA statistical software (version 13.3 PL; StatSoft Inc., Tulsa, USA; StatSoft, Krakow, Poland).

## Results

### *Characteristics of the factors affecting food insecurity for various reasons*

Results of a principal component analysis presenting the correlation coefficients between each situation describing food insecurity for various reasons and the identified factors were taken from the author's earlier publication [23]. These factors have been described as 1. 'economic-social' reasons (food insecurity due to a lack of financial resources to buy food and a lack of social support from family, friends and welfare centers), 2. 'spatial-health' reasons (food insecurity due to a long distance between the place of residence and the place where food is procured, as well as an impediment to food procurement associated with a loss of mobility).

### *Relationship between factors in food insecurity for variable reasons, physical activity and selected health situations*

A cluster analysis using Ward's hierarchical classification of variables identified two clusters of variables describing reasons for food insecurity, levels of physical activity and selected health situations in the group of people covered by the study (Fig.

1). The first cluster was characterized by an ‘economic-social’ reason for food insecurity of high importance and a ‘spatial-health’ reason of low importance. People assigned to this cluster were those with high physical activity, a health situation better than that of their peers, a normal body weight, no metabolic diseases and no diseases leading to a loss of mobility. The second cluster was characterized by a ‘spatial-health’ reason for food insecurity of high importance and an ‘economic-social’ reason of low importance. This cluster was characteristic of people with low to moderate physical activity, in a health situation described as the same as or worse than that of their peers, who were overweight or obese and declared the presence of at least one metabolic disease or disease leading to a loss of mobility.

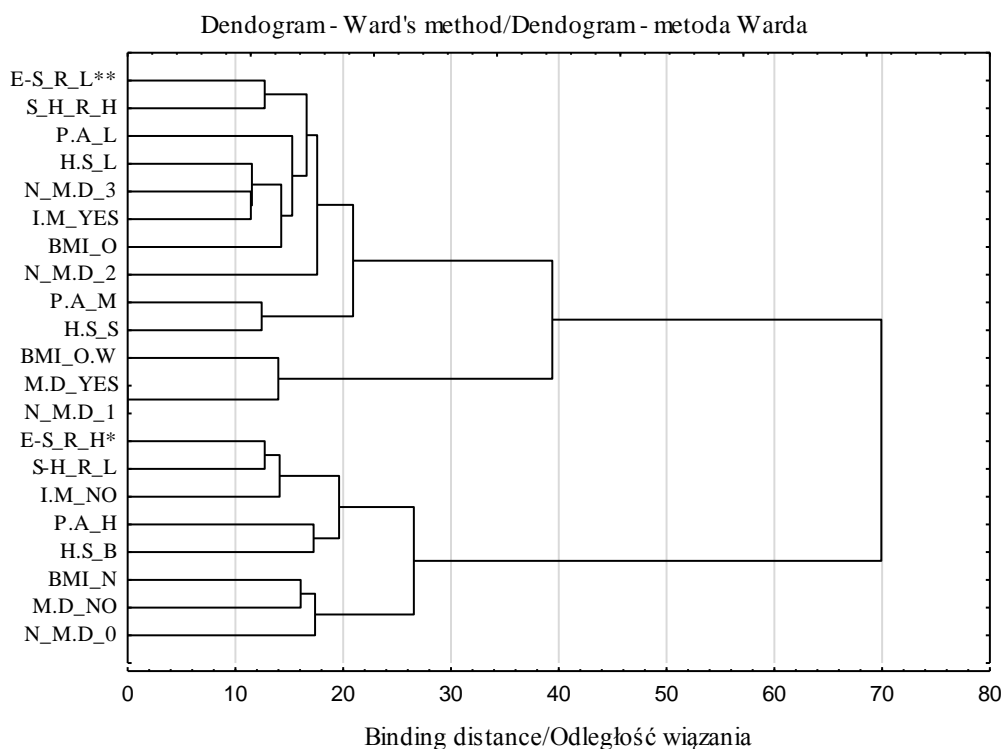


Fig. 1. Dendrogram showing a hierarchical classification of variables describing reasons for food insecurity, physical activity and selected health situations

Rys. 1. Dendrogram przedstawiający hierarchiczną klasyfikację zmiennych opisujących przyczyny braku bezpieczeństwa żywnościowego, aktywność fizyczną i wybrane sytuacje zdrowotne

Objaśnienia / Explanatory notes:

\*relationship between E-S\_R\_H – ‘economic and social’ reasons of high importance, S-H\_R\_L – ‘spatial and health’ reasons of low importance, P.A\_H – high of physical activity, H.S\_B – health status better than that of their peers, BMI\_N – BMI: normal, M.D\_NO – no metabolic diseases, N\_M.D\_0 – number of metabolic diseases: zero, I.M\_NO – no impaired mobility

\*związek między E-S\_R\_H - przyczyną "ekonomiczno-społeczną" o wysokim znaczeniu, S-H\_R\_L - przyczyną "przestrzenno-zdrowotną" o niskim znaczeniu, P.A\_H - wysoką aktywnością fizyczną, H.S\_B - stanem zdrowia lepszym niż rówieśników, BMI\_N - prawidłowym BMI, M.D\_NO - brakiem chorób metabolicznych, N\_M.D\_0 - liczba chorób metabolicznych: zero, I.M\_NO - brakiem zaburzeń mobilności.

\*\*relationship between S-H\_R\_H - 'spatial and health' reasons of high importance, E-S\_R\_L - economic and social' reasons of low importance, P.A\_L - low of physical activity, P.A\_M - medium of physical activity, H.S\_L - health status lower than that of their peers, H.S\_S - health status similar to that of their peers, BMI\_O.W - BMI: overweight, BMI\_O - BMI: obesity, M.D\_YES - presence of metabolic diseases, N\_M.D\_1 - number of metabolic disease: one, N\_M.D\_2 - number of metabolic disease: two, N\_M.D\_3 - number of metabolic disease: three and more, I.M\_YES - presence of impaired mobility.

\*\*związek między S-H\_R\_H - przyczyną "przestrzenno-zdrowotną" o wysokim znaczeniu, E-S\_R\_L - przyczyną "ekonomiczno-społeczną" o niskim znaczeniu, P.A\_L - niską aktywnością fizyczną, P.A\_M - średnią aktywnością fizyczną, H.S\_L - stanem zdrowia gorszym niż rówieśników, H.S\_S - stanem zdrowia takim samym jak rówieśników, BMI\_O.W - BMI świadczącym o nadwadze, BMI\_O - BMI świadczącym o otyłości, M.D\_YES - obecnością chorób metabolicznych, N\_M.D\_1 - liczbą chorób metabolicznych: jedną, N\_M.D\_2 - liczbą chorób metabolicznych: dwiema, N\_M.D\_3 - liczbą chorób metabolicznych: trzema i więcej, I.M\_YES - obecnością zaburzeń mobilności.

Table 2 presents results concerning the numbers and percentages of people characterized by different meanings of reasons for food insecurity considering levels of physical activity and selected health situations. It was shown that significantly more people who were affected by food insecurity for an 'economic-social' reason of high importance compared to the same reason of low importance had a high level of physical activity, a health situation better than that of their peers and a lower prevalence of obesity, metabolic diseases and diseases leading to a loss of mobility. Those whose food insecurity situation involved a 'spatial-health' reason of high importance relative to the same reason of low importance showed a lower prevalence of high physical activity, a lower prevalence of a health situation better than that of their peers and a higher prevalence of obesity and metabolic diseases, especially when at least three were present at the same time, and diseases leading to a loss of mobility.

The results of a logistic regression analysis presenting the relationship between food insecurity due to 'economic-social' and 'spatial-health' of high importance and the level of physical activity and selected health situations of the subjects are presented in Table 3. It was shown that those for whom the 'economic and social' reason for food insecurity was of high importance were more likely to be characterized by a medium (OR = 2.14, ref. low physical activity) or high level of physical activity (OR = 2.82, ref. low physical activity) and by a health status equal to (OR = 1.94, ref. lower than peers) or better than that of their peers (OR = 4.24, ref. lower than peers) and to deny the presence of diseases leading to a loss of mobility (OR = 2.12, ref. yes). People for whom the 'spatial-health' reason for food insecurity was of high importance were more likely to be characterized by a low level of physical activity (OR = 3.22, ref. medium;



Table 2. Importance of 'economic-social' and 'spatial-health' reasons for food insecurity according to physical activity and selected health situations of the study sample

Tabela 2. Znaczenie "ekonomiczno-społecznych" i "przestrzenno-zdrowotnych" przyczyn braku bezpieczeństwa żywnościowego w zależności od aktywności fizycznej i wybranych sytuacji zdrowotnych badanej próby

Characteristics / Charakterystyka	Total sample Ogółem		Cause for food insecurity Przyczyna braku bezpieczeństwa żywnościowego							
			„economic-social” <sup>a</sup> / „ekonomiczno- społeczna” <sup>a</sup>				„spatial-health” <sup>b</sup> / „przestrzenno- zdrowotna” <sup>b</sup>			
			high* / wysokie*		low** / niskie		high / wysokie		low / niskie	
	N	%	N	%	N	%	N	%	N	%
Total sample / Ogółem	760	100.0	677	89.1	83	10.9	245	32.2	515	67.8
Physical activity / Aktywność fizyczna										
low / niska	194	25.5	160	23.6	34	41.0	104	42.4	90	17.5
medium / umiarkowana	466	61.3	424	62.6	42	50.6	123	50.2	343	66.6
high / wysoka <sup>a, b</sup>	100	13.2	93	13.8	7	8.4	18	7.3	82	15.9
Health status / Stan zdrowia										
lower than peers / gorszy niż rówieśników	129	17.0	105	15.5	24	28.9	80	32.7	49	9.5
the same as peers / taki sam jak rówieśników	494	65.0	442	65.3	52	62.7	144	58.8	350	68.0
better than peers / lepszy niż rówieśników <sup>a, b</sup>	137	18.0	130	19.2	7	8.4	21	8.5	116	22.5
BMI										
normal weight / prawidłowa masa ciała	284	37.4	251	37.1	33	39.8	79	32.2	205	39.8
overweight / nadwaga	324	42.6	295	43.6	29	34.9	93	40.0	231	44.9
obesity / otyłość <sup>b</sup>	152	20.0	131	19.3	21	25.3	73	27.8	79	15.3
Metabolic diseases / Choroby metaboliczne										
no / nie <sup>a, b</sup>	180	23.7	165	24.4	15	18.1	43	17.6	137	26.6
yes / tak <sup>a, b</sup>	580	76.3	512	75.6	68	81.9	202	82.4	378	73.4
Number of metabolic diseases / Licza chorób metabolicznych										
zero / zero <sup>b</sup>	180	23.7	165	24.4	15	18.1	43	17.6	137	26.6
one / jedna	287	37.8	259	38.3	28	33.7	74	30.2	213	41.3
two / dwie	197	25.9	168	24.8	29	34.9	79	32.2	118	22.9
three and more / trzy i więcej <sup>b</sup>	96	12.6	85	12.5	11	13.3	49	20.0	47	9.2
Impaired mobility / Utrata mobilności										
no / nie <sup>a, b</sup>	621	81.7	563	83.2	58	69.9	157	64.1	464	90.1
yes / tak <sup>a, b</sup>	139	18.3	114	16.8	25	30.1	88	35.9	51	9.9

Objaśnienia / Explanatory notes:

\*high importance of the cause / wysokie znaczenie przyczyny, \*\*low importance of the cause / niskie znaczenie przyczyny

<sup>a,b</sup> significant differences between high and low importance of economic-social reason (<sup>a</sup>) and spatial-health reason (<sup>b</sup>) for individual categories of physical activity and selected health situations - chi-square test,  $p < 0.05$  / istotne różnice pomiędzy wysokim i niskim znaczeniem przyczyn ekonomiczno-społecznych (a) i przestrzenno-zdrowotnych (b) dla poszczególnych kategorii aktywności fizycznej i wybranych sytuacji zdrowotnych - test chi-kwadrat,  $p < 0,05$

OR = 5.26, ref. high), health status lower than (OR = 3.97, ref. the same as peers; OR = 9.00, ref. better than peers) or the same as that of their peers (OR = 2.27, ref. better than peers), obesity (OR = 2.39, ref. normal; OR = 2.29, ref. overweight), the presence of metabolic diseases (OR = 1.70, ref. no), including two metabolic diseases (OR = 1.60, ref. no; OR = 2.00, ref. one) or three or more (OR = 3.11, ref. one; OR = 2.19, ref. two), and the occurrence of diseases leading to a loss of mobility (OR = 5.09, ref. no).

## Discussion

Based on the same materials and methods of study, an earlier author's paper [23] identified reasons for food insecurity. The present study evaluates the relationship of these reasons to physical activity and selected health situations. The present study showed that for people with lower physical activity levels and a worse health situation (health status the same as or lower than that of their peers, overweight or obesity, the presence of metabolic diseases or those leading to a loss of mobility), the 'spatial-health' reason of high importance for food insecurity was more important than the 'economic-social' reason of high importance. By contrast, people with higher physical activity and a more favorable health situation (health status the same as or better than that of their peers, normal body weight or lower prevalence of obesity, metabolic diseases or those leading to a loss of mobility) were more likely to report that the 'economic-social' reason for food insecurity of high importance was more important than the 'spatial-health' reason of high importance.

The relationship between food insecurity, its reasons and lifestyle and health characteristics is complex and has not yet been addressed in a Polish study. The social-ecological model assumes that food insecurity in the elderly is related to a number of factors [12] and the multidirectional interrelationships among these factors. For example, food insecurity in the elderly is not only related to a lack of finances but also correlated with their physical health and psychosocial relationships [12]. Older people characterized by food insecurity are more likely to experience disability due to overweight and obesity [9, 63], chronic diseases [33] and functional limitations [3, 9, 63]. In addition, inadequate intake of quality food due to food insecurity can lead to inadequate energy and nutrient intake, resulting in reduced muscle strength and function [3]. On the other hand, remaining at home and a lack of mobility may limit the ability of the

Table 3. Odds ratios cause of food insecurity of high importance according to physical activity and selected health situations in the study sample  
Tabela 3. Iloraz szans przyczyn braku bezpieczeństwa żywnościowego o wysokim znaczeniu w zależności od aktywności fizycznej i wybranych sytuacji zdrowotnych w badanej próbie

Characteristics / Charakterystyka		Cause for food insecurity of high importance / Przyczyna braku bezpieczeństwa żywnościowego o wysokim znaczeniu			
		“economic-social” ”ekonomiczno-społeczna” (ref. <sup>a</sup> low importance/niskie znaczenie)		“spatial-health” ”przestrzenno-zdrowotna” (ref. low importance/niskie znaczenie)	
		OR <sup>b</sup>	p	OR	p
Physical activity Aktywność fizyczna	low / niska (ref. <sup>a</sup> medium / umiarkowana)	0.47 (0.29-0.76)	0.002	3.22 (2.27-4.57)	<0.001
	low / niska (ref. high / wysoka)	0.35 (0.15-0.83)	0.017	5.26 (2.93-9.45)	<0.001
	medium / umiarkowana (ref. low / niska)	2.14 (1.31-3.49)	0.002	0.31 (0.22-0.44)	<0.001
	medium / umiarkowana (ref. high / wysoka)	0.76 (0.33-1.74)	0.517	1.63 (0.94-2.83)	0.080
	high / wysoka (ref. low / niska)	2.82 (1.20-6.65)	0.017	0.19 (0.11-0.34)	<0.001
	high/ wysoka (ref. medium / umiarkowana)	1.31 (0.57-3.03)	0.517	0.61 (0.35-1.06)	0.080
Health status / Stan zdrowia	lower than peers / gorszy niż rówieśników (ref. the same as peers / taki sam jak rówieśników)	0.51 (0.30-0.81)	0.014	3.97 (2.64-5.95)	<0.001
	lower than peers / gorszy niż rówieśników (ref. better than peers / lepszy niż rówieśników)	0.24 (0.10-0.57)	0.001	9.00 (5.01-16.24)	<0.001
	the same as peers / taki sam jak rówieśników (ref. lower than peers / gorszy niż rówieśników)	1.94 (1.14-3.30)	0.013	0.25 (0.17-0.38)	<0.001
	the same as peer s/ taki sam jak rówieśników (ref. better than peers / lepszy niż rówieśników)	0.46 (0.20-1.03)	0.060	2.27 (1.37-3.76)	0.001
	better than peers / lepszy niż rówieśników (ref. lower than peers / gorszy niż rówieśników )	4.24 (1.75-10.28)	0.001	0.11 (0.06-0.20)	<0.001
	better than peers / lepszy niż rówieśników (ref. the same as peers / taki sam jak rówieśników)	2.18 (0.97-4.93)	0.060	0.44 (0.27-0.73)	0.001

BMI	normal weight / prawidłowa masa ciała (ref. overweight / nadwaga)	0.75 (0.44-1.27)	0.279	0.96 (0.67-1.37)	0.811
	normal weight / prawidłowa masa ciała (ref. obesity / otyłość)	1.22 (0.68-2.20)	0.508	0.42 (0.28-0.63)	<0.001
	overweight / nadwaga (ref. normal weight / prawidłowa masa ciała)	1.34 (0.79-2.27)	0.279	1.04 (0.73-1.50)	0.812
	overweight / nadwaga (ref. obesity / otyłość)	1.63 (0.90-2.97)	0.109	0.44 (0.29-0.65)	<0.001
	obesity / otyłość (ref. normalweight / prawidłowa masa ciała)	0.82 (0.46-1.48)	0.508	2.39 (1.59-3.62)	<0.001
	obesity / otyłość (ref. overweight / nadwaga)	0.61 (0.34-1.12)	0.109	2.29 (1.54-3.42)	<0.001
Metabolic diseases Choroby metaboliczne	no / nie (ref. yes/tak)	1.46 (0.81-2.63)	0.205	0.59 (0.40-0.86)	0.006
	yes / tak (ref. no/nie)	0.68 (0.38-1.23)	0.205	1.70 (1.16-2.50)	0.006
Number of metabolic diseases Liczba chorób metabolicznych	zero (ref. one / jedna)	1.19 (0.62-2.30)	0.605	0.90 (0.59-1.39)	0.646
	zero (ref. two / dwie)	1.46 (0.81-2.63)	0.205	0.59 (0.40-0.86)	0.006
	zero (ref. three and more / trzy i więcej)	1.47 (0.81-2.67)	0.207	0.68 (0.46-1.01)	0.053
	one / jedna (ref. zero)	0.84 (0.44-1.63)	0.605	1.11 (0.72-1.71)	0.646
	one / jedna (ref. two / dwie)	1.22 (0.74-2.02)	0.432	0.73 (0.52-1.02)	0.066
	one / jedna (ref. three and more / trzy i więcej)	0.96 (0.55-1.68)	0.892	0.69 (0.48-1.01)	0.050
	two / dwie (ref. zero)	0.61 (0.38-0.99)	0.048	1.60 (1.14-2.25)	0.006
	two / dwie (ref. one / jedna)	0.59 (0.35-0.97)	0.038	2.00 (1.40-2.85)	<0.001
	two / dwie (ref. three and more / trzy i więcej)	0.65 (0.39-1.10)	0.106	1.35 (0.92-1.98)	0.118
	three and more / trzy i więcej (ref. zero)	0.75 (0.45-1.21)	0.208	1.30 (0.80-2.11)	0.055
	three and more / trzy i więcej (ref. one / jedna)	0.78 (0.39-1.58)	0.496	3.11 (1.98-4.90)	<0.001
	three and more / trzy i więcej (ref. two / dwie)	1.02 (0.50-2.09)	0.948	2.19 (1.39-3.47)	<0.001
Impaired mobility Utrata mobilności	no / nie (ref. yes / tak)	2.12 (1.27-3.54)	0.004	0.20 (0.13-0.29)	<0.001
	yes / tak (ref. no / nie)	0.47 (0.28-0.78)	0.004	5.09 (3.45-7.53)	<0.001

Objaśnienia / Explanatory notes:

<sup>a</sup> reference group/grupa referencyjna; <sup>b</sup> point estimate at 95% Wald confidence/szacowanie metodą Walda przy 95% poziomie ufności; *p* – significance level of the Wald's test/poziom istotności testu Walda.

elderly to purchase food, thus increasing the risk of food insecurity [67]. In this situation, a long distance to food purchasing places from where people live can only exacerbate the problem. Moreover, the experience of social isolation can be a significant factor in food insecurity in the elderly [63]. For example, a subpopulation of the elderly living alone in household members experiencing a lack of social support may not be able to maintain sufficient food consumption, due to a decline in motivation to prepare and consume food [40].

Overall, the economic and social reasons for food insecurity among the elderly are more important than the spatial (geographic) and health reasons that have been studied and published thus far [43, 51, 66]. We can also learn about the importance of economic factors such as income or financial resources for ensuring household food security from other publications [27, 31]. The economic reasons are important because they also apply to developed countries [66]. Usually, the problem lies not in a country's national income, but in the finances of households or individuals. This is also the reason why the elderly are particularly vulnerable to food insecurity for economic reasons. Typically, financial resources available to the elderly in Poland are insufficient even to meet basic needs. In this situation, social relationships, social capital and social support become important [16, 58]. However, the results of the study in this regard turned out to be inconclusive, which may be the result of differences in the perception and management of financial resources, social assistance opportunities and willingness to use such assistance. It turns out that the elderly, especially those living in rural areas, who experienced food insecurity due to limited financial resources, wanted to use or did not express a desire to use social assistance [24, 69, 74]. In addition, this social group was more likely to use family support than social assistance, which is probably culturally determined in many countries [13, 24]. The relationship between economic and social factors seems reasonable, but further research is needed to understand mechanisms involved in the interplay of these factors [25]. In this survey, for almost 90 % of people, 'economic-social' reasons were of high importance relative to 'spatial-health' reasons. The latter reasons were important to 32 % of people. For people with normal lifestyles and good health, the distance to amenities, for example, the distance from the place of residence to the place where food is purchased, as well as problems with purchasing food for health reasons ('spatial-health' reasons) are less important [48, 67, 73]. For these people, 'economic-social' reasons may be more important, as partially demonstrated in this study.

An increase in the importance of 'spatial-health' reasons for food insecurity may accompany a loss of physical activity and health. Previous studies assessing food security among the elderly showed that its absence was associated with lower physical activity [18] and physical and mental health problems [45, 64], malnutrition [26, 34, 55], overweight, obesity [68] and chronic non-communicable (metabolic) diseases [19, 22,

34]. On the other hand, improving this safety was associated with improved quality of life and health indicators (greater vitality and activity, lower risk of depression and pain episodes) [18]. Some studies show that food insecurity was marginally related to mobility and self-assessed health status [18]. This study showed such a relationship, provided that food insecurity was caused by 'spatial-health' factors.

For the elderly, a greater distance to the nearest grocery store and a lack of access to public and private transportation increase the risk of food insecurity [12, 23, 59, 60]. This is due to the need to travel longer in terms of time and distance. A lack of transportation forces the elderly to make repeated visits to the grocery store for heavy groceries. This situation leads to demotivation in terms of shopping [12]. Some studies show that multimorbidity in the elderly [14] and a loss of mobility, e.g. due to disability [12], can become an insurmountable barrier to self-purchasing food at the point of sale and cause a serious loss of food security [12]. A similar conclusion can be drawn from our own study. In addition, a long distance between a place of residence and a place of food procurement in the households of the Polish elderly resulted in a shortage in the daily diet of such food products as fish and fish products, some fruits, beef and some vegetables, i.e. products that are important in conditioning a proper diet [23]. On the other hand, the residence of the elderly in areas with easy access to stores improved their dietary quality [50]. The indirect or direct relationship between 'spatial-health' reasons and diet quality can decisively affect the quality of life and health of the elderly.

### *Strengths and Limitations*

Household food insecurity is a fundamental public health problem. Understanding the factors associated with food insecurity is the key to understanding the needs of the elderly so that targeted interventions can be developed to reduce the impact of food insecurity on the quality of life of this subpopulation [2]. Although this study succeeded in determining the relationships among reasons for food insecurity, physical activity levels and selected health-related situations among the elderly, the study is cross-sectional and has its limitations. First, it does not allow an assessment of the cause-and-effect relationship between the reasons for food insecurity and the determinants of physical activity and health. Second, this type of study does not consider changes over time, which some researchers believe are very dynamic [1] and have a very significant impact on changes in food security. The changes are particularly important for not only socio-economic but also health reasons for the elderly in Poland. The investigated relationship should be verified in a longitudinal study determining its interrelationships and interactions. Thirdly, the results of the survey cannot be applied to the entire population of older people in Poland due to the lack of representativeness of the surveyed group (only two regions of Poland and only socially active participants of senior citi-

zen's clubs were included, excluding lonely and socially isolated people). Fourth, both the HFSS and KomPAN questionnaires have not been tested (validated) in Poland among the elderly.

### Conclusions

The results of the study confirmed the relationship between reasons for food insecurity, levels of physical activity and selected situations describing the health of the elderly. In addition, the principal component analysis allowed for the aggregation of reasons to two factors (reasons with interrelationships). The study confirmed that for the respondents, the 'economic-social' reason is more important than the 'spatial-health' reason for food insecurity. Nevertheless, once the characteristics associated with physical activity and situations describing health are considered, there is a change in the importance of these reasons. For people with higher levels of physical activity and better health, the 'economic-social' reason is more important, while for those with lower levels of physical activity and poorer health, the 'spatial-health' reason for food insecurity turns out to be crucial.

The results obtained can be applied to planning social and health policies for the elderly. When planning strategies to support the elderly, public health policy makers should consider not only the data and indicators that demonstrate food security, but also the reasons why this security is being lost and their relationship to the quality of life and health characteristics of this subpopulation.

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**ZWIĄZEK MIĘDZY BRAKIEM BEZPIECZEŃSTWA ŻYWNOŚCIOWEGO O ZMIENNEJ  
PRZYCZYŃIE, AKTYWNOŚCIĄ FIZYCZNĄ I WYBRANYMI SYTUACJAMI  
ZDROWOTNYMI WŚRÓD OSÓB STARSZYCH W POLSCE: BADANIE PRZEKROJOWE**

**Streszczenie**

**Wprowadzenie.** Wraz z wiekiem spada poziom aktywności fizycznej, wzrasta częstość występowania problemów zdrowotnych i niepełnosprawności. Ponadto osoby starsze doświadczają braku bezpieczeństwa żywnościowego. Celem badania było ustalenie związku między brakiem bezpieczeństwa żywnościowego o zmiennej przyczynie, poziomem aktywności fizycznej, występowaniem chorób metabolicznych i tych prowadzących do utraty mobilności. Badanie przeprowadzono wśród 760 osób w wieku 65 lat i starszych na przełomie 2018 i 2019 roku w dwóch regionach Polski. Pytania dotyczące bezpieczeństwa żywnościowego zostały zaadaptowane z kwestionariusza HFSS, a te dotyczące cech demograficznych, aktywności fizycznej i wybranych sytuacji zdrowotnych z kwestionariusza KomPAN. Przyczyny braku bezpieczeństwa żywnościowego wyłoniono na podstawie analizy głównych składowych (PCA). Do oceny zależności między zmiennymi wykorzystano hierarchiczną klasyfikację zmiennych metodą Warda oraz analizę regresji logistycznej. Do weryfikacji różnic między zmiennymi wykorzystano test chi-kwadrat. Wartość  $p < 0,05$  uznano za istotną.

**Wyniki i wnioski.** Na podstawie analizy PCA wyłoniono dwa czynniki opisujące przyczyny braku bezpieczeństwa żywnościowego. Pierwszy czynnik został określony jako przyczyna "ekonomiczno-społeczna", a drugi jako przyczyna "przestrzenno-zdrowotna". Pierwszy czynnik był związany z umiarkowaną lub wysoką aktywnością fizyczną, taką samą lub lepszą sytuacją zdrowotną niż rówieśników, prawidłową masą ciała lub mniejszą częstością występowania otyłości oraz brakiem chorób metabolicznych i chorób prowadzących do utraty mobilności. Drugi czynnik był związany z niską lub umiarkowaną aktywnością fizyczną, taką samą lub gorszą sytuacją zdrowotną niż rówieśników, nadwagą lub otyłością, co najmniej jedną chorobą metaboliczną i chorobami prowadzącymi do utraty mobilności. Badanie potwierdziło, że "ekonomiczno-społeczna" przyczyna braku bezpieczeństwa żywnościowego jest bardziej widoczna u osób z wyższym poziomem aktywności fizycznej i lepszym stanem zdrowia, podczas gdy przyczyna "przestrzenno-zdrowotna" jest bardziej widoczna u osób z niższym poziomem aktywności fizycznej i gorszym stanem zdrowia.

**Słowa kluczowe:** brak bezpieczeństwa żywnościowego, osoby starsze, aktywność fizyczna, BMI, choroby metaboliczne, utrata mobilności 