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Article

Mediation and moderation analysis of the relationship between total protein concentration and the risk of depressive disorders in older adults with function dependence in home care

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Abstract: Due to its devastating consequences, late life depression is an important public health problem. The aim of the study was the analysis of variables which may potentially influence risk of depression (GDS-SF). Furthermore, the aim was to study possible mediating effect of given variables on the relationship between the total protein concentration and risk of depression in older-adults with chronic diseases, and physical function impairment. The research sample included a total of 132 older adults with chronic conditions and physical function impairments, remaining under a long-term care in residential environment. Negative linear correlation was observed between patients' physical functionality, total protein concentration, concentration of HDL cholesterol, arm circumference, and the risk of depression. Considerably stronger relationship was observed between total protein concentration, and GDS-SF, in elderly suffering from sensory dysfunction (b = - 6.42, 95% CI = - 11.27; - 1.58). The effect of the mediation between depression risk is correlated to total protein concentration in blood serum, and the mediators are probably low function impairment and low levels of 25 (OH)D vitamin. Cohort control research is suggested to confirm the hypothesis.

Keywords: depression; total protein; elder people; physical function; long-term care

1. Introduction

Functional status, understood as the ability to perform basic and instrumental activities of the daily living (ADL), is of key importance when it comes to assessing the quality of life (QOF) in older adults, as well as in younger people, in case of health deficits which cause deterioration of the functional status. Research of mortality predictors, prove that functional status of the elderly is an independent predictive factor for mortality [1-3].

Physical function impairment in patients is a particularly problematic issue in long-term home care, and may lead to numerous health problems, as well as resulting in difficulties when providing care in the home environment. Nursing homecare is becoming a significant sector in the healthcare system for older adults. A long-term nursing care is of great importance for this healthcare system. In Poland, the long-term nursing care is a relatively new and developing discipline. In 1999, Residential long-term care facilities, i.e. nursing homes and care homes for the chronically ill, and incapacitated, were established. In 2004, medical services provided at homes, under the name of long-term nursing care [4], began to be contracted. Long-term nursing care can be provided only to

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patients scoring 0-40 points in the Barthel index, along with a referral from a doctor working within a health insurance scheme [5]. Other than the above mentioned, the elderly with physical function impairments, who are staying in home environment, are under the care of informal carers (usually family members), who support patients with slight or moderate dependence in the Barthel index.

The results of SHARE research, conducted in 2010-2011, show that the proportion of older adults with functional limitations, being a basis concerning the demand for certain assistance forms in daily life, is high in Poland.

Nearly 20% of people aged 65-79, and over 40% of those aged over 80, declare to have problems with performing activities of daily living - (ADL). Higher percentage of the elderly (23% of those aged 65-79, and 54% of those over 80) declare problems with performing instrumental activities of daily living - (IADL) [6].

Due to the important role of the long-term care, healthcare sector in patient's living environment, the demand is extremely high. However, the supply of long-term care in Poland is mainly informal, and is to be organised by the family- the care is provided primarily by the closest family members in the patient's home.

Several various and independent estimations consistently indicate that the most of elderly are under an informal care, between 80% [7] and 93% [8]. The reasons for high supply of informal care results from traditional family relations. Frequently, older adults reside with their children (high cohabitation index).

In Polish review literature, there are sparse estimates concerning quantity and the functional status of those in need of long-term care. When patients with physical functional impairment in home care were examined, using the Barthel index, the group n = 296included 21.3% of the examined scoring 0 points, and 78.7% of the examined scoring 5-40 [4,9]. In other study, concerning the assessment of functional status of patients, with long-term home nursing care, using the Barthel index (n = 190), almost two-thirds of the examined (64.21%) were patients with total dependence (Barthel index 0-20), i.e. demanding considerable help in performing the activities of daily life or unable to self-care. Remaining patients, 35.79%, were characterized by moderate dependence, scoring 21-40 in Barthel index. In cumulative assessment of patients with long-term nursing care (n = 575), between 2004 - 2008 in north-eastern Poland, 45% (n = 259) of people scored 0 points in Barthel index. The highest value of points qualifying for long-term nursing care, in Barthel scale - 40 points, was found in 4.9% (n = 28) of the examined. The rest, 50.1% (n = 288), scored between 5-35 points, and between 1-5 in the Barthel index, in the assessment of patients' self-care [11].

Physical functional impairment and resulting mobility limitations, are the reasons for impairments of physiological and biochemical reactions of human organism. The functions of cardiovascular, respiratory, nervous, and muscular-bone systems, along with water-electrolyte balance, mainly calcium metabolism, are distorted, affecting the blood clotting. The tempo of energy conversion has also changed, and the organism homeostasis is distorted [12]. Hypokinesis changes body composition, protein metabolism, hormonal profile and muscle function [13-15]. Additionally, hypokinesis results in the decrease in production of certain neurotransmitters and neuromodulators in the brain, eg. noradrenaline and endorphins. There might occur despondence and lowering in adaptation capacities of the central nervous system (concentration difficulties, sleep disorders, anxiety, aggression, as well as depression) [15].

The research concerning factors affecting the recovery, or maintaining the condition of patients with chronic diseases, and physical functional impairment, who are under the care of an informal carer and long-term care, should constitute one of the priority research areas in home care.

The aim of the study was the analysis of variables (medical, biochemical, and anthropometric) which may potentially influence risk of depression. Furthermore, the aim was to study possible mediating effect of given variables on the relationship between the total protein concentration and risk of depression (GDS-SF) in older-adults with chronic diseases, and physical function impairment.

2. Materials and Methods

2.1. Study designe

149 patients with long-term home care in 5 facilities (4 in urban, and 1 in rural area) took part in the study. The study was conducted between September 2016, and February 2017. Information was collected through a direct interview, by nurses, working in long-term home care, who were professionally assisting the families of the patients, during the home visits. The nurses (n = 18) of long-term home care were acquainted with the study project, and prepared for data collection, taking measurements, and materials for laboratory tests, in accordance with established study procedure. On the first day, the nurse filled in the questionnaire with the patient, took measurements, and informed about the preparation for the laboratory tests to be taken on the following day (blood collection in the morning, in the fasted state, after no food intake for 8 - 12 hours). On the second day, patient's venous blood was collected in order to mark biochemical parameters. Blood was transported in special containers to the laboratory, in the time, no longer than 30 - 60 minutes from the moment of collection.

Inclusion criteria were as follows: physical function impairment in the Barthel index: 0 - 85 points, medical diagnosis of systemic atherosclerosis (ICD10 - I70), lack of coexisting carcinoma or renal insufficiency, and lack of cognitive function impairments measured by MMSE ≥ 7 (the Mini-Mental State Examination), as well as the patient being cared for in home conditions.149 people qualified for the study. However, after conducting detailed analysis of the collected materials in the questionnaire (due to its incompleteness), finally 132 people, whose information was complete, were included in the analysis.

A written consent for the study was granted by the managers and directors of the health facilities, where the nurses performing research were employed. Each patient was orally informed by the nurses regarding the objective of the study, and the scope of the questionnaires, measurements, and then a written consent was taken from the patients. The study was voluntary and anonymous. Nurses completed the questionnaires during a patient interview, and provided the patient with necessary information and explanation. During each stage of the data collection, patients could resign or refuse further participation in the study.

The implemented study procedure was approved by Bioethics Committee of Medical University in Lublin (No. KE-0254/13./2016), and was consistent with the Declaration of Helsinki. The study was realized in the frame of own research, financed by Medical University of Lublin.

2.2. Measurements

Research tools consisted of two questionnaires: Geriatric Depression Scale - Short Form (GDS-SF) and the Barthel index. Questionnaires were supplemented by a sheet collecting sociodemographic information, and medical interview data. There were also anthropometric measures taken, along with the collecting of venous blood for laboratory tests.

Geriatric Depression Scale Short Form (GDS-SF) in the Polish version [17] was used to measure the degree concerning the risk of incidence of depression symptoms. GDS-SF scale was created as a screening tool to diagnose intensity of depression symptoms. Scale in the shortened version consists of 15 statements describing basic depression symptoms, the examined person confirms or denies its presence (yes/no) during the past two weeks.

Interpretation of the shortened version is based on the number of scored points: 0-5 no risk of depression, 6-15 there exists risk of depression symptoms. Reliability of the scale was measured with the alfa Cronbach indicator and its value was 0.86.

The Barthel index. The assessment concerning activities of the daily living was conducted using the Barthel index. The index takes into consideration: meal consumption, mobility, maintenance of personal hygiene, using the lavatories, taking full body baths, mobility on flat surfaces, walking the stairs, dressing, bladder and bowel control. Depending on the range of the patient's self-care, the patient may score between 0-100 points [18]. The amount of scored points shows the degree of disability, and describes the person's demand for care. Functional independence

of patients is differentiated depending on which category their score is qualified: 86-100 points - patient deals well with activities of the daily living; 21-85 - patient partly deals well with the activities of the daily living; 0-20 points - patient cannot deal with the activities of daily living alone [19]. The assessment of the applicability of the Barthel index in Polish condition, as a reliable tool (indicator α-Cronbacha = 0.78 ÷ 0.89; correlation co-indicator test-retest R = 0.93 ÷ 0.95) for measuring the range of self-reliance when performing activities of the daily living in older adults, was proven by research [20].

Demographic and clinical variables. Collected data, describing the examined group on sociodemographic grounds, were: gender, age, marital status ("single" or "in a relationship"), and living arrangements ("alone" or "with family"). Variables, taken into consideration when assessing the medical state, were concerned with comorbidities, i.e. systemic atherosclerosis, diseases (or lack thereof) of: cardiovascular, respiratory, endocrine, neurological, sensory, mental, rheumatic, and other systems, as well as medicinal substances intake and its amount. At the end of this part of the questionnaire, the interviewer calculated number of years the patient has been under long-term care.

2.3. Anthropometric measurements.

Because it was not possible to measure patients' height and weight in home conditions (bed-ridden patients), to perform anthropometric assessment, following criteria were noted: calf, arm, foot-knee length, as well as skinfold under the shoulder and skinfold of arm triceps muscle.

Circumference of calf was measured with accuracy up to 0.1 cm in the supine position using inelastic measuring tape. The tape was placed around a calf without compressing the subcutaneous tissue and was moved along the calf length to get the maximal circumference. The measures of both calves were registered as an average, resulting from the measurements of two trials for each limb, which were combined to establish an average for both legs.

The length of shin bones was measured between the distal end of the medial condyle of the tibia, and the apex of medial malleolus. The location of anthropometer was parallel to long axis of tibia [21].

Skin fold thickness (SFT) under the shoulder was measured using the Harpenden calliper (Harpenden Calliper) in precisely chosen points. Prior to using, the calliper was thoroughly calibrated to check the strains (so they are not loose) using an object with known dimensions.

Triceps Skinfold (TSF) was measured in a middle point of the non-dominant arm, with the upper limb freely stretched along the body. Next, the skinfold was pinched between fingers, and the calliper was used. The measurement was performed twice, and the average was used for further analysis.

2.4. Blood collection and biochemical analysis.

Blood samples were collected in fasted state, after all night rest and moderate-size supper the previous day. Blood was collected to a tube containing a clotting activator and a separation substance (granulate). Plasma was separated using centrifugation of 3000 spins per minute, for 10 minutes. Centrifuged serum was used to mark the levels of biochemical parameters. Total protein concentration, total cholesterol, triglyceride, and HDL cholesterol were marked usingAdvia1800 Siemen sapparatus, with original reagents. LDL cholesterol was measured with Friedewald formula. D3 25-OH Vitamin was marked on Cobas E411 Roche apparatus, with using of original set of reagents and electrochemiluminescence method. B12 vitamin and folic acid levels were marked using Advia Centaur Siemens apparatus, by chemiluminescence method.

2.3. Statistical analysis

Categorical variables were reported as number and percentages. The distribution of quantitative variables were described by the mean value (M) and the standard deviation (SD) or median (Me), and lower (Q1) and upper quartile (Q3). The Shapiro-Wilko test was used to assess conformity with a normal distribution.

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Linear regression was used to assess the relation between the values of the scale of depression risk (GDS-SF) and considered variables (age, gender, results of anthropometric measurements, laboratory test and comorbidities).

Furthermore, in order to study whether age, gender, or examined comorbidities change direction or magnitude relationship between total protein concentration, and the risk of depression; models with interaction term between the total protein concentration and the consider variable (moderator) were performed. The significance of the given moderato was assessed by the change of proportion concerning the explained variance (ΔR^2).

In order to investigate the mechanism of the relationship between total protein concentration, and the risk of depression, mediation analysis was used, by taking into consideration the third variable - mediator. The scheme of applied mediation analysis is shown on Figure 1. „The PROCESS macro" procedure was used [22]. Several models (steps) of linear regression were performed. The results of mediation analysis were presented by giving three factors (effects) from models:

1- Providing the coefficient for a given mediator (after controlling for total protein concentration) with 95% confidence interval (95% CI);
2- Direct effect, (c`) coefficient of regression model for the total protein concentration after controlling for mediating variable (mediator) with 95% CI;
3- Indirect effect with 95% CI, calculated with taking into consideration „biascorrected" and „accelerated" correction. Effect is the product (a*b, on the attached scheme) of the coefficients (in regression model) between total protein concentration and the studied mediating variable, and between the coefficient (in regression model) between the mediating variable and depression.

To establish the significance of the mediation effect, bootstaping method was used (made for 5000 drawings). This procedure estimates the indirect effect using the bootstaping technique (generating empirical representation of the sample distribution, treated as a population representation). All analyses were made with IBM SPPS v.22 software, as a statistical significance for bilateral tests $\alpha = 0.05$ was applied.

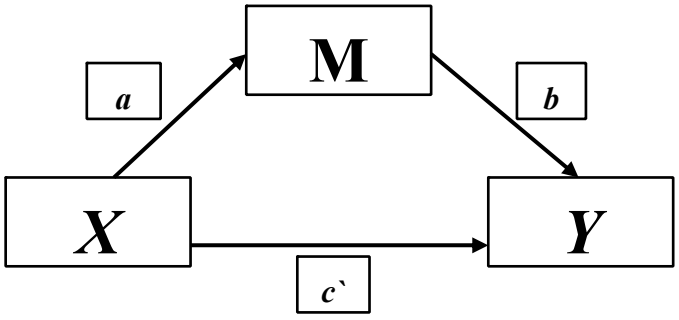

Figure 1. Model presenting the examined mediation effect. X: independent variable (protein concentration); M: mediator; Y: dependent variable (GDS-SF); a: association between X and M; b: association between M and Y after controlling for X; c`: indirect effects.

3. Results

3.1. Characteristics of the studied groups according to sociodemographic and medical data

Table 1 presents characteristics of the studied group. Analysis included 132 patients under long-term home care. The average age in the studied group was 78.75 8.75 years. Majority of the group were women (n = 103, 78%) and unmarried (n = 83, 62.9%).As many as 118 people (79.2%) lived with their families. The group of the examined patients included only those with slight (0-40 points), and moderate (41-85 points) dependency in the Barthel index. Average assessment of physical function was 43.20 (SD = 27.06). The largestgroup of 60 people (45.5%) consisted of patients scoring 21 - 40 points in the Barthel index; 44 people (33.3%) scoring 0-20 points, and 28 people (21.2%) scoring 41 - 85.All patients were under home care, which they have used on average for 3.59 years (SD = 2.68). Average amount of medications prescribed by the doctors taken by the patients was 7.9 (SD = 2.8). Patients were characterized by comorbidities, with domineering conditions being

242 rheumatic (77.9%), sensory (65.1%), psychiatric (51.7%), endocrine (45%), and those of the nervous
243 system (26.5%).
244 In the assessment concerningthe risk of depression symptoms occurrences, according to
245 GDS-SF, the average was 7.34 points (SD = 3.10). Lack of depression risk (0-5 points) occurred in 25%
246 (n = 33), and in other 75% (n = 99) there was a risk of depressive disorders.
247 38 people (28.8%) had total protein concentration within the 5.56 -6.61 mg/dl frame; 66 of the
248 examined (50%) 6.62 - 7.37 mg/dl, and 28 people had total protein concentration ranging in 7.38 - 8.14
249 mg/dl.

250 **Table 1.** Characteristics of the examined group.

Variable	n = 132
Medical interview	
Under long-term care (years)	3.91 ± 2.61*
Result in the Barthel index	43.20 ± 27.06*
Result in GDS scale	7.34 ± 3.10*
Amount of medicinal substances taken	7.9 ± 2.8*
Comorbities	
Respiratory system (n, %)	19 (14.4)**
Endocrine system (n, %)	54 (40.9)**
Nervous system (n, %)	35 (26.5)**
Sensory (n, %)	12 (9.1)**
Psychiatric (n, %)	55 (41.7)**
Rheumatic (n, %)	77 (58.3)**
Laboratory test results	
Total protein (g/dl)	7.09, 6.61 - 7.37***
25 (OH)D vitamin(ng/ml)	14.41, 8.64-26.63***
B12 vitamin (pg/ml)	390.76 ± 143.35*
Folic acid (ng/ml)	5.4, 3.74-9.92***
Total cholesterol (mg/dl)	183, 158-218***
HDL Cholesterol (mg/dl)	53.55, 42.62-64.22***
LDL Cholesterol(mg/dl)	106.5, 86-130.75***
Triglycerides (mg/dl)	115, 88.25-158.75***
Anthropometric variables	
Calf circumference (cm)	36.05 ± 5.42*
Arm circumference (cm)	30.79 ± 7.90*
Tibial bones length (cm)	48.02 ± 5.44*
Thickness of the skinfold under the shoulder (cm)	2.6, 2.1-4***
Skinfold of arm muscle triceps (cm)	2.3, 2-3.8***

251 Data are presented as: *mean ± SD; **n (%); ***median and Q1-Q3.

252 *3.2. Relation between GDS-SF and studied criteria*

253 Table 2 shows results of simple linear regression. Negative linear association was observed
254 between the results of the Modified Barthel Index, total protein concentration, concentration of HDL
255 cholesterol, arm circumference, and value of the GDS-SF scale. Along with the increase of the point

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256 value in the GDS-SF scale, the values of Barthel index assessment, total protein concentration, HDL
257 cholesterol, and arm circumference decreased.

258 **Table 2.** Multi-variable analysis of the linear regression of the depression risk (GDS-SF) determinant
259 in the examined group.

Variable	b	95%CI
Gender		
Male	0.40	(-0.89; 1.70)
Age	0.02	(-0.04; 0.09)
Marital status		
In a relationship	-0.86	(-1.97; 0.24)
Cohabitant		
Alone	0.75	(-0.54; 2.03)
Medical interview		
Under long-term healthcare (years)	-0.04	(-0.26; 0.17)
Results in the Barthel index	-0.02	(-0.04; -0.004)
Amount of medicinal substances taken	0.004	(-0.36; 0.36)
Morbidities:		
Respiratory system	-1.45	(-2.95; 0.06)
Endocrine system	-0.33	(-1.42; 0.76)
Nervous system	0.23	(-0.98; 1.44)
Sensory	-0.36	(-2.22; 1.50)
Psychiatric	-0.35	(-1.42; 0.72)
Rheumatic	0.51	(-0.58; 1.60)
Laboratory tests results		
Total protein	-1.10	(-2.08; -0.13)
25 (OH)D Vitamin	-0.008	(-0.02; 0.007)
B12 Vitamin	-0.001	(-0.004; 0.003)
Folic acid	0.001	(-0.05; 0.06)
Total cholesterol	-0.004	(-0.01; 0.007)
HDL Cholesterol	-0.03	(-0.07; -0.002)
LDL Cholesterol	0.001	(-0.01; 0.01)
Triglycerides	-0.001	(-0.01; 0.009)
Anthropometric variables		
Calf circumference	-0.08	(-0.18; 0.02)
Arm circumference	-0.079	(-0.15; -0.01)
Tibia bone length from foot base to the knee	-0.003	(-0.10; 0.10)
Thickness of under the shoulder skinfold	0.05	(-0.007; 0.12)
Skinfold of arm triceps muscle	0.06	(-0.008; 0.12)

260 b - coefficient from linear regression

261 *3.3. Moderation Model*

262 Table 3 presents the results concerning testing moderators of relationship between total protein
263 concentration, and the value of the GDS-SF scale, which is equal to occurrence of interactions

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between total protein, and the examined moderator. For this, estimates of the linear regression models were presented (separately for each moderator): model 1 involving total protein, and the examined variable and model 2 includes interaction between total protein concentration, and the examined variable. Moreover, determination coefficients (R^2) and its change(ΔR^2), when the interaction term was incorporated, were given.

Among the comorbidities, sensory disorders, significantly affected the relationship between the total protein concentration, and the risk of depression occurrence, estimated using the GDS-SF scale, increasing a part of the explained variability to 8% (ΔR^2=0.035) Figure 2. There was a stronger and significant association between the total protein concentration, and GDS-SF in participants with sensory disorders (b = - 6.42, 95% CI - 11.27 to - 1.58), in comparison to examined patients without such disorders (b = - 0.90, 95% CI - 1.89 to 0.08). However, in the model with interaction, both protein (b = - 11.95, 95% CI -21.67 to - 2.21), and the sensory disorders (b = - 39.7, 95% CI 23.75 to -162.29), were significantly related to the dependent variable. This means, that outside of the significant interaction, main effect (protein concentration) was also significant.

In the case of the other analysed diseases, there was no significant moderation effect observed.

Table 3. Moderation effect tested for the correlation between depression and protein concentration.

Model	Moderator coefficient (95% CI)	Protein coefficient (95% CI)	Interaction coefficient	F
Gender				
R^2 = 0.04	2.28 (-13.40; 17.96)	- 0.77 (-3.75; 2.21)	0.27 (-2.50; 1.97)	1.81
ΔR^2 = 0.0004	0.42 (- 0.86; 1.69)	-1.11 (-2.09; - 0.13)		2.71
Age				
R^2 = 0.037	0.06 (-56.86; 77.60)	- 0.44 (-9.94; 9.06)	- 0.008 (- 0.12; 0.11)	1.66
ΔR^2 = 0.0001	0.0002 (-0.065; 0.065)	-1.1 (-2.15; - 0.056)		2.49
Comorbidities				
Respiratory system				
R^2 = 0.06	- 0.67 (-18.78; 17.43)	- 0.89 (-5.73; 3.95)*	- 0.10 (-2.69; 2.48)	2.86
ΔR^2 = 0.000	-1.41 (-2.89; 0.08)	-1.09 (-2.005; 0.12)*		4.33
Endocrine system				
R^2 = 0.05	-8.34 (-22.14; 5.46)	-2.84 (-5.97; .28)	1.17 (- 0.80; 3.14)	2.16
ΔR^2 = 0.01	-0.18 (-1.26; 0.90)	-1.08 (-2.07; - 0.10)		2.55
Nervous system				
R^2 = 0.04	6.86 (-9.29; 23.01)	0.51 (-3.72; 4.73)	- 0.93 (-3.26; 1.39)	2.01
ΔR^2 = 0.005	0.39 (-0.81; 1.59)	-1.14 (-2.13; - 0.16)*		2.71
Sensory				
R^2 = 0.075	-39.7 (-74.85; -4.55)	-11.95 (-21.69; -2.21)	5.52 (0.58; 10.47)	3.44
ΔR^2 = 0.035*	-0.49 (-2.33; 1.35)	-1.12 (-2.10; -0.14)*		2.64
Psychiatric				
R^2 = 0.043	0.09 (-13.69; 13.87)	-1.04 (-4.33; 2.24)	- 0.05(-2.01; 1.92)	1.89
ΔR^2 = 0.000	-0.24 (-1.29; 0.82)	-1.12 (-2.08; - 0.16)*		2.86
Rheumatic				
R^2 = 0.046	1.59 (-12.31; 15.49)	- 0.93 (-3.92; 2.07)	- 0.14 (-2.12; 1.83)	2.05
ΔR^2 = .0002	0.58 (-0.49; 1.64)	-1.13 (-2.11; - 0.16)*		3.08

R^2 –coefficient of determination, ΔR^2 – increase R^2 due to interaction, F –test static from model

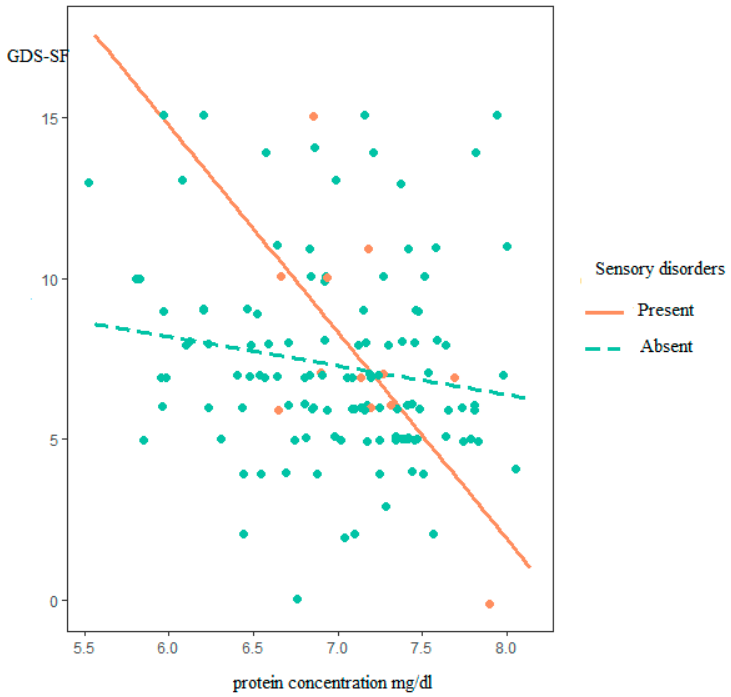

Figure 1. *Moderation analysis.*

3.4. Mediation Model

Table 4 shows the result of testing the mediation effect with models of linear regression. Multipleregression was used in order to assess whether laboratory parameters, anthropometric parameters, and the results of the Barthel index were mediators of the relationship between total protein concentration, and the assessment of the risk of depression occurrence (GDS-SF).Among the examined, indirect effect of 25 (OH)D vitamin concentration (b = - 0.162, 95 % CI - 0.452 to - 0.015), was significant, as well as for the Barthel index (b = - 0.22, 95% CI - 0.54 to - 0.05). In both cases, direct effect was statistically insignificant (because there was no statistically significant relationship between total protein concentration, and GDS-SF, after controlling for 25 (OH)D vitamin (coefficient for protein: b = -.88, 95% CI -1.87 to 0.11), as well as after controlling values of Barthel index (coefficient for protein: b = - 0.79, 95% CI - 1.78 to 0.21) - (direct effect). Therefore, we can speak about full mediation of the relationship between GDS-SF, and total protein concentration through 25 (OH)D vitamin and the Barthel index. This means, that the relationship between total protein concentration, and the GDS-SF is transmitted through assessment of the Barthel index and 25 (OH)D vitamin (mediator).

304 **Table 4.** Mediation effect tested for correlation between depression and protein concentration.

	Mediator (M)		Direct effect of protein→ GDS-SF		Indirect effect of protein→M→GDS-SF	
	b	95% Cl	b	95% CI	b	95% CI
Laboratory parameters:						
25 (OH)D vitamin	- 0.05	(- 0.10; - 0.007)	- 0.786	(-1.78; 0.21)	- 0.162	(- 0.45; - 0.01)
B12 vitamin	- 0.0003	(- 0.004; 0.003)	-1.09	(-2.12; - 0.06)	- 0.012	(- 0.31; 0.13)
Folic acid	0.045	(-0.05; 0.14)	-1.135	(-2.12; - 0.15)	0.032	(- 0.04; 0.23)
Total Cholesterol	- 0.003	(- 0.01; 0.007)	-1.078	(-2.06; - 0.09)	- 0.027	(- 0.25; 0.04)
HDL Cholesterol	-0 .027	(- 0.06; 0.006)	- 0.908	(-1.91; - 0.09)	- 0.197	(- 0.63; 0.01)
LDL Cholesterol	0.0004	(- 0.13; 0.014)	- 1.10	(-2.08; - 0.12)	- 0.0013	(- 0.13; 0.09)
Triglycerides	0.001	(- 0.008; 0.01)	-1.132	(-2.13; - 0.13)	0.027	(- 0.12; 0.30)
Result in the Barthel index	-0.02	(- 0.04; - 0.0002)	- 0.882	(-1.87; 0.11)	- 0.223	(- 0.54; - 0.05)
Anthropometric variables:						
Calf circumference (cm)	-0.073	(- 0.17; 0.02)	-1.039	(-2.01; - 0.07)	- .035	(- 0.35; 0.07)
Arm circumference (cm)	-0.141	(- 0.25; - 0.035)	- 0.900	(-1.86; 0.06)	- 0.174	(- 0.50; 0.02)
Tibia bone length from foot base to the knee (cm)	-0.011	(- 0.11; 0.09)	-1.082	(-2.06; - 0.10)	0.008	(- 0.12; 0.24)
Thickness of under the shoulder skinfold (cm)	0.05	(- 0.01; 0.11)	-1.014	(-1.99; - 0.04)	- 0.059	(- 0.50; 0.06)
Arm triceps muscle skinfold	0.05	(- 0.01; 0.12)	-1.014	(-1.99; - 0.04)	- 0.600	(- 0.47; 0.07)

305 b - coefficient from linear regression

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4. Discussion

Our study results concern a certain group of patients from an older age group with physical function impairment in the Barthel index (0-85 points) with comorbidities, requiring assistance of carers (professional and informal) concerning activities of daily living in home conditions, with a medium time span of using long-term care (3.91; SD = 2.61). Literature review shows, that in this group of patients, the studies are scarce and results of empirical studies are not published frequently.

Physical function impairment and hypokinesis connected with it, is reflected in reaction disorders in physiological and biochemical reactions of human organism. Ferrando et. al. [13] shows that the loss of protein in the organism, caused by lack of physical activity, connected with patients long-term time spent in bed, is mainly the result of decrease in muscle protein synthesis, and that the decrease is reflected both in the systemic parameters, and in skeletal muscles. The decrease in protein synthesis was connected with the corresponding decrease in the sum of intracellular amino-acid composition connected with protein decomposition and internal transport.

In our study, in the group of patients with physical function impairment, we found a mediating relationship between total protein concentration, and intensification of the depression risk GDS-SF. The mediators of this relationship were a low function impairment of the patients in the Barthel index, and low levels of 25 (OH)D vitamin. The theory named by the authors *Social Signal Transduction Theory of Depression* connects psychological factors (psycho-social), immune system response, and depression. Depression is connected with emergence concerning chronic state of immune response of moderate strength, and compensative activation of the system counter measuring the inflammation (CIRS, *anti-inflammatory reflex system*) [23]. It is accompanied by increased oxidative stress, and creation of antibodies aimed by protein, modified as a result of its action [24-26].

In clinical practice of psychiatric care, and home family care. the knowledge of the particular types of cells, and protein engaged in immune response, is not the matter of daily practice, and the examination concerning levels of particular pro-inflammatory cytokines, is unlikely to become a standard for the early diagnosis of depression. Our study showed that simple test on total protein of blood serum in patients with physical function impairment, can significantly affect the diagnosis of early depression symptoms, and the moderating factor of this correlation might also be a low level of 25 (OH)D vitamin.

A frequent reason for vitamin D deficiency is the decrease of synthesis of active form of vitamin D in kidneys. It can be said, that this is a physiological phenomenon concerning older adults, but also people with mobility disorders, frequently suffering from kidney disorders. Additionally, those people avoid exposition to sunlight [27]. The receptor for vitamin D is located in the brain, its deficiency not only impair mental functions, but also the development of selected psychiatric disorders, such as schizophrenia and depression [28, 29]. Zanetidouet al. [30] believes that vitamin D supplementation in older patients with coexisting dementia, can result in the decrease of depression symptoms.

In the study of possible mediating effect of depression symptoms (GDS-SF M = 3.5; SD = 3.2), correlation between ADL results (M = 96.2, SD = 8.1), and quality of life QOL in ambulatory community of older adults over the age of 65 (n = 490), it was discovered that depression is the mediator of the relationship between the modified Barthel index (MBI), and physical, psychological and environmental quality of life facets WHOQOL-BREF [31]. Because our study concerned the patients with impaired physical function (the Barthel index M = 43.20; SD = 27.06), and higher intensity of depressive disorders (M = 7.34; SD = 3,1), they show slightly different model of mediation effect, with the involvement of, at least, two similar variables (depression and function impairment).

Initial conclusion is that the mediation effect can be true and deserves further confirmation. This discovery may suggest, that in older adults with physical function impairment under home care, the risk of depression development might be controlled, if the simple biochemical blood

parameters, such as total protein and 25 (OH)D vitamin, would be appropriately managed in clinical practice of long-term care.

4.1. Implications of the present findings

The study also has implications for policy concerning people with physical function impairment under care in home conditions. Depression symptoms significantly affect the quality of life of both, the patient, and the informal carer, including the environment of care provision, and social relations. This discovery means that there is a need for public effort in every possible aspect to effectively manage the risk of depression occurrence in this group of patients.

4.2. Limitations

The limitations of the current study are as follows. First of all, the participants were recruited intentionally from communities with long-term care, rather than selected under randomisation. Cross-sectional character of the study, limits its strength to causal inference. Secondly, results of the studies are based on a relatively small sample group, which might also affect the generalisation of the obtained study results. A prospective, longitudinal, supplementary study is recommended in a future programme, in order to confirm the mediation effect of the risk of depression symptoms in relation to coefficient of total protein in blood serum, registering of parameters of physical function of the patients and the levels of the 25 (OH)D vitamin.

5. Conclusions

Risk of depression particularly affects older adults with chronic diseases and physical function impairment under home care. What is more, mediation effect of depression symptoms stays in relation to the levels of total protein in blood serum, and the mediators are probably low physical function, and low level of 25 (OH)D vitamin. Moreover, screening tests of simple laboratory blood indices, and their control, may decrease the risk of depression in older adults with physical function impairments. A cohort, control study is suggested to confirm our hypothesis.

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