RESEARCH ARTICLE

Received: 10 DEC 2024 | Accepted: 2 JAN 2025 | **DOI:** https://doi.org/10.57849/ulisboa.fm.jscml.0000001.2025

JORNAL DA SOCIEDADE DAS CIÊNCIAS MÉDICAS DE LISBOA

Frailty and nutritional status in institutionalized elderly patients with neurodegenerative disorders

Diana Miranda [1,2], **Vânia Costa** [3], **Rita Cardoso** [1,2], **Nilza Gonçalves** [2,4], **Ana Castro-Caldas** [1,4], **Joaquim J. Ferreira** [1,2,4]

[1] CNS- Campus Neurológico, Torres Vedras, Portugal

[2] Laboratory of Clinical Pharmacology and Therapeutics, Faculdade de Medicina, Universidade de Lisboa, Lisbon, Portugal

[3] Instituto Politécnico de Lisboa, Escola Superior de Tecnologia da Saúde de Lisboa, Lisbon, Portugal

[4] Instituto de Medicina Molecular, Faculdade de Medicina, Universidade de Lisboa, Lisbon, Portugal

✉ **Corresponding author:**
Diana Miranda
CNS- Campus Neurológico,
Torres Vedras, Portugal
Bairro de Santo António 47, 2560-280
Torres Vedras, Lisboa, Portugal
Tel: +351 261330701
E-mail: diana.santos.miranda@gmail.com

ABSTRACT: **Introduction:** Frailty is a geriatric syndrome defined as a state of increased vulnerability to negative health outcomes that is considered the most powerful predictor of disability, dependence, institutionalization and death, and so considered a major health burden. Malnutrition has been described to be independently associated with frailty. **Objectives:** Primary objective was to describe the frequency of frailty in institutionalized patients with neurodegenerative disorders. Secondary objectives were to describe the frequency of undernutrition and to evaluate the correlation between frailty and nutritional status. **Methods:** A cross-sectional observational pilot study was performed. All patients aged 65 years and older with at least one neurodegenerative disorder admitted in CNS- Campus Neurológico were included. A nutritional assessment, through the Mini Nutritional Assessment (MNA), anthropometric measurements and the Edinburgh Feeding Evaluation in Dementia Questionnaire (EdFED-Q), and a frailty assessment, through the Marigliano-Cacciafesta Polypathological Scale (MCPS) and the Clinical Frailty Scale (CFS), were conducted. **Results:** 76 participants were included with a mean age of 76±6.8 years. Parkinsonian syndromes represented 82.9% of the sample. The frequency of frailty was 71.1%. Patients with atypical parkinsonism were significantly frailer than patients with Parkinson's disease (PD) (85.7 and 60%, respectively). 69.3% of the patients with dementia were frail. The frequency of undernutrition (and risk of) was 73.7%. Although not statistically significant, undernutrition was more frequent in dementia syndromes, followed by atypical parkinsonism and PD (30.8, 21.2 and 10%, respectively). Significant correlations were found between all the nutritional assessment parameters and the MCPS, being the strongest with the MNA and the EdFED-Q. **Conclusions:** The prevalence of frailty in institutionalized patients with neurodegenerative disorders is high, along with the prevalence of undernutrition. Frailty and nutritional status parameters share significant correlations.

KEY WORDS: Frailty; Elderly; Nutritional status; Parkinsonism; Dementia

INTRODUCTION

Frailty is a common geriatric syndrome that results mostly from the cumulative decline of multiple physiological systems and their reserves that are associated with the ageing process[1-6]. This decline manifests as a state of increased vulnerability to negative outcomes when facing a stress, this increased vulnerability is due to the decreased ability to regain homeostasis and functional abilities[1,5-10].

Common symptoms of frailty are extreme fatigue, unintended weight loss, frequent infections, slow gait, muscle weakness, and low energy expenditure[1,7,11]. Balance and gait impairments, fluctuating confusion, delirium, and impaired awareness are considered major features of frailty and may occur as outcomes of frailty after a stress event[1,12-14].

The prevalence of frailty increases with age: it is estimated that 7% of adults aged 65 years are frail worldwide, while in those over 80 years it increases to 20%[1,4,11,15]. In healthcare institutions this prevalence is expected to be higher, and despite the heterogeneous results from the few studies that have been conducted, it is estimated that frailty affects nearly half the residents of healthcare institutions[16-18].

The physiopathology of frailty is a complex multifactorial process[1,11]. Although universal consensus regarding the operational criteria for assessing frailty is lacking, the physical model, known as the Frailty Phenotype [FP], is the most used and cited instrument to assess frailty, mainly in community-dwelling settings[19-22]. To assess all diagnostic criteria from the FP, the person must be able to comply, both physically and mentally, to perform the required tasks, consequently the validation study excluded patients with Parkinson's disease [PD], stroke, a history of depression, and cognitive impairment [CI][7,23].

Most of the validation studies for other instruments that assess frailty excluded dementia or CI and/or PD, making it difficult to assess frailty with validated instruments in this population[24].

Amici and colleagues designed an 11-item scale, the Marigliano-Cacciafesta Polypathological Scale [MCPS], that assesses the presence and severity of frailty by identifying and classifying the possible severity of disorders related to 11 physiological systems (such as neurological disorders, respiratory, renal, metabolism and nutritional status, and cognitive state and mood)[2].

Frailty and neurodegenerative diseases, such as PD and dementia syndromes, share common symptoms like balance and gait impairments, delirium, fluctuating confusion, impaired awareness, and disability that fluctuates over time[7,11,25,26]. For these reasons, it seems reasonable to hypothesize that the prevalence of frailty in this population is high[7,11,25,26].

The prevalence of malnutrition in the elderly is heterogeneous and rises as the level of care increases[27-30]. Nutritional status and frailty share a close relationship, being estimated that 90% of community-dwelling elders at risk of malnutrition are either prefrail or frail[31]. Malnutrition seems independently associated with frailty[32].

The primary objective is to describe the frequency of frailty in institutionalized patients with neurodegenerative disorders in the moment of admission in a healthcare institution. The secondary objectives are: *a)* To describe the frequency of undernutrition and risk of undernutrition; *b)* To evaluate the correlation between frailty and nutritional status; *c)* To evaluate the correlation between the MCPS and CFS.

MATERIALS AND METHODS

Study design and population

A cross-sectional observational pilot study was performed. All patients 65 years and older who were consecutively admitted to CNS - Campus Neurológico with at least one of the following neurodegenerative disorders were included:

a) Dementia syndromes, such as Alzheimer's disease (AD), frontotemporal dementia (FTD), vascular dementia (VD), or other non-specified dementia syndromes;
b) Parkinsonian syndromes, such as PD, Lewy body dementia (LBD), progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), multiple system atrophy (MSA), or vascular parkinsonism (VP);
c) Motor neuron disease (MND).

This study was approved by both the Scientific Board of the Faculty of Medicine of the University of Lisbon (FMUL) and by the Ethics Committee of CNS-Campus Neurológico (CNS) in 21st November 2017 and 1st February 2018, respectively.

Written informed consent to participate in the study was provided by all patients who met the inclusion criteria. This consent was obtained from a legal representative if the patient had dementia.

Data collection and Assessment protocol

Data collection was performed for 4 months within the first 24-48 hours after the patient was admitted. Sociodemographic information was collected, as was the main neurodegenerative disorder that had been diagnosed and its severity rated according to:

a) The Hoehn & Yahr scale (H&Y) for parkinsonian syndromes[33]
b) The Clinical Dementia Rating (CDR) for dementia syndromes[34]

Frailty was assessed with the MCPS and the Clinical Frailty Scale (CFS). Global frequency of frailty according to the MCPS was considered as the sum of medium-severe, severe and very severe states of the assessment tool, while for CFS a score of 4 or more.

Nutritional status was assessed with the Mini Nutritional Assessment (MNA), Body Mass Index (BMI) and the Edinburgh Feeding Evaluation in Dementia Questionnaire (EdFED-Q).

Statistical analysis

The distribution of the data was analysed by skewness and kurtosis, and normal distribution was considered when the variable followed a symmetric and mesocuric presentation.

All data was analysed using descriptive statistics: categorical variables through relative frequencies, and continuous variables through mean and standard deviation.

The Spearman's correlation test was used to assess the following correlations:

a) The correlation between the MCPS and the CFS
b) The correlation between the CFS and the BMI, MNA, and the EdFED-Q

The Pearson's correlation test was used to assess the following correlations:

a) The correlation between the MCPS and the H&Y (severity of parkinsonian syndromes)
b) The correlation between the MCPS and the CDR (severity of dementia syndromes)
c) The correlation between the MCPS and the BMI, MNA and the EdFED-Q
d) The correlation between the H&Y and the MNA and the EdFED-Q

To assess differences between the mean values of independent groups, the Mann- Whitney test was used for the following variables: age, MCPS score, MNA score, BMI value, and the EdFED-Q. The difference between median values of categorical variables such as the H&Y and the CFS with the Chi square test.

Statistical significance was considered ≤0.05 for all tests.

RESULTS

A total of 76 participants (69.7% males) were included in this study at the moment of admission, from which 82.9% were Parkinsonian syndromes. No participant with MND was included. Due to the low number of participants with PSP, LBD, MSA, CBD, VP, and non-specified parkinsonian syndromes, all these diseases were grouped in a single group: "Atypical parkinsonism"[35].

Frailty

According to the MCPS and the CFS most of the participants were medium-severely frail (46.1%) and severely frail (44.7%), respectively (table 1).

Table 2 displays data regarding the sociodemographic information, clinical data, and descriptive analysis of frailty and nutritional status.

TABLE 1. Frailty frequency according to the Marigliano-Cacciafesta Polypathological Scale and to the Clinical Frailty Scale.

Marigliano-Cacciafesta Polypathological Scale (n=76)		Clinical Frailty Scale (n=76)	
Classification	**Frequency (%)**	**Classification**	**Frequency (%)**
Slight	6.6 (n=5)	Managing well	3.9 (n=3)
Medium	22.4 (n=17)	Vulnerable	9.2 (n=7)
Medium-severe	46.1 (n=35)	Mildly frail	10.5 (n=8)
Severe	15.8 (n=12)	Moderately frail	27.6 (n=21)
Very severe	9.2 (n=7)	Severely frail	44.7 (n=34)
		Very severely frail	3.9 (n=3)

TABLE 2. Sociodemographic and clinical data of the participants in the admission moment.

	All participants (n=76)	Parkinsonian syndromes (n=63)									Dementia syndromes (n=13)			p [b]
		Parkinson's disease (n=30)	Atypical parkinsonism (n=33)	p [a]	Atypical parkinsonism diagnoses						Alzheimer's disease (n=5)	FTD (n=4)	Non-specified dementia syndrome (n=4)	
					LBD (n=12)	PSP (n=5)	MSA (n=4)	Corticobasal degeneration (n=3)	Vascular parkinsonism (n=2)	Non-specified parkinsonian syndrome (n=7)				
Age (years)	76±6.8	75.1±5.5	75.8±7.4	0.68[1]	78.4±8.4	76.6±7.8	72±6.6	74.7±4.0	72.0±1.4	74.6±7.7	80.0±6.6	82.5±10.7	73.0±2.9	0.18[1]
Gender (female/male)	23/53	7/23	–	–	2/10	1/4	0/4	½	1/1	4/3	4/1	2/2	1/3	–
Severity of the disease														
Hoehn & Yahr	4 (4)	3 (4)	5 (4)	0.05 [2*]	4 (4)	5 (2)	4.5 (2)	5 (0)	4.5 (1)	5 (3)	–	–	–	–
Clinical dementia rating	2 (2.5)	–	–	–	–	–	–	–	–	–	2 (1)	2.5 (1)	2 (2.5)	–
Frailty														
MCPS	38.3±21.0	31.8±18.1	45.2±22.5	0.01 [1*]	43.6±19.9	37.6±17.5	4 9.5±21.1	76.0±26.9	42.0±29.7	38.1±23.4	26.2±14.8	48.3±24.2	35.0±17.5	0.76[1]
Clinical Frailty Scale	3 (5)	3 (5)	2 (5)	0.31[2]	2 (4)	2 (2)	2 (1)	2 (1)	3 (0)	2 (4)	3 (3)	2.5 (1)	2.5 (2)	0.89[2]
Nutritional status														
MNA	20.3±5.0	21.3±4.7	19.8±5	0.18 [1]	19.7±4.1	21.4±3.9	17.8±6.6	14.3±6.3	25.0±0.7	20.9±5.3	18.6±6.5	19.9±6.9	19.5±3.2	0.46[1]
Body mass index	26.1±5.3	26.3±5.1	26.3±5.8	0.69 [1]	26.9±7.3	26.2±2.6	25.9±4.9	21.2±5.0	31.3±10.3	26.4±4.2	22.1±2.2	28.5±6.8	25.3±2.9	0.51[1]
EdFED-Q	3.7±3.7	2.6±3.4	4.5±4	0.01 [1*]	4.1±3.1	2.8±3.1	4.8±4.1	8.7±6.4	1.5±0.7	5.4±5.0	4.2±1.9	6.0±4.2	2.5±1.9	0.22[1]

Mean values ± standard deviation; Median values (interquartile range); **MCPS** (Marigliano-Cacciafesta Polypathological Scale); **MNA** (Mini Nutritional Assessment); **SGA** (Subjective Global Assessment); **EdFED-Q** (Edinburgh Feeding Evaluation in Dementia Questionnaire); **LBD** (Lewy Body Dementia); **PSP** (Progressive Supranuclear Palsy); **MSA** (Multiple Systems Atrophy); **FTD** (Frontotemporal dementia).

[a] p value for the comparison between Parkinson's disease and atypical parkinsonism groups;

[b] p value for the comparison between parkinsonian and dementia syndromes groups;

[1] p value for the Mann-Whitney test for independent samples;

[2] p value for the Chi square test for independent samples;

[*] Significant

Severe and very severe frailty was higher in atypical parkinsonism, followed by dementia syndromes (figure 1).

The MCPS score and the CFS classification were statistically significant correlated (rs=-0.665; p=0.000). This correlation was stronger in dementia syndromes (rs= -0.773; p=0.002), followed by atypical parkinsonism (rs= -0.635; p=0.000) and PD (rs= -0.501; p=0.005).

Nutritional status

The global frequency of undernutrition (and risk of) was 73.7% according to the MNA. Despite no statistically significant differences between parkinsonian and dementia syndromes, undernutrition seem more frequent in dementia (84.6%) followed by atypical parkinsonism (75.7%) (figure 2).

Most of the patients with PD were obese (30%) according to the BMI, while atypical parkinsonism were more frequently normal (30.3%) and dementia syndromes undernourished (23.1%) (figure 3).

Frailty and Nutritional status

Significant correlations were found between the nutritional assessment parameters and the MCPS. The MNA and the EdFED-Q scores both showed a strong correlation with the MCPS (table 3).

DISCUSSION

Frailty

In the present study, the frequency of frailty in institutionalized patients with neurodegenerative disorders is high (71.1%).

Due to the lack of studies examining frailty in institutionalized patients with neurodegenerative disorders it is difficult to compare our results[16]. However, the prevalence found in our study was considerably higher than in previous studies with community-dwelling older adults, since the overall prevalence of frailty in 10 European countries is 17%[15,31].

There is scant evidence on the prevalence of frailty in nursing homes, possibly due to the practical limitations of using screening tools: the majority of tools require the physical or mental collaboration of the patient, which may be difficult in institutionalized individuals. The high levels of dependence, comorbidity, disabilities, and malnutrition over long-term care may contribute to making such screening difficult[16].

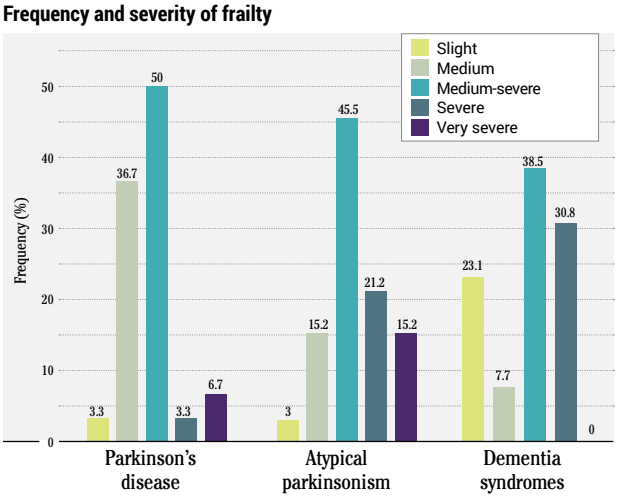

FIGURE 1. Frequency of the severity of frailty assessed by the Marigliano-Cacciafesta Polypathological Scale (MCPS) according to the neurodegenerative disorder (n=76).

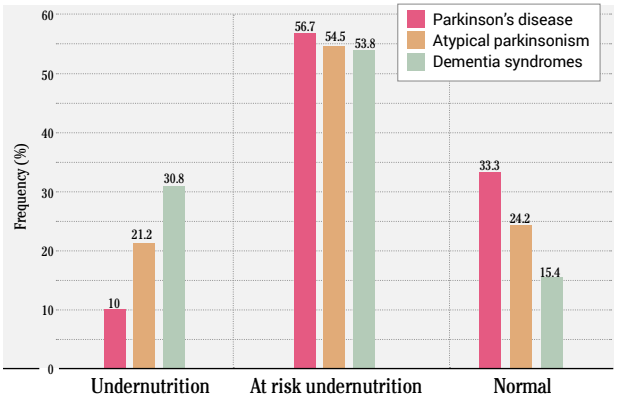

FIGURE 2. Frequency of nutritional status according to the Mini Nutritional Assessment (MNA) for the different neurodegenerative disorders (n=76).

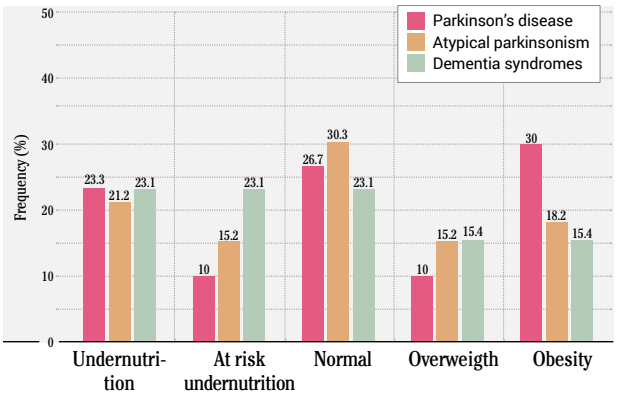

FIGURE 3. Frequency of nutritional status according to the body mass index (BMI) for the different neurodegenerative disorders (n=76).

TABLE 3. Correlations between frailty scales and nutritional parameters.

	Body mass index	MNA	EdFED-Q
MCPS	r= -0.363**	r= -0.732**	r= 0.714**
CFS	rs=0.227*	rs=0.629**	rs= -0.689**

MCPS (Marigliano-Cacciafesta Polypathological Scale), **CFS** (Clinical Frailty Scale), **MNA** (Mini Nutritional Assessment), **EdFED-Q** (Edinburgh Feeding Evaluation in Dementia Questionnaire). * $p<0.05$ ** $p<0.01$

A systematic review published by Kojima and colleagues assessed 9 studies of institutionalized elderly patients and estimated the prevalence of frailty to be 52%, and prefrailty to be 40% according to different assessment criteria (Frailty Phenotype, Clinical Frailty Scale, Edmonton Frail Scale, and two others)[16]. In our institutionalized elderly sample (average age of 76±6.8 years), the frequency of frailty was considerably higher, despite our sample being younger than those in the aforementioned systematic review (80.3 years)[16]. This suggests that the load of neurodegenerative disorders may influence the risk and/or severity of frailty even in those below the age of 80 years. However, it is impossible to make any conclusions as the clinical characteristics of the population pooled by the systematic review were not described[16].

Although few studies using the MCPS have been published, this tool has been considered useful for screening frailty and to program an intervention/rehabilitation as it allows for the severity of frailty to be stratified[36,37].

In our sample, participants with atypical parkinsonism presented more severe frailty than PD. Also, the atypical parkinsonism participants had greater disease severity compared to those with PD. These differences are in concordance with the literature[38-42]. Atypical parkinsonism usually has a faster and more severe progression than PD, with a poor response to dopaminergic treatment, a worse prognosis, shorter survival, and more complications in the early stages[35,42]. Motor features such as early postural instability and falls, early dysarthria and dysphagia, dystonia, and impaired response to levodopa treatment are frequent in atypical parkinsonism, along with early and severe cognitive and behavioral changes, apraxia, hallucinations, orthostatic hypotension, and urinary dysfunction[35].

In our study, the frequency of frailty in patients with Parkinsonian syndromes was 70.6% (corresponds to the sum of medium-severe, severe, and very severe frailty). Specifically, in PD the frequency was 60% and in atypical parkinsonism 85.7%.

In a sample of 133 patients in an acute hospital setting with an average age of 74 years, the frequency of frailty was 75.9%, which is similar to our results although assessed with different criteria[43]. Also, 76.7% of those patients were malnourished and at risk of malnutrition[43].

Although moderate, we found a statistically significant correlation between frailty and the severity of Parkinsonian syndromes[44]. A small number of studies have described the prevalence of frailty in PD, and some have demonstrated that women with PD have a higher risk of frailty than men[25,26,45,46]. Despite this, the prevalence of frailty in PD has been reported to be high (69.4%)[47]. Furthermore, the severity of PD assessed with the unified Parkinson's disease rating scale and levodopa dose seems higher in frail patients[22,46,48].

The high frequency of frailty found in our study was expectedly high since some of the clinical features of Parkinsonian and dementia syndromes are considered major risk factors for frailty and are part of several assessment tools. Slow gait speed is a common feature of Parkinsonian syndromes, along with postural instability, risk of falls, and balance impairment[49-51]. Depression, cognitive decline, malnutrition, and urinary dysfunction may also occur especially in advanced stages[46,52-54]. Since most of our participants were rated as having a high severity of the neurodegenerative disease, this frequency seems reasonable.

Frailty in this specific population is frequent and particularly more severe in patients with atypical parkinsonism. These results highlight the importance of an early screening for frailty.

Nutritional status

The frequency of undernutrition and the risk of undernutrition according to the MNA in our study is also high, and in concordance with a previous study performed in similar population (73.7 versus 77.1% respectively[55]), and, in general, higher than published studies in nursing homes or community[28,29,31,32,55-58].

Besides the wide variation, depending on the applied methodology, in PD patients the general prevalence of malnutrition varies between 0-24% while 3 to 60% are estimated to be at risk[59]. When assessed with the MNA, the variation between studies decreases to 0-2% of malnourished and 20-34% at risk[59]. Our results

in PD patients regarding undernutrition and risk of undernutrition (66.7%) were similar to the ones obtained in a sample of 34 institutionalized PD elders, where 62% were malnourished or at risk at the admission according to the MNA[55].

Body weight and PD share a relation that is still unexplained[52]. Weight loss is frequent, especially in advanced stages of the disease, and it has been shown that weight loss and low body weight (and BMI) are associated with a higher risk of developing dyskinesia due to the higher ratio of levodopa dose per kilogram (>6mg/kg)[60]. Also, weight loss is associated with mortality and poor quality of life[60,61].

The frequency of undernutrition or risk of undernutrition in patients with LBD in our study (n=12) was 83.3%, which is higher than the one found by Roque and colleagues in a community setting (77.3%)[62].

Regarding dementia syndromes, 84.6% of the patients were undernourished or at risk according to the MNA. Specifically, in AD patients (n=5), 80% was undernourished or at risk of undernutrition. Despite the small number of patients with AD included, this frequency is higher than the one found in community-dwelling AD elders (varies from 14.1 to 55.9%)[62].

Frailty and Nutritional Status

Interestingly, the general frequency of undernutrition (or risk of) is very similar to the frequency of frailty. This goes in favour of the strong correlation between MNA and MCPS that was demonstrated in our study ($r = -0.732$; $p<0.01$) and in line with previous studies regarding the correlation between nutritional status and frailty[31,43]. The MNA assesses several risk factors for frailty, namely weight loss and low BMI, reduced mobility, and low nutritional intake. In the parkinsonian syndromes, the undernourished participants were also the ones with more severe frailty while the patients at risk of undernutrition were also medium-severely frail. In dementia syndromes similar tendency was verified.

On the other hand, the correlation between BMI and MCPS was weak ($r = -0.363$; $p<0.01$). In the MCPS, nutritional status can be assessed with the MNA or the BMI, however the considered BMI cut-offs are commonly used for adults and not for elders. This means that an elder can be mistakenly considered overweight instead of normal since the reference value for normal in older adults is 24-26.9kg/m2 that is close to overweight cut-offs in adults (25-29.9kg/m2). Despite this, in our study we also found a U-shaped relation between frailty and BMI[63-65]. This relation was more obvious in parkinsonian syndromes than in dementia syndromes possibly due to the differences in the number of participants in both groups.

CONCLUSIONS

The frequency of frailty in institutionalized patients with neurodegenerative disorders is, as expected, high. Similar frequency of undernutrition (or risk of) was found. Nutritional status and frailty seem to be significantly correlated. Since inadequate nutrition and/or poor nutritional status are potentially treatable causes for frailty, it seems reasonable to further investigate the effects of therapeutic nutritional interventions to prevent and to treat frailty.

CONFLICT OF INTEREST STATEMENT AND FUNDING SOURCES: *All authors each declare no conflicts of interest and have approved the final article. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.*

REFERENCES

1. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752–62.
2. Amici A, Baratta A, Linguanti A, Giudice G, Servello A, Scalise C, et al. The Marigliano-Cacciafesta polypathological scale: A tool for assessing fragility. Arch Gerontol Geriatr. 2008;46(3):327–34.
3. Bonnefoy M, Berrut G, Lesourd B, Ferry M, Gilbert T, Guerin O, et al. Frailty and Nutrition : Searching for Evidence. (9).
4. Choi J, Ahn A, Kim S. Global Prevalence of Physical Frailty by Fried's Criteria in Community-Dwelling Elderly With National Population-Based Surveys. J Am Med Dir Assoc [Internet]. 2015;16(7):548–50. Available from: http://dx.doi.org/10.1016/j.jamda.2015.02.004
5. Chen X, Mao G, Leng SX. Frailty syndrome: An overview. Clin Interv Aging. 2014;9:433–41.
6. Rowe JW, Fried LP. Incorporating Frailty into Clinical Practice and Clinical Research. J frailty aging [Internet]. 2013 [cited 2018 Jun 5];2(3):126–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27070811
7. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in Older Adults: Evidence for a Phenotype. J Gerontol Med Sci Am. 2001;56(3):146–56.
8. Fielding RA. Frailty , Identification , Treatment , and Clinical Practice Commentary. 2014;18(5):2014.
9. Ritt M, Schwarz C, Kronawitter V, Delinic A, Bollheimer LC, Gassmann KG, et al. Analysis of Rockwood et al's Clinical Frailty Scale and Fried et al's frailty phenotype as predictors of mortality and other clinical outcomes in older patients who were admitted to a geriatric ward. J Nutr Heal Aging. 2015;19(10):1043–8.
10. Sinclair AJ, Rodriguez-Mañas L. Diabetes and Frailty: Two Converging Conditions? Can J Diabetes [Internet]. 2016 Feb [cited 2018 Jun 3];40(1):77–83. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26683240

11. International Association of Gerontology and Geriatrics. White book on frailty. J Frailty Aging. 2015;4.
12. Dani M, Owen LH, Jackson TA, Rockwood K, Sampson EL, Davis D. Delirium, Frailty, and Mortality: Interactions in a Prospective Study of Hospitalized Older People. Journals Gerontol Ser A [Internet]. 2018 Mar 2 [cited 2018 Jul 21];73(3):415–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29099916
13. Verloo H, Goulet C, Morin D, von Gunten A. Association between frailty and delirium in older adult patients discharged from hospital. Clin Interv Aging [Internet]. 2016 [cited 2018 Jul 21];11:55–63. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26848261
14. Cheng M-H, Chang S-F. Frailty as a Risk Factor for Falls Among Community Dwelling People: Evidence From a Meta-Analysis. J Nurs Scholarsh [Internet]. 2017 Sep [cited 2018 Jul 21];49(5):529–36. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28755453
15. Castell M-V, Sánchez M, Julián R, Queipo R, Martín S, Otero Á. Frailty prevalence and slow walking speed in persons age 65 and older: implications for primary care. BMC Fam Pract [Internet]. 2013 Dec 19 [cited 2018 Jun 16];14(1):86. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23782891
16. Kojima G. Prevalence of Frailty in Nursing Homes: A Systematic Review and Meta-Analysis. J Am Med Dir Assoc [Internet]. 2015;16(11):940–5. Available from: http://dx.doi.org/10.1016/j.jamda.2015.06.025
17. Tamura BK, Bell CL, Masaki KH, Amella EJ. Factors Associated With Weight Loss, Low BMI, and Malnutrition Among Nursing Home Patients: A Systematic Review of the Literature. J Am Med Dir Assoc [Internet]. 2013;14(9):649–55. Available from: http://dx.doi.org/10.1016/j.jamda.2013.02.022
18. Van Bokhorst-de van der Schueren MAE, Guaitoli PR, Jansma EP, de Vet HCW. A Systematic Review of Malnutrition Screening Tools for the Nursing Home Setting. J Am Med Dir Assoc [Internet]. 2014;15(3):171–84. Available from: http://dx.doi.org/10.1016/j.jamda.2013.10.006
19. Bieniek J, Wilczyński K, Szewieczek J. Fried frailty phenotype assessment components as applied to geriatric inpatients. Clin Interv Aging. 2016;11:453–9.
20. Apóstolo J, Cooke R, Bobrowicz-Campos E, Santana S, Marcucci M, Cano A, et al. Predicting risk and outcomes for frail older adults. JBI Database Syst Rev Implement Reports [Internet]. 2017 Apr [cited 2018 Jun 16];15(4):1154–208. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28398987
21. Buta BJ, Walston JD, Godino JG, Park M, Kalyani RR, Xue Q-L, et al. Frailty assessment instruments: Systematic characterization of the uses and contexts of highly-cited instruments. Ageing Res Rev [Internet]. 2016 Mar [cited 2018 Jun 16];26:53–61. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26674984
22. Bouillon K, Kivimaki M, Hamer M, Sabia S, Fransson EI, Singh-Manoux A, et al. Measures of frailty in population-based studies: an overview. BMC Geriatr [Internet]. 2013;13(1):64. Available from: http://bmcgeriatr.biomedcentral.com/articles/10.1186/1471-2318-13-64
23. Bernstein MA, Tucker KL, Ryan ND, O'Neill EF, Clements KM, Nelson ME, et al. Fried frailty phenotype assessment components as applied to geriatric inpatients. Clin Geriatr Med [Internet]. 2016;56(3):2009. Available from: http://dx.doi.org/10.1016/j.jamda.2013.10.006
24. Abellan Van Kan G, Rolland Y, Bergman H, Morley JE, Kritchevsky SB, Vellas B. The I.A.N.A. task force on frailty assessment of older people in clinical practice. J Nutr Heal Aging. 2008;12(1):29–37.
25. Roland KP, M. D. Cornett K, Theou O, Jakobi JM, Jones GR. Physical activity across frailty phenotypes in females with Parkinson's disease. J Aging Res. 2012;2012.
26. Roland KP, Cornett KMD, Theou O, Jakobi JM, Jones GR. Concurrence of Frailty and Parkinson's Disease. J Frailty Aging [Internet]. 2012 [cited 2018 Jun 3];1(3):123–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27093200
27. Isenring EA, Banks M, Ferguson M, Bauer JD. Beyond Malnutrition Screening: Appropriate Methods to Guide Nutrition Care for Aged Care Residents. J Acad Nutr Diet [Internet]. 2012 Mar [cited 2018 Mar 13];112(3):376–81. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22717197
28. Törmä J, Winblad U, Cederholm T, Saletti A. Does undernutrition still prevail among nursing home residents? Clin Nutr [Internet]. 2013;32(4):562–8. Available from: http://dx.doi.org/10.1016/j.clnu.2012.10.007
29. Agarwal E, Miller M, Yaxley A, Isenring E. Malnutrition in the elderly: A narrative review. Maturitas [Internet]. 2013;76(4):296–302. Available from: http://dx.doi.org/10.1016/j.maturitas.2013.07.013
30. Volkert D, Beck AM, Cederholm T, Cruz-Jentoft A, Goisser S, Hooper L, et al. ESPEN guideline on clinical nutrition and hydration in geriatrics. Clin Nutr [Internet]. 2018; Available from: https://doi.org/10.1016/j.clnu.2018.05.024
31. Bollwein J, Volkert D, Diekmann R, Kaiser MJ, Uter W, Vidal K, et al. Nutritional status according to the mini nutritional assessment (MNA®) and frailty in community dwelling older persons: A close relationship. J Nutr Health Aging [Internet]. 2013 Feb 9 [cited 2018 Jun 16];17(4):351–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23538658
32. Kurkcu M, Meijer RI, Lonterman S, Muller M, de van der Schueren MAE. The association between nutritional status and frailty characteristics among geriatric outpatients. Clin Nutr ESPEN [Internet]. 2017 Feb [cited 2018 Jun 17];23:112–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29460785
33. Martínez-Martín P, Rodríguez-Blázquez C, Alvarez M, Arakaki T, Arillo VC, Chaná P, et al. Parkinson's disease severity levels and MDS-Unified Parkinson's Disease Rating Scale. Park Relat Disord. 2015;21(1):50–4.
34. Clinical Dementia Rating (CDR) [Internet]. [cited 2017 Sep 27]. Available from: http://knightadrc.wustl.edu/cdr/cdr.htm
35. Litwan I. What is an Atypical Parkinsonian Disorder? Curr Clin Neurol [Internet]. 1978;I(1957):857–87. Available from: http://dx.doi.org/10.1016/B978-0-12-384430-9.50039-1
36. Martocchia A, Frugoni P, Indiano I, Tafaro L, Comite F, Amici A, et al. Screening of frailty in elderly patients with disability by the means of Marigliano-Cacciafesta polypathology scale (MCPS) and Canadian Study of Health and Aging (CSHA) scales. Arch Gerontol Geriatr [Internet]. 2013;56(2):339–42. Available from: http://dx.doi.org/10.1016/j.archger.2012.11.004
37. Martocchia A, Indiano I, Tafaro L, Frugoni P, Amici A, Cacciafesta M, et al. The evaluation of the presence of comorbidity by the Marigliano-Cacciafesta polypathology scale (MCPS) and the cumulative illness rating scale (CIRS) in elderly subjects with disability. Arch Gerontol Geriatr. 2009;49(1):150–2.
38. Tison F, Yekhlef F, Chrysostome V, Balestre E, Quinn NP, Poewe W, et al. Parkinsonism in multiple system atrophy: Natural history, severity (UPDRS-III), and disability assessment compared with Parkinson's disease. Mov Disord [Internet]. 2002 Jul [cited 2018 Jul 21];17(4):701–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12210859
39. Suzuki A, Mochizuki H, Ebihara Y, Shiomi K, Nakazato M. Body mass index and severity of parkinsonism in multiple system atrophy. Neurol Int [Internet]. 2017 Aug 29 [cited 2018 Jul 21];9(3):7276. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29071042
40. Radicati FG, Martinez Martin P, Fossati C, Chaudhuri KR, Torti M, Rodriguez Blazquez C, et al. Non motor symptoms in progressive supranuclear palsy: prevalence and severity. NPJ Park Dis [Internet]. 2017 [cited 2018 Jul 21];3:35. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29238748
41. Bluett B, Litvan I, Cheng S, Juncos J, Riley DE, Standaert DG, et al. Understanding falls in progressive supranuclear palsy. Parkinsonism Relat Disord [Internet]. 2017 Feb 1 [cited 2018 Jul 21];35:75–81. Available from: https://www.sciencedirect.com/science/article/pii/S1353802016304904

42. Müller J, Wenning GK, Jellinger K, McKee A, Poewe W, Litvan I. Progression of Hoehn and Yahr stages in Parkinsonian disorders: a clinicopathologic study. Neurology [Internet]. 2000 Sep 26 [cited 2018 Jul 10];55(6):888–91. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10994019
43. Dorner TE, Luger E, Tschinderle J, Stein K V., Haider S, Kapan A, et al. Association between nutritional status (MNA®-SF) and frailty (SHARE-FI) in acute hospitalised elderly patients. J Nutr Health Aging [Internet]. 2014 Mar 21 [cited 2018 Jun 16];18(3):264–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24626753
44. Tan AH, Hew YC, Lim S-Y, Ramli NM, Kamaruzzaman SB, Tan MP, et al. Altered body composition, sarcopenia, frailty, and their clinico-biological correlates, in Parkinson's disease. Parkinsonism Relat Disord [Internet]. 2018 Jun 13 [cited 2018 Sep 22];0(0). Available from: http://www.ncbi.nlm.nih.gov/pubmed/29914840
45. Ahmed NN, Shermanb SJ, VanWyckc D. Frailty in Parkinson's disease and its clinical implications. Park Relat Disord. 2008;(14):334–7.
46. Smith N, Brennan L, Gaunt DM, Ben-Shlomo Y, Henderson E, Peball M, et al. Frailty in Parkinson's Disease: A Systematic Review. J Parkinsons Dis [Internet]. 2019;9(3):104268. Available from: https://doi.org/10.1016/j.archger.2020.104268
47. Tan AH, Hew YC, Lim S-Y, Ramli NM, Kamaruzzaman SB, Tan MP, et al. Altered body composition, sarcopenia, frailty, and their clinico-biological correlates, in Parkinson's disease. Parkinsonism Relat Disord. 2018 Jun;0(0).
48. Panza F, Lozupone M, Solfrizzi V, Sardone R, Dibello V, Di Lena L, et al. Different Cognitive Frailty Models and Health-and Cognitive-related Outcomes in Older Age: From Epidemiology to Prevention. J Alzheimer's Dis. 2018;62(3):993–1012.
49. Benninger DH. Parkinson ' s disease. Handb Clin Neurol. 2013;
50. Contreras A, Grandas F. Risk of falls in Parkinson's disease: a cross-sectional study of 160 patients. Parkinsons Dis [Internet]. 2012 [cited 2018 Aug 27];2012:362572. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22292126
51. Santamato A, Ranieri M, Cinone N, Stuppiello LA, Valeno G, De Sanctis JL, et al. Postural and Balance Disorders in Patients with Parkinson's Disease: A Prospective Open-Label Feasibility Study with Two Months of Action Observation Treatment. Parkinsons Dis [Internet]. 2015 [cited 2018 Aug 27];2015:902738. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26798551
52. Ma K, Xiong N, Shen Y, Han C, Liu L, Zhang G, et al. Weight Loss and Malnutrition in Patients with Parkinson's Disease: Current Knowledge and Future Prospects. Front Aging Neurosci [Internet]. 2018 [cited 2018 Aug 27];10:1. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29403371
53. Varanese S, Birnbaum Z, Rossi R, Di Rocco A. Treatment of advanced Parkinson's disease. Parkinsons Dis [Internet]. 2011 Feb 7 [cited 2018 Aug 27];2010:480260. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21331376
54. Frucht SJ, Jain S. Parkinson disease: an update. Neurologist [Internet]. 2004 Jul [cited 2018 Aug 27];10(4):185–94. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15245584
55. Miranda D, Cardoso R, Gomes R, Guimarães I, Abreu DDE, Godinho C, et al. Undernutrition in institutionalized elderly patients with neurological diseases: comparison between different diagnostic criteria. J Nurs Home Res Sci. 2016;2(Cc):76–82.
56. Marshall S, Young A, Bauer J, Isenring E. Malnutrition in Geriatric Rehabilitation: Prevalence, Patient Outcomes, and Criterion Validity of the Scored Patient-Generated Subjective Global Assessment and the Mini Nutritional Assessment. J Acad Nutr Diet [Internet]. 2016;116(5):785–94. Available from: http://dx.doi.org/10.1016/j.jand.2015.06.013
57. Wells JL, Dumbrell AC. Nutrition and aging: assessment and treatment of compromised nutritional status in frail elderly patients. Clin Interv Aging. 2006;1(1):67–79.
58. De Morais C, Oliveira B, Afonso C, Lumbers M, Raats M, De Almeida MDV. Nutritional risk of European elderly. Eur J Clin Nutr [Internet]. 2013;67(11):1215–9. Available from: http://dx.doi.org/10.1038/ejcn.2013.175
59. Sheard JM, Ash S, Silburn PA, Kerr GK. Prevalence of malnutrition in Parkinson's disease: A systematic review. Nutr Rev. 2011;69(9):520–32.
60. Sharma JC, Vassallo M. Prognostic significance of weight changes in Parkinson ' s disease : the Park – weight phenotype. 2014;4:309–16.
61. Sheard JM. Malnutrition and Neurodegenerative Diseases. 2014;102–9.
62. Roque M, Salva A, Vellas B. Malnutrition in community-dwelling adults with dementia (Nutrialz Trial). J Nutr Heal Aging. 2013;17(4):295–9.
63. Rietman ML, van der a DL, van Oostrom SH, Picavet HSJ, Dollé MET, van Steeg H, et al. The Association Between BMI and Different Frailty Domains: A U-Shaped Curve? J Nutr Heal Aging. 2018;22(1):8–15.
64. Blaum CS, Xue QL, Michelon E, Semba RD, Fried LP. The Association Between Obesity and the Frailty Syndrome in Older Women: The Women's Health and Aging Studies. J Am Geriatr Soc [Internet]. 2005 Jun [cited 2018 Jun 2];53(6):927–34. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15935013
65. Hubbard RE, Lang IA, Llewellyn DJ, Rockwood K. Frailty, body mass index, and abdominal obesity in older people. Journals Gerontol - Ser A Biol Sci Med Sci [Internet]. 2010 Apr 1 [cited 2018 Jun 2];65 A(4):377–81. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19942592