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Nutritional and dietary intervention in the evolution of nutritional status and frailty in two units of the National Network of Integrated Continued Care

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Nutritional and dietary intervention in the evolution of nutritional status and frailty in two units of the National Network of Integrated Continued Care

Intervenção nutricional e alimentar na evolução do estado nutricional e da fragilidade em duas unidades da Rede Nacional de Cuidados Continuados Integrados

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Trabalho apresentado à Faculdade de Ciências da Nutrição e Alimentação da Universidade do Porto

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LIST OF PUBLICATIONS

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Castro MJ, Oliveira B, Afonso C. Translation and linguistic validation of the European Portuguese version of the PAIR (Physical Activity in Inpatient Rehabilitation) assessment. 2023 – Submitted for publication

ABBREVIATIONS

ARS-Norte Portuguese Health Organization of the North
BMI Body mass index
BW Body weight
BWL Body weight loss
CC Calf circumference
CES-D Centre for Epidemiological Studies Depression Scale
EFSA European Food Safety Authority
ESPEN European Society for Clinical Nutrition and Metabolism
HGS Handgrip strength (HGS)
HPP Hospital Particular de Paredes
ICOPE Integrated Care for Older People
ISAK International Society for the Advancement of Kinanthropometry
KGF Kilogram-force (kgf)
MNA Mini-Nutritional Assessment
MUAC Mid-upper arm circumference
RNCCI National Network of Integrated Continuing Care
ONS Oral Nutritional Supplements
PA Physical Activity
PAIR Physical Activity in Inpatient Rehabilitation
PEN-3S Portuguese Elderly Nutritional Status Surveillance System
QMCI-P Quick Mild Cognitive Impairment - Portuguese Version
UC Convalescence Unit
UMDR Medium Term and Rehabilitation Unit
WHO World Health Organization

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CHAPTER 1

GENERAL INTRODUCTION

According to data from the 2021 Census, the elderly population (which includes people over 65 years) in Portugal has increased by 20.6% compared to 2011, while the young population has decreased, characterized by a worsening of the ageing population[1].

The World Health Organization (WHO) and the United Nations propose to promote healthy ageing of the world's population between 2021-2030, with a change in the classic paradigm of restoring and promoting the health and quality of life of the older people, by proposing the "Decade of Healthy Ageing", which highlights the importance of older people and reducing their vulnerability in the current decade[2, 3]. The WHO defines older people as those aged 60 years and over[3].

According to the WHO, a quarter of older adults do not meet physical activity (PA) guidelines and sedentary behavior is associated with cardiometabolic risk factors and higher mortality rates, whilst even low-level PA has a negative correlation with health status[4-6]. Elderly patients who are admitted to hospitals typically exhibit substantially reduced levels of physical activity. Hence, it is imperative to utilize a recognized measurement technique to precisely measure it[4-6]. The lack of data on daily PA during hospitalization is a hindrance to implementing strategies that could enhance PA. Typically, patients admitted to hospitals have reduced muscle mass and functional capacity[7, 8]. It is beneficial to encourage them to participate in physical exercise and daily activities, as this could have a positive impact on their rehabilitation[8-10].

On the other hand, malnutrition, used here as a synonym for undernutrition, is widespread among the world's elderly population, with an estimated one quarter of this age group malnourished or at risk of malnutrition[11].

The European Society for Clinical Nutrition and Metabolism (ESPEN) describes malnutrition as "a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease"[12]. Clinical malnutrition results from an imbalance between macronutrient intake and dietary requirements, leading to a measurable reduction in skeletal muscle and consequently to body weight loss (BWL)[2].

Once thought to be associated only with hunger, malnutrition is now linked with poorer patient and health system outcomes and with adverse functional and

clinical outcomes, such as obesity, cachexia, undernutrition, micronutrient abnormalities and frailty[13-16]. The diagnosis of malnutrition should be related to one of three causal subcategories: disease-related malnutrition due to inflammation, disease-related malnutrition without perceived inflammation, and malnutrition due to starvation not related to disease[11, 13, 14].

Depending on the type of malnutrition, protein catabolism may be accentuated. For example, disease-related malnutrition leads to a rapid loss of skeletal muscle mass, whereas age-related malnutrition is associated with a slower but progressive loss of muscle mass. This reduction in muscle mass is one of the consequences of protein catabolism, which also affects strength and muscle function[2]. It is known that full functional recovery is unlikely due to the loss of skeletal muscle mass, even with optimal nutritional support[14]. The prevalence of malnutrition in older adults increases with functional dependency[14].

Nutritional status is the balance between the requirements for physiological function and the intake and absorption of nutrients. If these requirements are not adequately met, nutritional status may deteriorate and malnutrition may develop[17, 18].

To predict outcomes related to nutritional status, screening and assessment are essential[13, 17-19]. The former should be performed routinely as part of the integral care of every hospitalized or ill person, and the latter should be performed in all those identified as being at risk, with the aim of reducing nutrition-related morbidity and mortality. These two processes are distinct, as screening identifies individuals at risk and nutritional status assessment contributes to the nutritional diagnosis[18-20].

Nutritional assessment provides more detailed information than screening, as the most commonly used criteria are dietary assessment, medical, social and psychological history, anthropometry, biochemical indices, body composition and nutrient requirements[12, 13, 17].

The main cause of malnutrition in older people is not fully understood because of its complex and multifactorial origin. Typically, there is an unintentional reduction in food intake or a disorder in the absorption of nutrients that has led to BWL.[2, 14]. O'Keeffe M et al found moderate evidence that hospitalization, food

dependency, poor self-perceived health, physical functioning and poor appetite were determinants of malnutrition[21].

Results from the Portuguese Elderly Nutritional Status Surveillance System (PEN-3S) study suggest that the nutritional status of older people, whether they are institutionalized or living in the community, is equally associated with socioeconomic and health characteristics[22].

The age-related decline in physical performance and muscle strength is significantly greater than the decline in muscle mass[23, 24]. As body composition changes, markers of muscle mass such as fat-free mass, muscle mass index or body cell mass decrease[13].

Malnutrition has been associated with impaired immune function, impaired vision and hearing, wound healing and tissue repair, development of dementia and delirium, depression, incontinence, risk of falls, sarcopenia and frailty[2, 22].

For optimal nutritional management, early identification of malnutrition through multidisciplinary intervention is essential in both hospitalized and community-dwelling older people [2]. The strong consensus level of recommendation states that screening for malnutrition in older people should be routine and that, if malnutrition is detected, systematic assessment, individualized and monitored intervention should take place[17].

The dietary requirements of older adults differ from other age groups, and attention to energy and protein-energy intake is important, as they require nutritional strategies to maintain lean body mass and physiological function due to a decline in their ability to utilize protein and a higher anabolic threshold of protein intake per meal[14, 17, 20].

In Portugal, according to the cross-sectional study "Nutrition UP 65", frailty and pre-frailty are common, with 21.5% and 54.3% of the population affected, respectively. Handgrip strength (HGS) was the most commonly identified criterion of Fried's phenotype[25]. Older adults diagnosed with this syndrome are at a higher risk of functional and physical decline, as well as mortality[26].

Frailty is primarily associated with the inflammatory process related to ageing, chronic diseases and their interplay with the environment. Nevertheless, lifestyle interventions could potentially modify it[27]. Risk factors that develop over time and may contribute to malnutrition and subsequent frailty include low educational

and socio-economic status, being from an ethnic minority, BWL, being overweight or obese, age-related anorexia, presbyphagia, dysphagia, poor oral health, sedentary lifestyle, high risk of cardiovascular disease and alcohol consumption[12, 18, 28, 29].

According to the WHO, two valid definitions of frailty have emerged in the last two decades, both of which predict a high mortality rate and risk of institutionalization: Fried's Phenotype and the Frailty Index [30-32].

Frailty syndrome is increasingly prevalent and significantly affects public health. This trend may be related to the ageing of the world's population, which experiences higher survival rates and comorbidities, as well as more sedentary lifestyles and reduced family support networks[28, 33].

The ageing process involves a decrease in basal metabolic rate, leading to a progressive decline of energy needs of about 150 kcal per decade, due to the ensuing loss of muscle mass and gain in fat mass[17, 34].

The energy requirements for elderly individuals should be individually adjusted, accounting for factors such as nutritional status, physical activity level, health status and tolerance. The recommended energy intake for the elderly is 30kcal/kg/day. In case of underweight elderly people (Body Mass Index (BMI)<21 kg/m^2), their daily energy requirement may range between 32-38 kcal/kg/day and for those who are unhealthy, it may range from 27-30 kcal/kg/day (ESPEN)[17].

According to the European Food Safety Authority (EFSA), the protein requirement for healthy older individuals who are healthy is equivalent to those who are not (0.8g/kg/day)[35]. Since this population experiences a greater decline in lean mass, functional status, and health, ESPEN reported that the protein requirement should be a minimum of 1.0g/kg/day[17]. According to recent experimental and epidemiological studies, such as the international PROT-AGE study, older individuals may require varying amounts of protein intake based on their health status and physical activity, ranging from 1.0-2.0g/kg/day[36]. Nevertheless, there is a lack of strong scientific evidence suggesting the benefits of a protein-rich diet, whether or not combined with supplementation, for elderly who have frailty[12, 26].

As for protein quality, high-protein diets including 1.7-2.8g of leucine per meal could be an effective strategy as they stimulate muscle protein synthesis more

effectively in older individuals compared to adults. However, findings require confirmation through long-term investigations[26, 37].

The Mediterranean diet is characterized by a high intake of foods rich in micronutrients, polyphenols and antioxidants, which is associated with a lower incidence of frailty in older people, thus contributing to the prevention of this syndrome[38]. However, while this diet is considered to be advantageous for promoting healthy ageing and preventing disabilities within this age group, there is insufficient evidence to support its use as a treatment for frailty[26].

The WHO acknowledges that interprofessional collaboration in healthcare can promote a favorable influence on health outcomes, thus on strengthening healthcare systems[39, 40].

In 2017, the WHO released a comprehensive report on Integrated Care for Older People[30]. The report consists of 13 evidence-based guidelines that are aimed at healthcare and social assistance experts. The objective is to facilitate the development and delivery of Integrated Care for Older People (ICOPE). The recommendations promote a multi-disciplinary approach that is designed to enhance seniors' intrinsic capacity and encourage healthy ageing. The guidelines emphasize individual-centered and community-based approaches, serving as both national directives and means of integrating services to prevent dependence on primary care programs and essential care packages for universal health coverage. Nutrition is intrinsic to this approach, particularly because of its direct effect on increasing muscle mass and strength, cognitive ability, locomotor capacity, vitality, and psychological function[30, 41].

The National Network of Integrated Continued Care (RNCCI) operates as an active response, it adheres to a multidisciplinary strategy to offer health and social care in an integrated and continuous approach for individuals in a state of dependence[42].

The RNCCI for general scope encompasses four response typologies, two of which are Convalescent Units (UC) and Medium Term and Rehabilitation Units (UMDR). The UC accommodates patients for a maximum of 30 days and caters to individuals who no longer necessitate hospital care, but due to a sudden or worsening chronic illness or disability, require healthcare of a certain frequency, complexity or duration which cannot be administered at home. The UMDR is intended for

individuals who have temporarily lost their ability to function independently and require rehabilitation potential. This program is designed for hospitalizations that last between 30 to 90 days and caters to those who require medical and social assistance that cannot be provided at home due to its frequency or length. Patients may need to stay for shorter or longer periods at either of these facilities[42].

Regarding nutritional care, the RNCCI strives to promote and sustain an adequate nutritional status for institutionalized individuals, preventing weight loss and dehydration, whilst also intervening when corrective action is required[43].

OBJECTIVES

The objectives of this thesis are the conduction of:

1. Translation and linguistic validate a physical activity assessment to elderly inpatients. to the European Portuguese language;
2. A cross-sectional study that:
    - Evaluates the nutritional status on admission and discharge of patients aged ≥ 65 years admitted to a rehabilitation hospital;
    - Determines the presence of frailty in these patients
    - Assesses the evolution of frailty and nutritional status throughout the hospital stay and relate them to nutritional and dietary interventions
    - Identifies the relationship between nutritional status and the presence of frailty.

CHAPTER 2

TRANSLATION AND LINGUISTIC VALIDATION OF THE EUROPEAN PORTUGUESE VERSION OF PAIR (PHYSICAL ACTIVITY IN INPATIENT REHABILITATION) ASSESSMENT

ABSTRACT

Introduction: Physical activity of elderly inpatients is undervalued during rehabilitation, leading to low levels of mobility, related to negative health outcomes. Assessing physical activity in order to promote its increase has proved crucial to improving the health of the elderly. However, there are few instruments that assess this issue. The Physical Activity Inpatients Rehabilitation (PAIR) is a self-assessment questionnaire, developed to be applied in geriatric rehabilitation and to provide a practical and valid assessment.

Objectives: The aim of this study was to translate and linguistically validate the PAIR to European Portuguese, while maintaining conceptual equivalence to the original version.

Methods: For the translation and linguistic validation process, the twelve-step Patient-Reported Outcome (PRO) Consortium guidelines were followed. A process of forward translation and back-translation was carried out, with intermediate and final harmonization. The PAIR was applied to a convenience sample, in order to complete the linguistic and cultural adaptation of the translated Portuguese version.

Results: The three independent forward translation presented some literal and conceptual discrepancies. The back-translation had some wording discrepancies and a conceptual difference, which was revised. After proofreading and cognitive interviewing, a final revision was performed to determine possible spelling, grammatical, syntactic and formatting errors, culminating in the final consensus version.

Conclusions: The European Portuguese version of the PAIR proved to have adequate comprehension properties, easy to apply and therefore suitable for the Portuguese patients. However, a validation study with Portuguese elderly patients is needed.

KEYWORDS:

Physical activity; Rehabilitation; Rehabilitation Hospital; Translations.

RESUMEN

Introducción: La actividad física de los ancianos hospitalizados está subestimado durante la rehabilitación, lo que conduce a bajos niveles de movilidad, relacionados con resultados negativos para la salud. Evaluar la actividad física para promover su aumento ha demostrado ser crucial para mejorar la salud de los ancianos. Sin embargo, existen pocos instrumentos que evalúen esta cuestión. El Physical Activity Inpatients Rehabilitation (PAIR) es un cuestionario de autoevaluación, desarrollado para ser aplicado en rehabilitación geriátrica y proporcionar una evaluación práctica y válida.

Objetivo: El objetivo de este estudio fue traducir y validar lingüísticamente el PAIR al portugués europeo, manteniendo la equivalencia conceptual con la versión original.

Métodos: Para el proceso de traducción y validación lingüística, se siguieron las directrices de doce pasos del Patient-Reported Outcome (PRO) Consortium. Se llevó a cabo un proceso de traducción directa y retrotraducción, con armonización intermedia y final. El PAIR se aplicó a una muestra de conveniencia, con el fin de completar la adaptación lingüística y cultural de la versión traducida al portugués.

Resultados: Las tres traducciones directas independientes presentaron algunas discrepancias literales y conceptuales. La retrotraducción presentaba algunas discrepancias de redacción y una diferencia conceptual, que fue revisada. Tras la corrección de pruebas y la entrevista cognitiva, se realizó una revisión final para determinar posibles errores ortográficos, gramaticales, sintácticos y de formato, que culminó en la versión final consensuada.

Conclusiones: La versión en portugués europeo del PAIR demostró tener propiedades de comprensión adecuadas, ser fácil de aplicar y, por lo tanto, adecuada para los pacientes portugueses. Sin embargo, es necesario realizar un estudio de validación con pacientes portugueses de edad avanzada.

PALABRAS CLAVE:

Actividad física; traduciones, Rehabilitación hospitalar; Rehabilitación.

INTRODUCTION

Physical activity (PA) is defined as any movement produced by the skeletal muscle that requires energy expenditure and can be performed in different ways. There is a health benefit when PA is performed regularly and with a sufficient duration and intensity[2].

In contrast, sedentary behavior is described as any activity that involves an energy expenditure of less than 1.5 metabolic equivalents (METs), the equivalent of sitting or lying down. Evidence shows that sedentarism with a high degree of inactivity, such as sitting for a long time, is associated with altered glucose metabolism and cardiometabolic morbidity, as well as increased mortality. According to the World Health Organization (WHO), 1 in 4 adults does not meet the PA recommendations of this organization[2].

In 2020, WHO published a report that describes recommended PA as 150-300min weekly of moderate-intensity activity, 75-150min weekly of vigorous-intensity activity or a combination of both[3]. This report also states that regular PA is beneficial for all adults, as even at low levels, for example, 15-30min of vigorous walking daily, has a positive association in health status[3, 4].

PA confers benefits in decreasing and preventing mortality, hypertension, type 2 diabetes, cancer such as breast and colon cancers, improving mental health, cognitive health, sleep and decreasing fat mass levels[3, 4]. Sedentary lifestyle contributes to 6-10% of these non-communicable diseases and 9% of premature mortality[4].

In the elderly defined as people aged 60 years and over, a regular level of PA can promote physical, social and mental health, prevent falls, falls-related injuries and frailty and delay declines in bone health, aging and functional ability [2, 3].

In order to obtain reliable information on PA, it is important to assess it in hospitalized patients so that health professionals and patients themselves can be aware and define strategies to increase PA in this specific context[5, 6]. Physical exercise and activities of daily living have a positive impact on muscle mass and functional capacity and can improve physical performance in the elderly, which are key aspects to promote recovery[6, 7].

High levels of PA during hospitalization were related to lower clinical complications rates, shorter length of stay and early discharge with good functional capacity. However, hospital stay is still related with very high levels of sedentarism, since about 83% of the hospital stay is spent in the prone position and only 6% of patients are active[5, 7].

Assessment of PA during hospitalization can be controversial, as we have often considered patients to be active because they have been prescribed rehabilitation exercises, which does not reflect their actual daily PA[8]. Patients admitted to a rehabilitation center are mostly alone, inactive and/or asleep. This low level of physical, cognitive and social activity is associated with poor adherence to treatment and reduced autonomy[5, 9].

Studies of PA levels and functional activity have relied on questionnaires, continuously monitored PA such as accelerometry and/or even behavioral mapping. The latter requires long periods of observation and, as an observational method, can influence and overestimate participants' PA levels[5, 9, 10].

Therefore, Denkinger et al.[8] developed an assessment tool called Physical Activity in Inpatient Rehabilitation (PAIR), which has been validated to estimate PA, but not functional activity, in elderly inpatients without the use of technical equipment. The main objective was to create a user-friendly questionnaire with low associated costs that can be used during the rehabilitation process of older inpatients and may also be useful in intensive care units if the reason for hospitalization allows PA measurement[8].

The PAIR assessment collects information regarding PA between physiotherapy sessions rather than during them, assessing, for example, in the context of participation with relatives[8].

The PAIR is currently considered to be the most valid questionnaire for assessing PA in hospitalized older people. It was designed to be used in geriatric rehabilitation and to provide a practical, short, easy to use and valid assessment. For example, unlike other instruments, the PAIR assesses PA in this age group, which is mostly 'walking', and therefore focuses on the range of mobility, which mostly involves ambulation[11].

In order to supply the existing gap in the assessment of PA in elderly inpatients, the aim of this study is to translate and adapt and validate the PAIR into European

Portuguese, in the light of the recommendations of the Patient-Reported Outcome (PRO) Consortium[12], ensuring language and cultural equivalence of the translation and verify the difficulty of completion and understanding and the applicability of the instrument.

MATERIAL AND METHODS

This study was approved by the Ethics Committee of the Portuguese Northern Regional Health Administration (ARS-Norte) and Hospital Particular de Paredes (CE/2022/140). All patients gave written informed consent. Patient anonymity was maintained at all stages of the validation process.

The PAIR Questionnaire

The original PAIR consists of a self-assessment questionnaire with 5 questions and 8 possible scores, with the option of 1 or 2 answers in each question (Table I). The final score, ranging from 0 to 7, is the maximum score and not a cumulative score, with values up to 1 classifying inactivity and above 1 activity[8, 11, 13]. Its completion should follow a well-defined order: start with the question corresponding to the least difficult activity and progress to the most difficult one, or vice versa, without skipping any question or answer hypothesis. Regardless of the answer, all questions should be answered, as the patient may spend most of the time "lying down" and "sitting down" and answer "yes" to both questions[8].

TABLE I - Original pair questionnaire[8]

Between therapy sessions….	To what extent	Score
1. … I was mostly lying-in bed in order to recover	Yes	0
2. … I was mostly sitting in my room in order to recover	Yes	1
3. … I was undertaking little walks on the ward	Yes, sometimes	2
	Yes, often	3
4. …I was undertaking little walks outside the ward (i.e. cafeteria)	Yes, sometimes	4
	Yes, often	5
5. … I was undertaking little walks outside the hospital	Yes, sometimes	6
	Yes, often	7

PAIR: Physical Activity Inpatients Rehabilitation

Translation and Linguistic and Cultural Adaptation

In order to develop a valid European Portuguese translation of the PAIR, this study followed the PRO Consortium guidelines[12]. The translation was carried out according to the 12 steps of this standard: preparation, forward translation, reconciliation, back-translation, revision of reconciled forward translation, international harmonization, proofreading, cognitive interview, post-cognitive interview, final review and documentation, report and record-keeping.

Preparation

This consisted of granting access to the questionnaire and permission to translate it into European Portuguese (PT). Preliminary authorization to translate and validate the PAIR into European Portuguese (PT) was requested and granted by email from the main author of the questionnaire, Dr. Michael D. Denkinger. The author sent the original version of the questionnaire in English.

Forward Translation

Three forward translations from the original English form into European Portuguese (PT) were carried out by three unofficial English-speaking translators: two nutritionists and a nurse, all native speakers of Portuguese and fluent in English, and one also a native English speaker. Our aim was to obtain three independents, conceptually and culturally equivalent translation of the PAIR, originally written in English, into Portuguese, rather than a purely literal translation.

Reconciliation

The consolidated questionnaire version 1 (Portuguese) was developed by the panel of translators after the three translations were discussed and consensus was reached. The language and concepts were adapted to the cultural and hospital reality in Portugal, always aiming to be as close as possible to the original version.

Back-translation

A backward translation of version 1 was produced by an official English language translator, who had no prior knowledge of or access to the original version of the PAIR. Version 2 (English) was developed.

Revision of reconciled forward translation

The panel compared version 2 with the original one and minor discrepancies were documented and analyzed, with the conclusion that these were irrelevant differences as they did not change the original meaning in any way.

International harmonization

Conceptual equivalence and linguistic consistency between version 1 and the original questionnaire were checked and version 3 (Portuguese) was drafted.

Proofreading

The panel sent version 3 to an experienced physiotherapist in the area, of Portuguese nationality and fluent in English, to review this version and check for grammatical and conceptual consistency. The panel analyzed the suggestions and made the changes deemed relevant, keeping the aim to obtain a faithful translation of the tool and adapting it to the context in which it will be used. One conceptual change was suggested and introduced in version 4 (Portuguese). The changes were made in order to avoid ambiguity in the interpretation.

Cognitive Interview

Version 4 was applied in person to a pilot group composed of 10 patients, corresponding to the target population: patients admitted to a rehabilitation hospital (Portuguese National Network for Continuing Integrated Care) aged 60 years or older. It consisted of a comprehensive questionnaire that was read and interpreted. The patients were asked to comment on the meaning, interpretation and possible ambiguity of each question and answer. The purpose of this step was to verify the degree of difficulty in completing, understanding and applicability of this version.

Post-cognitive interview

Suggestions were noted and the dubious expressions and/or words found were revised. No changes were incorporated into the translated version, as this would not improve its applicability.

Final review and documentation

Version 4 was reviewed for possible orthographic, syntactic, and final formatting errors. The translation process was completed, resulting in the final Portuguese version of the PAIR (version 5).

Report

The preparation of the final report is outlined in this document.

Record-keeping

The different versions of the translation were saved, as well as the registered changes and suggestions for improvement.

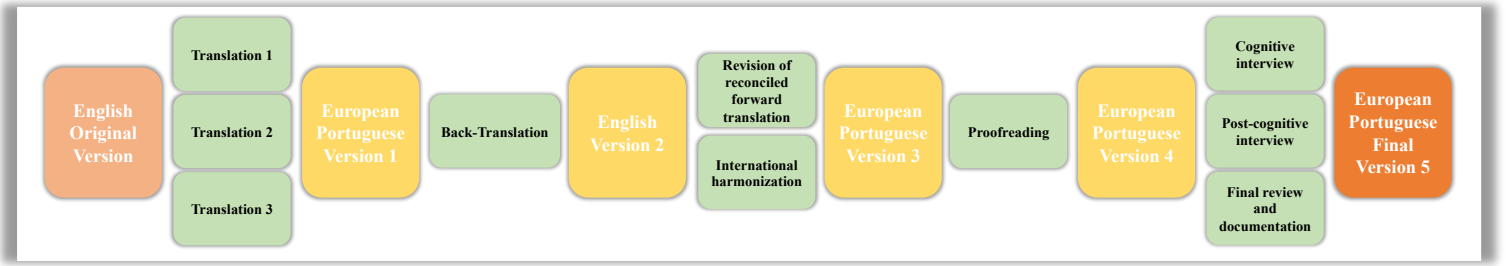

Figure A. Translation and linguistic validation process

RESULTS

The analysis of the three independent forward translations showed that there were differences, mainly literal, but with some conceptual discrepancies. For instance, in the item “To what extent”, the word “extent” was translated to “measure” and “proportion”, these words are literal different, but have the same conceptual meaning.

One of the conceptual divergences observed at this phase, was in the item “I was undertaking little walks on the ward”, the word “ward” was translated to “hallway” and “infirmary”, where both of these words have different concept meaning. All differences were discussed and reviewed in order to resemble the original one (Table I) in a consolidated version (version 1).

Regarding sentence structure requirements, some grammatical differences were identified, especially in verb tenses. All discrepancies were duly addressed, discussed, and reviewed. To resemble the original version, a consensually translated version (version 2) was done.

The back-translation had predominantly wording discrepancies when compared with original English version, for instance in the item “I was undertaking little walks on the ward” the backward translation was “I took short walks on the ward”. The only conceptual difference at this point was at the item “score”, which was back-translated to “result”, however the forward translated Portuguese word “resultado” can be translated, with the same conceptual meaning, to both English words, so the item was not changed.

The physiotherapist reviewed version 3 and suggested that "to what extent" should be translated conceptually rather than literally, so he chose "resposta", which is the direct translation of "answer" and can have the same meaning as the first.

As regards the patients’ group (Table II), version 4 of the questionnaire was applied to 10 selected patients in the form of cognitive interviews through: reading and interpretation by 3 of them; listening and interpretation by 5 patients; use of proxies by 2 patients with severe cognitive impairment (Table III). At the item “I was undertaking little walks on the ward”, one of the patients did not know which place we were referring to, as he was confusing it with the nurses’ pantry. The item was not change, because “ward” is a name that has no similar

translation. Two of the patients didn't understood what was the definition of "yes, sometimes" and "yes, often" as they considered it was during the week instead of during the day. The questionnaire instructions were once again read/listened, and this doubt was solved. No item has been amended.

TABLE II - Socio-demographic characteristics of the convenience sample

	VARIABLE	TOTAL N = 10
AGE, IN YEARS, MEAN (SD)		72,3 (6,7)
GENDER, n (%)	Female	6 (60,0)
	Male	4 (40,0)
PRIMARY DIAGNOSIS, n (%)	Hemorrhagic/ischemic stroke	1 (10,0)
	Diseases of the digestive system	1 (10,0)
	Diseases of the respiratory system	1 (10,0)
	Diseases of the circulatory system (others)	1 (10,0)
	Diseases of the nervous system	2 (20,0)
	Diseases of the musculoskeletal system and connective tissue	4 (40,0)
QMCI_P, b (%)	SCORE > 62 – Normal Cognitive Aging	7 (70,0)
	SCORE ≤ 62 – Cognitive Impairment or Dementia	3 (30,0)

TABLE III - Pair assessment

	VARIABLE	TOTAL N = 10
ASSESSMENT TIME, MEAN (SD)		3,5 (1,6)
PAIR SCORE, n (%)	0	2 (20,0)
	1	3 (30,0)
	2	3 (30,0)
	3	2 (20,0)
	[4; 7]	0 (0)
PAIR IMPLEMENTATION, n (%)	Self-assessment or Reading by others	8 (10,0)
	Assessment by proxies (i.e. relatives or nurses)	2 (10,0)
ASSESSMENT TIME, n (%)	SCORE > 62 – Normal Cognitive Aging	7 (70,0)
	SCORE ≤ 62 – Cognitive Impairment or Dementia	3 (30,0)

Final proofreading was carried out to determine possible spelling, grammatical, syntactic, and formatting errors, culminating in the final version 5 (Table IV).

TABLE IV - EUROPEAN PORTUGUESE VERSION OF THE PAIR QUESTIONNAIRE

ENTRE SESSÕES DE TERAPIA …	Respostas	Resultado
1. ... EU ESTIVE A MAIOR PARTE DO TEMPO NA CAMA PARA RECUPERAR	Sim	0
2. ... EU ESTIVE A MAIOR PARTE DO TEMPO NO QUARTO SENTADO/A PARA RECUPERAR	Sim	1
3. ... EU FAZIA PEQUENAS CAMINHADAS NA ENFERMARIA	Sim, às vezes	2
	Sim, muitas vezes	3
4. ... EU FAZIA PEQUENAS CAMINHADAS FORA DA ENFERMARIA (POR EXEMPLO NO BAR)	Sim, às vezes	4
	Sim, muitas vezes	5
5. ... EU FAZIA PEQUENAS CAMINHADAS FORA DO HOSPITAL	Sim, às vezes	6
	Sim, muitas vezes	7

PAIR: PHYSICAL ACTIVITY INPATIENTS REHABILITATION

DISCUSSION

The elderly inpatients spend most of their time lying in bed or sitting. Regardless of the cause of hospitalization, these low levels of PA are related to adverse health outcomes, with studies showing that these patients experience a deterioration in functional activity, prolonged hospital stay and increased mortality risk. Therefore, it is of utmost importance to develop interventions that can mitigate this problem and to monitor the PA of inpatients throughout their hospital stay[8, 14-16].

The validity of accelerometers for measuring PA in hospitalized patients is sometimes uncertain as it depends on the device, its placement on the body, the type of patient and their willingness to wear it. Some accelerometers cannot distinguish between decubitus, sitting and standing positions[5, 17-19].

There are several studies using questionnaires to assess PA in community-dwelling older people, but very few assess PA in hospitalized older people, and these are rarely validated or are not instruments that focus primarily on inpatient PA[20, 21].

The PAIR allows to assess elderly inpatients PA, with good sensitivity to change throughout the hospitalization, high practicality and with similar validity to more complex PA assessments[8, 11, 13].

Throughout this research, the PAIR has been translated into European Portuguese language, following guidelines and models principles of good practice, to obtain a properly translated and culturally adapted questionnaire[12]. It was also possible to demonstrate its linguistic feasibility for elderly patients admitted to a rehabilitation hospital in Portugal.

The forward translations tended to present literal rather than conceptual writing differences, such as back-translation, when compared with the original version. The version used to inpatients was well harmonized and without ambiguity of interpretation, as patients completed the assessment without apparent difficulty. The stepwise approach and revisions of the translation method were essential to obtain a final version translated by consensus and equivalent to the original version.

The European Portuguese version of the PAIR is, until the publication of this article, the only questionnaire that allows assessing the PA of inpatients aged 60

years and older, in rehabilitation hospitals, such as the Portuguese National Network of Integrated Continued Care.

This questionnaire was found to be easy and quick to apply and consists of a simple and short questionnaire, even when patients lack the cognitive capacity to do so, as it allows family members and/or the nursing team to answer for them. The average administration time was 3,5 minutes, slightly longer than the author's time (median of 2 minutes). This may be a result of statistical fluctuation, since our study sample (n=10) was smaller than the author's original PAIR study (n=96). This assessment has some limitations, such as the inpatients' use of wheelchairs, as it is not validated for their use, thus the study sample of this research was a simple non-randomized sample. Another issue is related to the hospital ambulation area and legal regulations, since patients were not allowed to walk outside the hospital or could not go to the cafeteria alone, so the assessment score might have some bias. Therefore, as the lead author of the PAIR points out in his research, this assessment has to be adjusted according to the needs of the institutions.

In conclusion, a European Portuguese version of the PAIR has been developed which can be applied to Portuguese elderly inpatients in the linguistic and cultural context. However, a validation study should be conducted to assess the validity and sensitivity properties in Portuguese elderly inpatients to ensure that the proposed tool behaves similarly to the original questionnaire.

Chapter 3

Nutritional and dietary intervention in the evolution of nutritional status and frailty in two units of the National Network of Integrated Continued Care

ABSTRACT

Introduction: The elderly population in Portugal has risen by 20.6% since 2011, leading to an increase in the ageing population. Malnutrition is widespread amongst the elderly globally, with around 25% of individuals in this age range at risk or already affected by it. Screening and assessment are crucial to foresee nutritional outcomes. Despite a connection with several conditions, including frailty, the root cause of malnutrition within ageing is not fully comprehended, owing to its manifold and intricate character.

Objectives: To evaluate the nutritional status on admission and discharge of patients aged ≥ 60 years in two integrated care unit, determine the presence of frailty, at the admission, identify the relationship between nutritional status and the presence of frailty and assess the evolution of frailty and nutritional status throughout the hospital stay and relate them to nutritional and dietary interventions.

Method: This was a cross-sectional study involving 61 inpatients over 60 years old in integrated continued care units. Clinical and social data were gathered via interviews within 72 hours of admission and monthly until the participant was discharged between January to July 2023. Nutritional status was assessed via the Mini Nutritional Assessment (MNA), and frailty was evaluated utilizing the criteria of Fried's Frailty. Personalized diets were adapted and nutritional and modular supplementation (ONS), were prescribed when necessary.

Results: Throughout the study, the hospital stay varied: 29 days (61 patients) to 87 days (12 patients). The MNA mean at the admission was 16.0, with a positive progression of 3.3 points. MNA evaluation as a significant negative correlation between hospital stay and Unit reference. The largest positive change is found in MNA for patients who were offered ONS or a personalized diet. The mean score for MNA improved significantly ($t(60) = -5.33$; $p < 0.001$). Regarding MNA and BMI lower values for patients with prescribed ONS than for those without it. On admission, 98.4% of the participants were classified as frail. Low *physical activity* had the lowest rate of occurrences, with rates of 73.8% and 47.5% respectively, at admission and at 29th day evaluation. The data suggest that frailty on admission is related to worse nutritional status assessment for nearly all items.

Conclusion: These findings indicate that patients have a high prevalence of frailty and malnutrition upon admission. It is crucial to define the length of hospital stay during referral, as it impacts these parameters significantly, especially the MNA outcome. The MNA score on admission could guide the decision to prescribe SNO, Additionally, MNA is strongly linked with at least three frailty criteria.

KEYWORDS:

Elderly Rehabilitation; Frailty; Nutritional Intervention; Nutritional Status.

RESUMO

Introdução: A população idosa em Portugal registou um aumento de 20,6% desde 2011, levando a um envelhecimento da população idosa. A desnutrição está generalizada entre os idosos a nível global, com cerca de 25% dos indivíduos nesta faixa etária em risco ou já desnutridos. O rastreio e a avaliação são cruciais para prever os resultados nutricionais. Apesar de estar relacionada com várias condições, incluindo a fragilidade, a causa principal da desnutrição no envelhecimento não é totalmente compreendida, devido ao seu carácter multifatorial.

Objetivos: Avaliar o estado nutricional na admissão e na alta de doentes com idade ≥ 60 anos, em duas unidades de cuidados continuados integrados, determinar a presença de fragilidade, na admissão, identificar a relação entre o estado nutricional e a presença de fragilidade e avaliar a evolução da fragilidade e do estado nutricional ao longo do internamento, assim como, relacioná-los com as intervenções nutricionais e dietéticas.

Métodos: Trata-se de um estudo transversal que envolveu 61 doentes internados em duas unidade de cuidados continuadas integrados com idade igual ou superior a 60 anos de idade. Os dados clínicos e sociais foram recolhidos através de entrevistas realizadas nas 72 horas após a admissão e tiveram lugar mensalmente até à alta do paciente, entre janeiro e julho de 2023. O estado nutricional foi avaliado através da *Mini Nutritional Assesment* (MNA), e a fragilidade foi avaliada utilizando os criterios de Fragilidade de *Fried*. Sempre que indicado, foram adaptadas dietas personalizadas, com base nas necessidades alimentares individuais e foram prescritos suplementos nutricionais e modulares (SNO).

Resultados: Ao longo do estudo, o tempo de hospitalização variou entre 29 dias (61 pacientes) e 87 dias (12 pacientes). A média do MNA na admissão foi de 16.0, com uma progressão positiva de 3.3 pontos. A avaliação da MNA apresentou uma correlação negativa significativa entre o tempo de internamento e o tipo de unidade. A maior alteração positiva é registada na MNA, para os doentes a quem foi prescrita a SNO ou a dieta personalizada. A pontuação média do MNA melhorou significativamente ($t(60) = -5,33$; $p < 0,001$). Relativamente ao MNA e ao IMC, os valores foram mais baixos para os doentes com SNO prescritos, em comparação

aos que não a tinham. No momento da admissão, 98,4% dos participantes foram classificados como frágeis. A baixa atividade física teve a menor taxa de ocorrência, com taxas de 73,8% e 47,5% respetivamente, na admissão e na avaliação ao 29º dia. Os dados sugerem que a fragilidade na admissão está relacionada com uma pior avaliação do estado nutricional.

Conclusão: Os resultados indicam que os doentes admitidos têm uma elevada prevalência de fragilidade e desnutrição no momento da admissão. É crucial definir a duração do internamento hospitalar durante a referenciação, uma vez que tem um impacto nestes parâmetros, especialmente no resultado da MNA. A pontuação da MNA na admissão pode orientar a decisão de prescrever SNO. Além disso, a MNA está fortemente associada a pelo menos três critérios de fragilidade

PALAVRAS-CHAVE:

Reabilitação de Idosos; Fragilidade; Intervenção Nutricional; Estado Nutricional.

INTRODUCTION

Adequate nutritional status of the older adults is relevant because it is a determinant of their healthy ageing, quality of life and independence, and the presence of malnutrition is positively associated with the loss of physical, functional, cognitive and/or intellectual capacity and reduced ability to recover[1].

Knowing that age is a major risk factor for the development of chronic diseases, older people are more likely to suffer from disease-related body weight loss (BWL), sarcopenia and frailty syndrome, with a real impact on disease recovery and overall clinical outcome[2]. BWL is common in older patients and is a marker of macronutrient deficiency and catabolism, usually of multifactorial origin, which can promote catabolic events leading to increased morbidity and mortality[2].

Malnutrition, although still lacking a universal definition, is a widespread condition that has been identified worldwide and has a great impact, being associated with increased morbidity, mortality and health costs[1, 3]. In Portugal, according to the cross-sectional study "Nutrition UP 65", in a community dwelling, when the MNA short-form was applied to elderly people, it was estimated that malnutrition and the risk of malnutrition reached 16% of the population studied[4]. Additionally, the PEN-3S study, carried out in nursing homes and the community in Portugal, revealed a malnutrition risk prevalence of 29.3% and 14.1%, correspondingly[5].

Hospital malnutrition is very common in older adults and is associated with several factors, including interruption of meals, length of hospital stay, neglected nutritional needs, fasting, aversion to food and effects of disease and/or treatment[1, 6, 7].

The first important step in addressing nutritional status is malnutrition risk screening[3]. Screening includes individuals who are malnourished and would benefit from a nutritional assessment and possible intervention.

According to a meta-analysis by Cereda, E et al.[8], the Mini Nutritional Assessment (MNA) is the most widely used and validated tool for nutritional assessment and screening in older adults. However, they state that more evidence is needed to support the use of the same tool in all settings, as it has some shortcomings[8].

Reduced muscle mass is a phenotypic criterion with strong evidence for malnutrition status, but there is no gold standard measure. Physical examination or anthropometric measurements of calf or arm muscle circumference are alternatives to expensive measures[3]. Diagnosis of malnutrition remains a challenge in all healthcare settings[3].

The diagnosis of malnutrition must be distinguished from the diagnosis of sarcopenia, frailty and cachexia, although there is some overlap in symptoms and diagnostic criteria[1, 8].

Frailty is a clinical syndrome linked to a multifactorial and complex process. It is a consequence of increased vulnerability due to age-related declines in resilience and physiological reserves, which can worsen the prognosis of associated trauma or disease[9-11]. The resulting chronic disruption in homeostasis, followed by acute changes, increase the risk of dependence and disability[9-13].

The Fried phenotype definition of frailty, developed by Fried et al[14], is widely employed and recognized as valid for defining frailty, with strong consensus from ESPEN[15]. It permits identification of frailty and prediction of physical disability and mortality in older individuals[11, 12, 14, 15]. Frailty is diagnosed through 5 criteria: weakness, unintentional BWL, fatigue or exhaustion, slow walking speed and low physical activity levels. The presence of 3 or more criteria determines frailty, while having 1 or 2 criteria is defined as pre-frailty and 0 criteria are associated with non-frailty. All of these factors may be associated with malnutrition[11, 14, 16, 17]. However, this tool has its limitations, as it does not assess psychological factors that are determinants of this syndrome[9].

Malnutrition and frailty require multimodal interventions that go beyond nutritional supplements. These interventions may include pharmacological agents and exercise regimens[3, 9, 12, 18, 19].

The connection between nutritional status and frailty seems evident according to some studies[19]. This syndrome is associated with a decrease in muscle mass and can impact both underweight and overweight individuals. In the community, elderly individuals who are ate an elevated risk of malnutrition are predisposed to frailty and dependence [11, 13].

Nutrition therapy, according to the ESPEN guidelines[20, 21], requires an individualized and comprehensive nutrition care plan aimed at increasing energy

and protein-energy intake and maintaining physical function. This may include education and counselling, oral nutritional supplements (ONS), and enteral or parenteral nutrition[1]. Micronutrient deficiencies are more common in older people, so micronutrient supplementation may also be very useful[2].

The diet of elderly individuals may impact the progression of frailty[18]. However, most studies have focused on preventing rather than treating frailty, resulting in a deficiency of scientific data bolstering the affirmative correlation between dietary quality and the treatment and management of frailty[22].

The 2019 International Conference on Frailty and Sarcopenia Research (ICFSR) guidelines for clinical practice in the identification and management of physical frailty state that the following should be combined with good clinical judgement[22]:

A. **Screening for frailty in adults aged 65 years and older using a valid and simple tool - Strong recommendation - Low level of evidence;**
B. **Calorie/protein supplementation may be considered for individuals with frailty and a diagnosis of BWL and/or malnutrition - Conditional recommendation - Very low level of evidence**. Although frailty is often linked with malnutrition in literature reviews, clinical intervention studies suggest that the scientific evidence supporting energy and protein supplementation in older adults with frailty is significantly limited. This is particularly true when there are no associated BWL, malnutrition and/or sarcopenia;
C. **Oral nutritional supplementation (ONS) combined with prescription of physical activity - conditional recommendation - low level of evidence.** Based on these guidelines, dietary interventions have positive effects on physical activity and vice versa. However, researching the two topics together reveals a high level of bias.
D. **Vitamin D supplementation is not systematically recommended unless there is a deficiency in this vitamin - Conditional recommendation - Very low level of evidence.** Unless a deficiency of this micronutrient has been diagnosed, Vitamin D supplementation should not be advised for the management of frailty.

According to the 2022 ESPEN guidelines on clinical nutrition and hydration in older adults, it is advised, among other recommendations, that[21]:

A. **Nutritional intervention should be part of a multidisciplinary team approach to ensure adequate dietary intake, BW maintenance or to increase and improve functional capacity and clinical status - Grade B recommendation – Strong consensus;**
B. **Restrictive diets should be avoided in overweight older adults to prevent loss of muscle mass and consequent decline in functional capacity – Grade moderate – strong consensus.** Unintentional or involuntary BWL accelerates the loss of muscle mass, resulting in a higher risk of frailty, sarcopenia, reduced functional capacity, fractures and malnutrition;
C. **Restrictive diets should be considered in obese older adults with comorbidities only after careful individual assessment, taking into account the risk-benefit balance – Conditional recommendation – Strong consensus.** Obesity increases the risk of metabolic and cardiovascular conditions, along with mobility impairment and frailty among the elderly. Given the loss of muscle mass associated with BWL, this decision should be based on an individual assessment of each older person;
D. **Hospitalized older adults with malnutrition or at risk of malnutrition should be prescribed oral nutritional supplements to improve food intake and promote BW gain and to reduce the risk of complications and hospital readmissions – Level A recommendation – Strong consensus;**
E. **Older people should be considered at risk of dehydration due to low fluid intake and should therefore be motivated to consume adequate fluid - Conditional recommendation – Strong consensus.** Frailty and vulnerability are relevant indicators of increased risk for dehydration.

According to ESPEN guidelines, nutritional intervention should be included as part of a multimodal and multidisciplinary team[20, 21].

OBJECTIVES

General Objetives

- **A.** Evaluate the nutritional status on admission and discharge of patients aged ≥ 60 years in two integrated care unit;
- **B.** Determine the presence of frailty in these patients; at the admission;
- **C.** Assess the evolution of frailty and nutritional status throughout the hospital stay and relate them to nutritional and dietary interventions;
- **D.** Identify the relationship between nutritional status and the presence of frailty.

METHODS

This is a prospective observational and cross-sectional study of patients admitted to the RNCCI from a UC and UMDR of the Hospital Particular de Paredes (HPP). The length of hospital stay is dependent on their functional independence, chronic illness, or disability. While the UC accommodates patients for up to 30 days, the UMDR caters to hospitalizations lasting between 30 and 90 days. Occasionally, certain patients require shorter or longer stays at these establishments[23].

The Ethics Committee of the HPP and the Ethics Committee of the Portuguese Health Organization of the North (ARS-Norte) approved all procedures, methods and instruments.

All participants signed an informed consent form in accordance with the Declaration of Helsinki and Portuguese legislation, after reading a brief explanation of the subject matter, the study's objectives, its voluntary nature and the assurance of confidentiality both during and after the investigation.

Data collection

A convenience sample of elderly patients was gathered within the initial 72 hours of admission and on a monthly basis until their discharge, from January to July 2023. Each individual was interviewed and their clinical and social data was collected from their medical records, including the computerized database of the RNCCI and the records of the multidisciplinary team. The set of criteria for inclusion criteria were as follows: 1) Patients admitted to the UC and UMDR units

HPP; 2) aged 60 years; 3) conscious enough to provide information on the assessment tools and to be assessed for frailty; 4) able to know and willing to sign the informed consent or, in case of incapacity, have their legal representative sign the consent form, as indicated in the medical file; 5) discharged after the completion of the study's follow-up period; 6) admitted after the Ethics Committee of ARS-Norte and HPP's approval date (CE/2022/140).

Clinical and social data were collected from the medical record, namely the digital database of the RNCCI and the multidisciplinary team's records, within the initial 72 hours of admission:

- Health information: Main diagnosis, health history, pharmacotherapy, pressure ulcers;
- Sociodemographic information: age, sex, current marital status, level of education, social vulnerability, employment status, housing accommodation, monthly remuneration;
- Lifestyle information: smoking habits, alcohol habits, physical activity.

During hospitalization, patients received standard nutritional care according to the following assessment of their nutritional status:

- Screening for malnutrition - using the MNA[24];
- Collection of anthropometric data – in compliance with international standards for anthropometric assessment and standard procedures:
    a. Patient's usual body weight (BW) (in kilograms), was obtained based on either their self-report or according to the discharge summary. Patient's current BW was measured using a calibrated portable electronic scale (SECA® 803, SECA GmbH, Hamburg, Germany – 0.1 cm resolution) or through estimation using their height and arm circumference[25];
    b. Height (in centimeters) was measured using a calibrated stadiometer (SECA® 213, SECA GmbH, Hamburg, Germany – 0.1cm resolution), according to the citizen card, with self-reported or from non-dominant hand length used as indirect measures[26];
    c. BMI was determined by dividing BW (in kilograms) by the square of height (in meters). The subjects were then classified according to the WHO standards[27];

d. Calf circumferences (CC) and arm circumferences (AC), were measured in centimeters using a metal tape(Cescorf® with 0.1 cm resolution), following the guidelines of the International Society for the Advancement of Kinanthropometry (ISAK)[28].

- Information from the multidisciplinary team - Medicine, Nursing, Social Work, Psychology, Occupational Therapy, Speech and Language Therapy and Physiotherapy (e.g. pharmacotherapy, assessment of functional abilities, clinical assessment of swallowing, rehabilitation exercises);
- Assessment of the cognitive status – Conducted by the Psychology team using the Quick Mild Cognitive Impairment - Portuguese Version (QMCI-P)[29];
- Assessment of functional ability to perform essential life activities: assessed by the Occupational Therapy team using the Barthel Index[30];
- According to the Fried et al. frailty phenotype, frailty was assessed by using the following five criteria[14]:
  - Shrinking: evaluated has unintentional BWL or reported decreased appetite. BWL was calculated as (weight in previous year - current measured weight > 4.5 kg unintentionally lost in the prior year)[14, 31]
  - Exhaustion: assessed by self-reported exhaustion. It was measured using two items from the Centre for Epidemiological Studies Depression Scale (CES-D)[14]. The exhaustion criterion was considered if patients answered “moderate amount of the time” or “most of the time” to the question “How often in the last week did you feel this way?”.
  - Low physical activity: Using the Physical Activity in Inpatient Rehabilitation (PAIR) questionnaire, patients who answered “I was mostly lying in bed in order to recover” or “ I was mostly sitting in my room in order to recover” were given a score of 0 or 1 and therefore classified as inactive, which is a positive criterion for frailty[32];
  - Slowness: assessed by gait speed (adapted to height and gender). Walking time was measured in seconds over a distance of 4.6 m using a stopwatch and classified according to Fried phenotype. Patients were asked to walk at their usual speed in an unobstructed corridor. Those who were unable to walk because of mobility or balance problems were considered frail for this criterion[14].

- Weakness: evaluated as low handgrip strength (HGS) adjusted for sex and height, recorded in kilogram-force (kgf): BMI [men: ≤29 kgf (BMI ≤24 kg/m^2), ≤30 kgf (BMI 24. 1-26 kg/m^2), ≤30 kgf (BMI 26.1-28 kg/m^2), ≤32 kgf (BMI >28 kg/m^2)/Women: ≤17 kgf(BMI ≤23 kg/m^2), ≤17.3 kgf (BMI 23.1-26 kg/m^2), ≤18 kgf (BMI 26. 1-29 kg/m^2), ≤21 kgf (BMI >29 kg/m^2)]. Non-dominant HGS measurement with a calibrated JAMAR Plus Digital Hand Dynamometer (Sammons Preston Inc., Bolingbrook, Illinois, USA – 0.1 kg resolution), as recommended by the American Society of Hand Therapists[33]. Each participant took three measurements, one minute apart, and the higher value was used. If the individual was unable to perform the measurement with that hand, the dominant hand was used.

If an individual exhibits one or two of the aforementioned criteria, they would be considered pre-frail, whereas frailty is described as exhibiting three or more of the aforementioned criteria. [14].

After nutritional screening and assessment, and following multidisciplinary intervention, nutrition therapy was provided: personalization and adaptation of the dietary plan (personalized diet) to the patient's nutritional needs, food preferences, functional and cognitive changes and/or prescription of nutritional supplementation and/or modular nutritional supplementation (here considered both as ONS) if deemed necessary.

Statistical Analysis

Statistical analyses were conducted using the IBM SPSS® Statistics version 27.0 for Mac OS (SPSS, Inc, an IBM Company, Chicago, IL).

Descriptive analyses were presented as absolute (n) and relative (%) frequencies, means, medians, standard deviations (SD) or ranges. The skewness and kurtosis coefficients were utilized to assess the normality of each quantitative variable distribution, assumed when both belonged to [-2; 2]. The data followed a normal distribution, except for the hospital stay data. The Chi-square test (x^2) or Fisher's exact test was conducted to compare groups, while the t-Student's test was utilized to compare the mean of independent samples. Spearman's correlation coefficient (r_s) was utilized to gauge the correlation between variable pairs.

Statistical significance level was set at 0.05.

RESULTS

Sample characterization

A total of 61 participants with a mean age of 78 years (DP= 9.0), were included in this study. Females represented 65.6% of the sample, and the median age was 83.0 (age range: 60 - 96 years). The majority (83.6%) had no education or only attained elementary school level. Additionally, 24.6% were socially vulnerable and only 57.4% lived in their own homes. With regard to lifestyle habits, only a few had smoking (11.5%) and alcohol (16.4%) habits. Table 1.1 presents the descriptive statistics for sample. Females were older, and were more likely than males to be widowed, to be retired, and to not consume tobacco or alcohol.

TABLE 1.1 -DESCRIPTIVE ANALYSIS SOCIODEMOGRAPHIC AND LIFESTYLE CHARACTERISTICS

		n (61)			
		TOTAL	**FEMALE**	**MALE**	***p***
Age (years), Mean (SD)		78.3 (9.0)	80.3(7.8)	74.0(10.0)	0.008*
Marital status, n (%)	Single/Divorce/Married	32 (52.5)	16(40.0)	16(76.2)	0.014‡
	Widowed	29 (47.5)	24(60.0)	5(23.8)	
Educational level, n (%)	No Education	17 (27.9)	14(35.0)	3(14.3)	0.081†
	Elementary School	34 (55.7)	22(55.0)	12(57.1)	
	Middle, High School or University Degrees	10 (16.4)	4(10.0)	6(28.6)	
Social vulnerability, n (%)	Yes	15 (24.6)	10(25.0)	5(23.8)	1.000‡
	No	46 (75.4)	30(75.0)	16(76.2)	
Employment Status, n(%)	Retired (excluding disabled)	50 (82.0)	36(90.0)	14(66.7)	0.032‡
	Other Occupation	11 (18.0)	4(10.0)	7(33.3)	
Housing Accommodation, n (%)	Owned	35 (57.4)	22(55.0)	13(61.9)	0.510†
	Rented	13 (21.3)	8(20.0)	5(23.8)	
	Family House	9 (14.8)	6(15.0)	3(14.3)	
	Institution	4 (6.6)	4(10.0)	0(0.0)	
Monthly Remuneration, n (%)	< 500€	37 (60.7)	28(70.0)	9(42.9)	0.055‡
	≥ 500€	24 (39.3)	12(30.0)	12(57.1)	
PAIR, n (%)	Inactive (score ≤1)	45 (73.8)	31(77.5)	14(66.7)	0.376‡
	Active (score ≥2)	16 (26.2)	9(22.5)	7(33.3)	
Smokers, n (%)	Yes	7 (11.5)	2(5.0)	5(23.8)	0.042‡
	No	54 (88.5)	38(95.0)	16(76.2)	
Drinks Alcoholic Beverages daily/weekly, n (%)	Yes	10 (16.4)	2(5.0)	8(38,1)	0.002‡
	No	51 (83.6)	38(95.0)	13(61.9)	

PAIR, Physical Activity in Inpatient Rehabilitation; SD, Standard Deviation.
* Independent Samples T-student test
† X2 test
‡ Fisher exact test

Throughout the study, the hospital stay varied depending on the patients' clinical and/or social vulnerability and type of unit they were admitted to. There were 61 patients in total who stayed for 29 days, 20 who stayed for 58 days, and 12 who stayed for 87 days.

The health status and lifestyle habits of the study participants are displayed in Table 1.2. The main diagnosis was more commonly attributed to musculoskeletal system and connective tissue diseases in females (52.5%) and nervous system diseases in males (28.6%). Additionally, 70.5% of inpatients had a health history of hypertension. The findings indicate that 29.5% of all inpatients had ulcer pressures, out of which 23.8% were female.

Upon admission, it was observed that 59.1% of patients were moderately to completely dependent on daily activities, as assessed by the Barthel Index.

Only 53 inpatients undertook the QMCI-P survey, of those, 64.2% displayed indications of mild to moderate cognitive impairment or dementia.

The majority of the patients exhibited complete or partial edentulism and only 11.5% had a full dentition. Furthermore, findings indicated that 19.7% of all hospitalized patients suffered from dysphagia.

TABLE 1.2 - DESCRIPTIVE ANALYSIS HEALTH STATUS AND FUNCTIONAL STATUS

		TOTAL	FEMALE	MALE	*p*
Main Diagnosis, n (%) n = 61	Haemorrhagic or Ischaemic Stroke	6 (9.8)	3(7.5)	3(14.3)	**0.004**†
	D. Circulatory System (others)	2 (3.3)	0 (0.0)	2(9.5)	
	D. Respiratory System	5 (8,2)	1(2.5)	4(19.0)	
	D. Digestive System	5 (8,2)	2(5.0)	3(14.3)	
	D. Nervous System	17 (27.9)	11(27.5)	6(28.6)	
	D. Musculoskeletal System and Connective tissue	22 (36,1)	21(52.5)	1(4.8)	
	Neoplasm	3 (4,9)	1(2.5)	2(9.5)	
	D. of the Genitourinary System	1 (1.6)	1(2.5)	0(0)	
Medical History, n (%) n = 61 **Total greater than n, since participants could have more than one disease.**	Obesity	20 (32.8)	13(32.5)	7(33.3)	1.000‡
	Diabetes	20 (32.8)	14(35.0)	6(28.6)	0.776‡
	Dyslipidaemia	43 (59.0)	25(62.5)	11(52.4)	0.585‡
	Hypertension	36 (70.5)	30(75.9)	13(61.9)	0.378‡
Pressure Ulcers, n (%) n = 61	Yes	18 (29.5)	13(32.5)	5(23.8)	0.564‡
	No	43 (70,5)	27(67.5)	16(76.2)	
Barthel Index, n (%) n = 61	Slight Dependency (score: >60)	25 (41.0)	16(40.0)	9(42.9)	0.958†
	Moderate Dependency (score: >40 ≤60)	14 (23.0)	10(25.0)	4(19.0)	
	Severe Dependency (score: ≥20 ≤40)	16 (26.2)	10(25.0)	6(28.6)	
	Total Dependency (score ≤20)	6 (9.9)	4(10.0)	2(9.5)	
QMCI-P, n (%) n = 53	Normal Cognition	19 (35.8)	11(32.4)	8(42.1)	0.556‡
	Mild Cognitive Impairment or Dementia	34 (64.2)	23 (67.6)	11(57.9)	
Oral Health Status, n (%) n = 61	Full Dentition	7 (11.5)	4(10.0)	3(14.3)	0.864†
	Partial Edentulism	37 (60.7)	25(62.6)	12(57.1)	
	Complete Edentulism	17 (27.9)	11(27.5)	6(28.6)	
Dysphagia, n (%) n = 61	Present	12 (19,7)	8(20.0)	4(19.0)	1.000‡
	Normal swallowing	49 (80.3)	32(80.0)	17(81.0)	

D., Disease; QMCI-P, Quick Mild Cognitive Impairment Portuguese version; SD, Standard Deviation.
† X2 test
‡ Fisher exact test

Nutritional Status

Table 2 depicts the different indicators that exhibit the nutritional status of patients from admission up-to the three-month period. The nutritional screening and assessment were conducted using the MNA, CC, AC and BMI. Each parameter was assigned a progression factor, denoting the variation between the assessment at admission and discharge.

During the hospital stay, the mean MNA score increased by 3.3 points, suggesting an improvement in the nutritional status from admission to discharge. The mean AC value did not change between admission and discharge. BMI showed a mean

increase of 0.2 between admission and discharge. Conversely, CC demonstrated a decrease by the 29th day follow-up, whilst MNA and BMI appeared to be improving, but later declined. It is worth noting, however, that the sample size for longer follow-up periods is relatively small.

TABLE 2 – PROGRESSION OF NUTRITIONAL STATUS DURING HOSPITAL STAY

		n	TOTAL Mean (SD)
MNA	Admission	61	16.0 (5.6)
	29th day	61	18.7 (5.5)
	30 to 57 days	20	17.6 (5.9)
	≥ 58 days	12	17.8 (6.3)
	Progression	61	3.3 (4.2)
BMI (kg/m²)	Admission	61	22.9 (4.5)
	29th day	61	23.0 (4.5)
	30 to 57 days	20	22.5 (3.9)
	≥ 58 days	12	22.7 (3.4)
	Progression	61	0.2 (0.9)
CC (cm)	Admission	61	31.4 (4.1)
	29th day	61	31.2 (4.2)
	30 to 57 days	20	30.4 (4.2)
	≥ 58 days	12	30.0 (4.5)
	Progression	61	-0.3 (1.1)
AC (cm)	Admission	61	26.1 (4.2)
	29th day	61	26.1 (4.1)
	30 to 57 days	20	25.0 (2.8)
	≥ 58 days	12	25.3 (3.2)
	Progression	61	0.0 (1.1)

AC, Arm Circumference; BMI, Body Mass Index; CC, Calf Circumference; MNA, Mini-Nutritional Assessment; SD, Standard Deviation.

Table 3, present a predominantly negative correlation between the nutritional status (MNA, BMI, CC, AC) and hospital stay duration, according to hospital units. There is a statistically significant negative correlation between hospital stay and the MNA evaluation of all patients at the 29th follow-up, and the AC evaluation of UMDR patients at the follow-up period ≥ 58 days. Patients with lower MNA scores tend to have longer hospital stays, except for three correlations that are positive.

TABLE 3 - ASSOCIATION BETWEEN NUTRITIONAL STATUS AND HOSPITAL STAY AND UNIT

		HOSPITAL STAY (TOTAL)					
		n	UC r_s (*p*)	n	UMDR r_s (*p*)	n	Total r_s (*p*)
MNA	Admission	43	-0.189(0.249)	18	0.056(0.826)	61	-0.191(0.141)
	29th day	43	-0.283(0.066)	18	-0.192(0.446)	61	**-0.311(0.015)**
	30 to 57 days	10	-0.333(0.347)	10	-0.424(0.222)	20	-0.272(0.246)
	≥ 58 days	5	0.400(0.505)	7	-0.324(0.478)	12	0.078(0.811)
BMI (kg/m²)	Admission	43	-0.138(0.133)	18	0.208(0.407)	61	-0.127(0.329
	29th day	43	-0.155(0.321)	18	0.269(0.281)	61	-0.111(0.393)
	30 to 57 days	10	-0.103(0.777)	10	-0.225(0.532)	20	-0.161(0.497)
	≥ 58 days	5	0.300(0.624)	7	-0.309(0.500)	12	-0.087(0.789)
CC (cm)	Admission	43	-0.093(0.555)	18	0.119(0.639)	61	-0.047(0.718)
	29th day	43	-0.105(0.509)	18	0.053(0.836)	61	-0.071(0.589)
	30 to 57 days	10	0.0330(0.934)	10	-0.218(0.431)	20	-0.065(0.785)
	≥ 58 days	5	0.400(0.505)	7	0.000(1.000)	12	0.226(0.480)
AC (cm)	Admission	43	-0.190(0.223)	18	0.323(0.191)	61	-0.149(0.251)
	29th day	43	-0.218(0.166)	18	0.293(0.237)	61	-0.194(0.137)
	30 to 57 days	10	0.249(0.487)	10	-0.422(0.224)	20	0.020(0.933)
	≥ 58 days	5	0.400(0.505)	7	**-0.764(0.046)**	12	-0.301(0.342)

AC, Arm Circumference; BMI, Body Mass Index; CC, Calf Circumference; MNA, Mini-Nutritional Assessment; SD, Standard Deviation; UC, Convalescence Unit; UMDR, Medium-Term Continuing Care and Rehabilitation Unit
r_s - Spearman's correlation.

No statistical significance is observed in any of the variations. The largest positive change is found in MNA for patients who were offered ONS or a personalized diet. Conversely, patients who did not receive ONS and/or a personalized diet experienced more negative results.

Regarding MNA and BMI, there were significant differences in the means analyzed, with lower values for patients with prescribed ONS than for those without it. The MNA variation in the prescribed patients was greater than that of the others, although it was not statistically significant. In CC, there was a negative variation without statistical significance among all patients. Patients on a personalized diet showed improvements in mean MNA and BMI with positive variations, but without statistical significance. The average value of AC remained nearly constant during the first phase of treatment.

TABLE 4 - NUTRITIONAL STATUS VS. NUTRITIONAL INTERVENTION

		ONS (at admission) Mean (SD)		*p*	**Personalized Diet** (at admission) Mean (SD)		*p*
		Yes	**No**		**Yes**	**No**	
MNA	Admission	13.1(5.3)	17.5(5.2)	**0.003**	14.8(5.9)	16.8(5.4)	0.165
	29th day	16.2(5.4)	20.0(5.1)	**0.008**	18.0(5.6)	19.1(5.3)	0.445
	Δ	3.0(3.4)	2.5(4.1)	0.589	3.2(3.0)	2.3(4.4)	0.352
BMI	Admission	20.4(4.1)	24.2(4.2)	**0.001**	22.3(4.8)	22.3(4.3)	0.426
	29th day	20.6(4.1)	24.3(4.2)	**0.002**	22.4(4.7)	23.4(4.4)	0.412
	Δ	0.1(0.6)	0.1(0.8)	0.697	0.1(0.6)	0.1(0.8	0.910
CC	Admission	29.3(4.7)	32.4(3.3)	**0.003**	29.3(4.7)	32.4(3.3)	0.250
	29th day	29.2(5.0)	32.2(3.4)	**0.007**	29.2(5.0)	32.3(3.4)	0.435
	Δ	-0.1(0.9)	-0.2(1.1)	0.519	- 0.1(0.9)	-0.2(1.1)	0.169
AC	Admission	23.9(3.3)	27.2(4.1)	**0.002**	25.3(4.0)	26.6(4.3)	0.237
	29th day	23.9(3.6)	27.2(4.0)	0.765	25.3(4.1)	26.6(4.1)	0.258
	Δ	0.1(0.8)	0.0(1.2)	0.765	0.0(1.1)	0.0(1.0)	0.878

AC, Arm Circumference; BMI, Body Mass Index; CC, Calf Circumference; MNA, Mini-Nutritional Assessment; ONS, Oral Nutrition Supplements; SD, Standard Deviation; Δ = evaluation at the 29th day – evaluation at admission.
Independent Samples T-student test.

Frailty

On admission, 93.4% of the participants were classified as frail. After 29 days, the percentage of frail participants decreased to 85.2%, with 14.8% categorized as pre-frail. Table 5 displays the mean number of frailty criteria assessed for inpatients at two RNCCI units during each evaluation time, without statistical significance between units. The mean number of frailty criteria appears to decrease between the initial two assessments, but among those with longer stays at UC, the average number of frailty criteria is higher than that observed upon admission.

TABLE 5 - DESCRIPTIVE ANALYSIS OF FRAILTY CRITERIA AND HOSPITAL STAY

		UC		**UMDR**		
		n	Mean (SD)	**n**	Mean (SD)	*p*
Frailty	Admission	43	4.19(1.029)	18	4.50(0.707)	0.243
	29th day	43	3.44(1.053)	18	3.83(1.098)	0.196
	30 to 57 days	10	3.90(1.197)	10	4.10(0.994)	0.689
	≥ 58 days	5	4.00(0.816)	7	3.86(1.215)	0.840

SD, Standard Deviation; UC, Convalescence Unit; UMDR, Medium-Term Continuing Care and Rehabilitation Unit.
Independent Samples T-student test.

Table 6 shows that the hospital stay exhibited no significant correlation with the majority of frailty criteria diagnoses. However, during the 29th day assessment, a positive correlation was observed, which had statistical significance, at the UC and overall units study.

TABLE 6 - ASSOCIATION BETWEEN HOSPITAL STAY AND FRAILTY CRITERIA NUMBER

		HOSPITAL STAY (TOTAL)					
		n	UC r_s (*p*)	n	UMDR r_s (*p*)	n	Total r_s (*p*)
Frailty	Admission	43	0.250(0.106)	18	-0.095(0.707)	61	0.191(0.141)
	29th day	43	**0.507(0.001)**	18	0.315(0.203)	61	**0.461(0.001)**
	30 to 57 days	10	0.267(0.456)	10	0.036(0.922)	20	0.123(0.607)
	≥ 58 days	5	-0.632(0.368)	7	0.170(0.716)	12	-0.196(0.563)

UC, Convalescence Unit; UMDR, Medium-Term Continuing Care and Rehabilitation Unit
r_s - Spearman's correlation.

The tool used to determine frailty syndrome entails quantifying five factors. Table 7 presents a decrease in the five criteria when assessed for frailty across two evaluation moments. It is worth noting that *weakness* was consistently considered a positive criteria. Upon analysis of the remaining four criteria, it was found that *slowness* was the most prevalent during admission as well as at the 29th day evaluation, with a higher prevalence during the latter (95.1% vs 91.8%). *Low physical activity* had the lowest incidence rate as a criterion during both periods, with rates of 73.8% and 47.5% respectively.

TABLE 7 - FREQUENCY OF FRAILTY CRITERIA AT ADMISSION AND AFTER A 29-DAY HOSPITAL STAY

		YES		NO	
		n	%	n	%
Shrinking	Admission	48	78.8	13	21.3
	29th day	39	63.9	22	36.1
Exhaustion	Admission	49	80.3	12	19.7
	29th day	32	52.4	29	47.6
Low Physical Activity	Admission	45	73.8	16	26.2
	29th day	29	47.5	32	52.5
Slowness	Admission	58	95.1	3	4.9
	29th day	56	91.8	5	8.9
Weakness	Admission	61	100.0	0	0.0
	29th day	61	100.0	0	0.0

Table 8 shows a paired sample t-test for each of the 5 items at both admission and 29th day assessment. The mean score for MNA improved significantly (t(60) = - 5.33; p < 0.001) and presented a strong and positive correlation between moments.

TABLE 8 - COMPARISON OF NUTRITIONAL STATUS AND FRAILTY CRITERIA DURING HOSPITAL STAY

		TOTAL Mean (SD)	***p*** (paired)	**r_s (*p*)**
MNA	Admission	16.0(5.6)	**<0.001**	**0.756(<0.001)**
	29th day	18.7(5.5)		
BMI (kg/m^2)	Admission	22.9(4.5)	0.306	**0.987(<0.001)**
	29th day	23.0(4.5)		
CC (cm)	Admission	31.4(4.1)	0.341	**0.970<0.001)**
	29th day	31.2(4.1)		
AC (cm)	Admission	26.1(4.2)	0.903	**0.968(<0.001)**
	29th day	26.1(4.1)		
BW (kg)	Admission	57.3(13.1)	0.166	**0.991(<0.001)**
	29th day	57.6(12.9)		
Frailty	Admission	4.28(1.0)	**<0.001**	**0.564(<0.001)**
	29th day	3.56(1.1)		

AC, Arm Circumference; BMI, Body Mass Index; BW, Body Weight; CC, Calf Circumference; MNA, Mini-Nutritional Assessment; *p*, p-value; SD, Standard Deviation.
r_s - Spearman's correlation.
Paired-sample t-test.

Spearman correlation coefficients were computed to examine the relationship between MNA, BMI, CC, and AC at all four evaluation points and frailty on admission and at day 29. The data suggest that frailty on admission is related to worse nutritional status assessment for all items. Furthermore, the statistical analysis at day 29 indicates a significant negative correlation for most of the relationships. It is worth noting that the correlation with MNA is strong (Table 9).

TABLE 9 - ASSOCIATION BETWEEN NUTRITIONAL STATUS AND NUMBER OF FRAILTY CRITERION

		n	FRAILTY ADMISSION r_s (*p*)	FRAILTY 29 DAY r_s (*p*)
MNA	Admission	61	**-0.472(<0.001)**	**-0.499(<0.001)**
	29th day	61	**-0.548(<0.001)**	**-0.651(<0.001)**
	30 to 57 days	20	-0.381(0.970)	**0.460(0.041)**
	≥ 58 days	12	0.073(0.821)	0.0(1.000)
BMI	Admission	61	**-0.390(0.002)**	**-0.292(0.022)**
	29th day	61	**-0.413(<0.001)**	**-0.290(0.023)**
	30 to 57 days	20	-0.407(0.075)	-0.185(0.434)
	≥ 58 days	12	-0.368(0.239)	-0.058(0.857)
CC (cm)	Admission	61	**-0.357(0.005)**	**-0.400(0.001)**
	29th day	61	**-0.326(0.011)**	**-0.398(0.002)**
	30 to 57 days	20	-0.142(0.550)	-0.315(0.176)
	≥ 58 days	12	0.073 (0.821)	0.198(0.536)
AC (cm)	Admission	61	**-0.330(0.009)**	-0.232(0.072)
	29th day	61	**-0.302(0.019)**	-0.243(0.061)
	30 to 57 days	20	-0.036(0.882)	0.006(0.981)
	≥ 58 days	12	0.000(1.000)	0.308(0.330)

AC, Arm Circumference; BMI, Body Mass Index; CC, Calf Circumference; MNA, Mini-Nutritional Assessment; SD, Standard Deviation
r_s - Spearman's correlation.

As shown in Figure 1, there is a slight improvement in the average number of frailty criteria, however, there is no correlation with BMI.

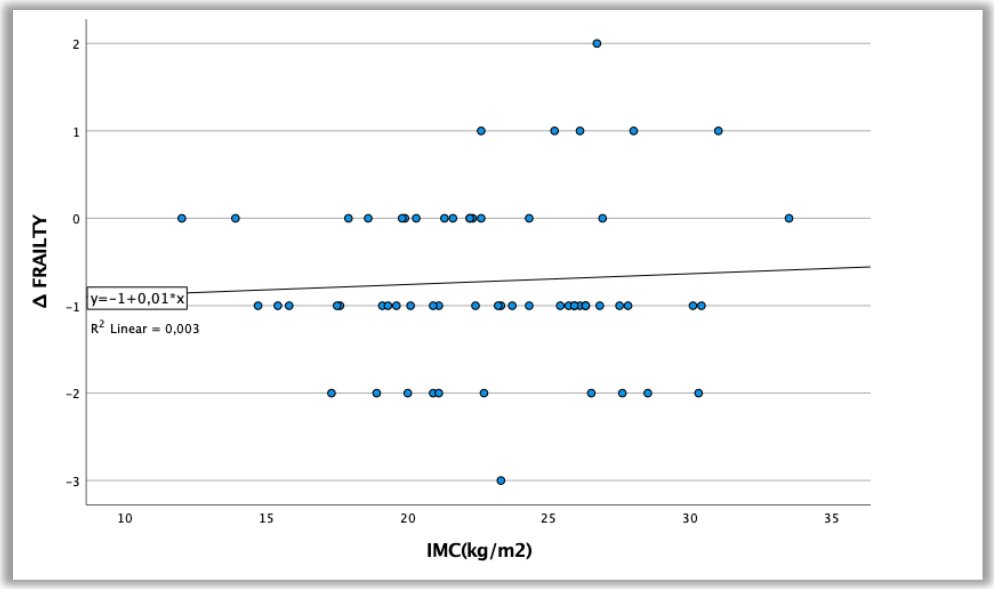

Figure 1 – Frailty variation between admission and the 29th day and BMI at admission.

Table 10 compares the variation in frailty between the first and second assessments, whether or not ONS and personalized diet were recommended. Patients who were prescribed ONS and/or a personalized diet displayed more positive criteria of frailty at both evaluation points, with statistical significance observed at day 29 for ONS prescribed at admission. While there was a decrease in the number of criteria between the two evaluation points, the change was not statistically significant.

TABLE 10 - FRAILTY CRITERIA NUMBER VS. NUTRITIONAL INTERVENTION

		ONS (at admission) Mean (SD)		*p*	**Personalized Diet (at admission)** Mean (SD)		*p*
		Yes	**No**		**Yes**	**No**	
Frailty	Admission	4.5(0.8)	4.1(1.0)	0.243	4.4 (0.8)	4.1(1.1)	0.366
	29th day	4.0(0.9)	3.3(1.1)	**0.036**	3.8(0.9)	3.4(1.1)	0.172
	Δ	-0.5(0.8)	-0.8(1.0)	0.243	-0.6(1.0)	-0.9(0.9)	0.529

AC, Arm Circumference; BMI, Body Mass Index; CC, Calf Circumference; MNA, Mini-Nutritional Assessment; ONS, Oral Nutrition Supplements; SD, Standard Deviation;
Δ = evaluation at the 29th day – evaluation at admission.
Independent Samples T-student test.

When examining the association between MNA and the five Fried's frailty criteria, we see that the mean MNA of patients with a positive criterion for *shrinking*, *exhaustion* and *low physical activity* is lower than that of patients with a negative criterion for these criteria, all of which are statistically significant. In cases where positive frailty criteria were present, the mean MNA values were less than 17.0. All individuals have *weakness*, therefore that criteria is missing from the table. There was no statistically significant association found between *slowness* and MNA results (Table 11).

TABLE 11 - ASSOCIATION AT ADMISSION BETWEEN MNA AND FRAILTY CRITERIA

		MNA Mean (SD)	*p* (paired)
Shrinking	**Yes**	15.0(5.5)	**0.006**
	No	19.9(4.7)	
Exhaustion	**Yes**	14.9(5.4)	**<0.001**
	No	20.8(3.9)	
Low Physical Activity	**Yes**	14.9(5.0)	**0.008**
	No	19.1(6.3)	
Slowness	**Yes**	16.0(5.6)	0.987
	No	16.1(7.2)	

MNA, Mini-Nutritional Assessment; *p*, p-value; SD, Standard Deviation.
Independent Samples T-student test.

DISCUSSION

The ageing process is the key determinant of well-being in old age. If inadequate, it leads to a gradual deterioration in health and an increase in dependency levels, potentially resulting in institutionalization or, in the most severe cases, hospitalization[34].

The objective of this study is to examine potential disparities in the nutritional status and frailty of patients upon admission and during various periods of hospitalization at a rehabilitation hospital. We also evaluated any potential links between nutritional interventions and these outcomes. To achieve this, we explored the effects of different nutritional strategies on the patients' nutritional status and frailty over the course of their hospital stay.

All patients had been hospitalized in the HPP for a minimum of 29 days upon conducting the second assessment. Subsequently, the study sample was reduced for the next two assessments. Due to a smaller sample size during these assessment periods (n=20 and n=12, respectively), statistical analysis was limited to the first two evaluations in certain cases, which was a limitation in this study. All patients included in this study were referred from another hospital center and had previously been hospitalized for a period of time. This, in turn, is deemed to be a potential risk factor for the development of malnutrition and frailty[35].

Our sample consists only of older people (age ≥ 60 years). Older age is conducive to the development of age-related declines, including malnutrition and frailty syndrome[1, 35]. There was a predominance of females in the sample (65.6%).

The participants had a significant occurrence of hypertension, present in the majority, accounting for 70.5%, mild cognitive impairment or dementia, accounting for 64.2%, and dyslipidemia, found in 59.0% of cases, these are crucial factors in the development of malnutrition and frailty[9, 35]. The occurrence of chronic diseases in this population was similar to the National Health Survey with Physical Examination (INSEF) 2015, conducted for the 15-74 age group[36].

Dementia and dysphagia were observed in 19.7% of the participants. Additionally, the poor condition of their oral cavity (72.2%) also could have an impact on the nutritional status of the elderly. These factors restrict their food intake due to changes in taste and smell, loss of appetite resulting in reduced food intake,

inability to consume food independently, and agnosia leading to food refusal[20, 22].

Upon admission, 59.1% of patients in our sample exhibited moderate to complete dependence on daily activities, with a further 73.8% being categorized as inactive. These findings are of pertinent relevance to our study, as we are assessing nutritional status and frailty from admission onwards, and monitoring their evolution throughout hospitalization. We must consider that patients in a poorer state of functional capacity may experience only marginal improvements in this regard over the short term, without necessarily achieving good health outcomes[37, 38].

Nutritional Status

This study found that hospitalized patients upon admission had a higher prevalence of malnutrition (mean score of 16.0) as per the MNA assessment. This can be attributed to their previous hospitalization, which puts them at greater risk of developing malnutrition due to their clinical condition, disuse myopathy, morbidity, absence of their social environment, and other factors[39]. On day 29 of hospitalization, the second evaluation showed that patients were, on average, at risk of malnutrition with a mean value of 18.7, indicating a positive trend with an average increase of 3.3. According to a systematic review by Cereda *et al*[8], there is a 29% prevalence of malnutrition in rehabilitation hospitals, which was also assessed using the MNA like in this study[8]. All other values assessed, including BMI, CC and AC, showed marginal changes on average. The changes were either negative in the case of CC. Regarding BMI, the average of all the assessment readings indicated normal weight individuals, with very minor fluctuations recorded across multiple assessments. This can be explained by the fact that at the time of admission, certain weight values for the BMI equation were estimated or derived from discharge information rather than directly measured. During subsequent assessments, some of these weights were actually measured and recorded at the time of follow-up. The CC results reveal that, on average, individuals had a CC ≥ 31cm during the first two assessments. These values are somewhat surprising, given that CC is an anthropometric measurement related to

malnutrition[8]. Several studies have shown a correlation between low MNA values and CC values ≤ 31 cm[8, 31, 40, 41]. Leandro-Merhi *et al*[40] investigated CC as a predictive factor for MNA, but our findings suggest the opposite.

The correlation between different measures of nutritional status and length of hospital stay tends to be negative. Patients indicating lower MNA, BMI, CC, and AC values, hence poorer nutritional status, tend to experience longer hospital stays. Patients in this hospital are referred based on the length of their rehabilitation needs and initial pathologies and disabilities. As a result, it is reasonable to assume that those with the worst nutritional status will stay for the longest duration. Regardless of whether individuals are referred to the UC or UMDR unit, the MNA value demonstrates a statistically significant inverse correlation with the length of stay for all patients ($r_s = -0.311$; $p = 0.015$). As noted in their article review, Cassy A R *et al*[7] have found that anywhere from 10% to 65% of inpatients can experience nutritional deterioration during hospitalization due to frequently reported barriers like mealtime obstacles, such as interruptions during mealtimes, dissatisfaction with meals, fasting before procedures, effects of illness or treatment, difficulties with chewing, and poor appetite[7]. Once again, when contemplating patients who have been transferred from another hospital and have undergone lengthy hospital stays it is likely to assume that nutritional status could still be subject to change at this preliminary stage[42].

The prescription of ONS and/or personalized diets is determined by objective factors, such as the patient's nutritional state, clinical condition, functional capacity, and food preferences. ESPEN guidelines suggest energy/protein supplementation for malnourished or at-risk elderly patients, in cases where personalized diets or fortified foods prove ineffective in yielding improvements. In the present study, the decision to prescribe ONS upon admission was not always made, despite the fact that personalizing the diet appeared to be more advantageous in certain cases[20, 21].

Prescribing ONS in this study resulted in a noticeable enhancement in the average MNA and BMI, when examining the changes in these measurements between the initial and subsequent assessments. It was determined with statistical significance that patients who were prescribed ONS exhibited the worst MNA, BMI, and AC values. As a result, their MNA remained on average at a value corresponding to

malnutrition, while their BMI exhibited slight improvement. As noted earlier, supplements should only be prescribed to patients in poor conditions. Therefore, it is possible that patients at the second assessment point, although seemingly improved, are not yet healthy. The CC worsened, consistent with the previous finding. Based on Schuetz, P *et al*[39] review, the benefits of ONS consumption may be delayed, a view reiterated by ESPEN[21, 39].

Regarding the personalized diet, despite the absence of statistical significance in these findings, the patients who underwent this intervention appeared to be in a poorer nutritional state compared to those who received supplementation, albeit marginally better.

The MNA was the sole nutritional indicator that exhibited a strong positive correlation with prolonged hospitalization, within the initial two-time frames. Usually, patients admitted to the hospital experienced a transition from malnutrition to a heightened risk of malnutrition, which may be linked to the extended multidisciplinary care provided in this medical center.

Frailty

Frailty was identified in 93.4% of all inpatients upon admission, which contrasts with findings from studies featuring elderly patients admitted to geriatric hospitals. A meta-analysis and systematic review revealed that only 47.5% of older inpatients were diagnosed with frailty[43]. Our study was carried out at a rehabilitation center and the primarily admitted patients in this study had musculoskeletal and connective tissue diseases (36.1%) or nervous system disorders (27.9%). Ailments of this nature are often correlated with decreased physical mobility and loss of muscle mass, both of which are strongly associated with frailty syndrome[44].The frequency of frailty criteria upon admission is an indicator of this correlation. In particular, weakness and slowness that were the primary positive criteria identified.

Our findings show that there is a decrease in the mean frailty number criteria between admission and the first assessment. As a result, when evaluating frailty diagnoses, the results are highly comparable. There is a significant positive correlation linking frailty to hospital stay during the second evaluation. This

indicates that the higher the positive criteria, the longer the duration of the hospital stay. This can be attributed to the extended hospital stay required in these units due to the admitted inpatients being in worse medical conditions, wherein the more severely ill patients tend to have longer durations of hospitalization.

Frailty is a widespread yet treatable ailment among elderly individuals. This population exhibits a considerable incidence of dietary deficiencies and sedentary behavior, predisposing them to the onset of frailty, which can significantly impact their bone and muscular wellbeing[45]. Therefore, it is unsurprising that insufficient nutrition can worsen the usual progression of frailty either directly or indirectly. On the other hand, numerous approaches aimed at slowing or alleviating frailty incorporate strategies that involve enhancing nutrition[21, 45, 46]. Marques M *et al*[47] reported a significant association between nutritional risk and frailty, which is consistent with our results. The study revealed that patients with the worst nutritional status upon admission were the frailest.

Frailty average during the two first assessments, appears to improve, but there is no relation to BMI score. Although the literature provides references to an association between frailty and obesity, the evidence remains unclear due to the overlap between the two conditions[13, 20, 27, 48, 49]. Body composition-wise, frailty exhibits higher body fat mass and percentage, as well as low muscle mass, resulting in reduced physical functioning, which are typical characteristics of obesity[13, 48, 50, 51]. Our sample comprises individuals with a BMI average of <30 kg/m^2. Therefore, there is no established relationship between frailty and BMI, which may be attributed to our sample type.

The link between nutritional intervention and improved frailty lacks clarity due to the multifaceted approach used across all studies and the vast variation in nutritional interventions employed[13, 21, 45]. Based on this study, patients who received ONS had a positive change in the number of frailty criteria during the first 29 days of hospitalization, suggesting that the frailest patients may benefit most from ONS treatment.

Another significant finding in this study is the identification of a relationship between MNA and three indicators of frailty: shrinking, exhaustion, and low

physical criteria. This result could signal progress in understanding the link between nutritional status and frailty.

As other investigation studies, the study presents some limitations: firstly, it is an observational study, which makes it difficult to establish a cause-effect relationship, secondly, the sample size was small and its decline at the 3rd and 4th assessment points meant that it was not possible to draw statistically significant conclusions, and the analyses comparing nutritional status, frailty status and with or without nutritional intervention may be less powerful. Thirdly, the fact that there is few literature on this topic in rehabilitation hospitals means that some of our analyses are even less statistically significant because there are no other studies to support them. On the other hand, the strengths of the present study are that the study is original in assessing the nutritional status and frailty of elderly people admitted to a RNCCI in Portugal, as well as the relationship with nutritional intervention in these cases. It thus attempts to demonstrate the real importance of nutritional support in this kind of hospital.

In summary, these findings indicate that patients admitted to these hospitals share similar characteristics and have a high prevalence of frailty and malnutrition upon admission. It is crucial to define the length of hospital stay clearly during referral, as it impacts these parameters significantly, especially the MNA and frailty outcome. The MNA score on admission could guide the decision to prescribe ONS, as the study demonstrates a significant improvement in MNA variation with ONS. Additionally, MNA is strongly linked with at least three frailty criteria.

CONCLUSION

In conclusion, older patients admitted to RNCCI have a high probability of frailty and poor nutrition status. These two parameters progress differently during hospitalization. The MNA is the most reliable indicator of nutritional status and shows positive progression, particularly with nutritional intervention. The progression of frailty remains poorly understood, although there appears to be a positive effect with ONS. Those undergoing nutrition interventions typically have poorer nutrition status and frailty, resulting in a slower progression. A positive correlation exists between nutrition status and criteria for frailty. Overall, these findings emphasize the significance of conducting a thorough nutritional assessment and intervention for patients receiving care at RNCCI. However, additional research is required to comprehensively understand the impacts on comorbidities and quality of life for these patients in relation to nutrition interventions targeting their nutritional status and frailty.

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Chapter 2 -Translation and linguistic validation of the European Portuguese version of the PAIR (Physical Activity in Inpatient Rehabilitation) assessment

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Chapter 3 Nutritional and dietary intervention in the evolution of nutritional status and frailty in two units of the National Network of Integrated Continued Care

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