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Clinical Outcomes in a Geriatric Population admitted in an Internal Medicine Ward with Infectious Respiratory Disease

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Abstract

Within the present-day context and alongside the continuous evolution of medical technology, the demographic trend shows an increase of life expectancy across the globe. Therefore, there are a growing need to better comprehend the geriatric population, as well as the increasing of comorbidities, handicaps and individual frailty.

In fact, this issue is a highly complex one, thereby making it unattainable to address the association between frailty in the elderly and all the chronic diseases that commonly accompanies the aging process. For that reason, the focus of this study lies on its association with infectious respiratory diseases.

With this study, we intent to better understand, within the geriatric population and through the utilization of the "Short Physical Performance Battery" (SPPB), whether there is any way to distinguish patients in states of pre-frailty and frailty, in order to better address the course of their disease, treatment, and management.

Although there are several scores that have shown their utility in Geriatrics, the SPPB corresponds to a new promising score, with quick access and easy execution, which we hope will be easy for screening high-risk patients in an Internal Medicine ward. Additionally, given the recent introduction of the SPPB score, its application within the Portuguese population is limited. Therefore, it is crucial to gain a better understanding of its suitability within our society.

Keywords

Geriatric; Frailty; Tracheobronchitis; Pneumonia; Chronic Obstructive Pulmonary Disease; Short Physical Performance Battery.

Resumo

No contexto atual, aliado à contínua evolução da tecnologia médica, observa-se uma tendência demográfica de aumento da esperança de vida mundialmente. Consequentemente, há uma necessidade crescente de compreender melhor a população geriátrica, assim como o aumento das comorbidades, limitações físicas e fragilidade individual.

Trata-se de uma questão é extremamente complexa, tornando inviável abordar a associação entre fragilidade em idosos e todas as doenças crónicas que comumente acompanham o processo de envelhecimento. Por esse motivo, o foco deste estudo encontra-se na associação entre fragilidade e doenças respiratórias infeciosas.

O objetivo deste estudo passa pela melhor compreensão, dentro da população geriátrica e com a utilização do "Short Physical Performance Battery" (SPPB), de maneiras de distinguir pacientes em estados de pré-fragilidade e fragilidade, a fim de melhor abordar o decorrer das suas doenças, tratamento e gestão clínica.

Embora existam diversos scores que demonstraram sua utilidade em Geriatria, o SPPB representa uma nova ferramenta promissora, de rápido acesso e fácil execução, que esperamos ser útil para o rastreio de doentes de alto risco numa enfermaria de Medicina Interna. Adicionalmente, dada a recente introdução do escore SPPB, sua aplicação na população portuguesa é limitada. Portanto, é crucial obter uma melhor compreensão de sua adequação na nossa sociedade.

Palavras-Chave

Geriatric; Frailty; Tracheobronchitis; Pneumonia; Chronic Obstructive Pulmonary Disease; Short Physical Performance Battery.

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1. Introduction

1.1. The Process of Healthy Aging

In 2015, the necessity to redefine Healthy Aging emerged, leading to a revised definition by the World Health Organization (WHO). Since then, Healthy Aging has been defined as "the life-long process of developing and maintaining functional ability, determined by intrinsic capacity, the environment, and the interaction between these two factors" (1).

Understanding the concept of intrinsic capacity (IC) is crucial, which includes the physical and mental abilities of an individual, including cognition, mobility, sensory functions, vitality, and psychology (1)(2). Although genetic factors influence the decline or maintenance of intrinsic capacity, there is also significant interaction with the surrounding environment (Figure 1) (1).

With the decline in IC with aging and the consequent failure to maintain the functionality and health status, potential health problems arise (Figure 1). Thus, by paying closer attention and better understanding this decline, it becomes possible to improve quality of life, reduce adverse events, and strive to maintain the physical and cognitive functionality of patients. (1)(2)

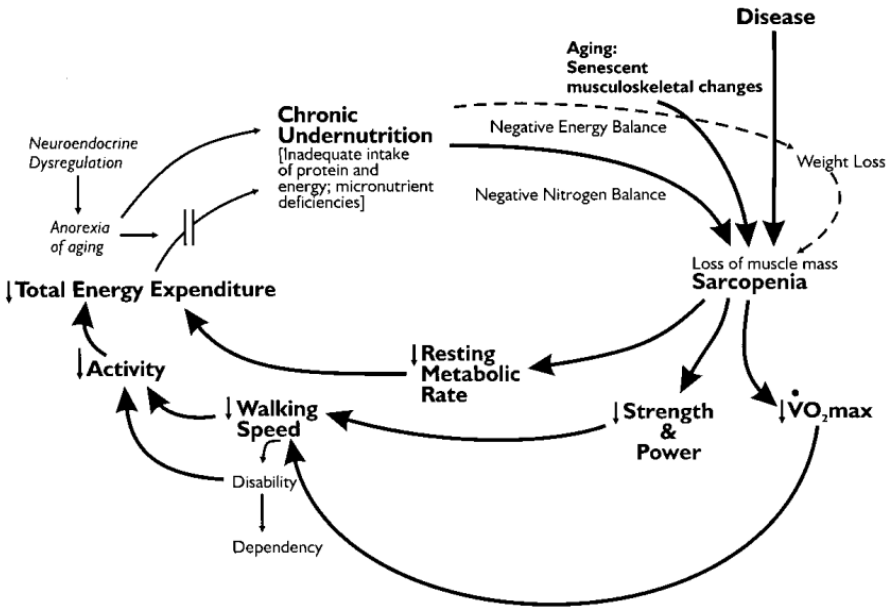


Figure 1 - Cycle of Frailty

[Fried et al. (2001), Frailty in Older Adults: Evidence for a Phenotype, Journal of Gerontology]

Despite the definitions of healthy aging, it is also important to note the impact that a patient's comorbidities have throughout this process, not only due to the characteristics of the diseases themselves but also because of the need for pharmacotherapy, as well as the potential harm that may result from incorrect treatment or polypharmacy, which can be defined as the use of five or more medications (3).

1.2. Frailty in the elderly

Nowadays, with the advances in Medicine, not only have we managed to increase the average life expectancy, but we have also been able to ensure a higher quality of life for the elderly. However, with the rise of life expectancy and the increase in the geriatric age group, there is also another issue that we must take into account: the intrinsic frailty of the elderly. Only by better understanding geriatric frailty can we truly understand this population and ensure improved living conditions for them.

From a biological perspective, the process of aging, the presence of other comorbidities and environmental factors will result in an accumulation of deficits and cellular damage, leading to a decline in their physical and cognitive abilities (4)(5). Thus, by understanding this accumulation of deficits and the progression of these events, we can strive to lessen their impact on the elderly and endeavour to prevent their consequences for their functionality.

Besides the aging process, other geriatric syndromes, such as senescence, will affect this population, leading to a higher risk of falls, disability, hospitalization, and mortality (6). However, these negative outcomes must be acknowledged in order to better understand the physical and functional decline of the elderly, guiding future interventions and referrals that may enhance the functionality and physical and cognitive autonomy of this population (7).

1.3. Frailty Definitions

To better address frailty in the elderly, different ways of defining frailty have emerged, with the most widely used frailty models being the Frailty Phenotype and the Frailty Index of Deficit Accumulation (Figure 2). Although both scores are essentially based on lower limb function, with the Frailty Phenotype focusing more on clinical presentations of physical frailty and the Frailty Index of Deficit Accumulation focusing more on the total burden that certain health deficits have on the elderly, from both a subjective perspective through self-report and an objective perspective through observation by healthcare professionals (6)(8).

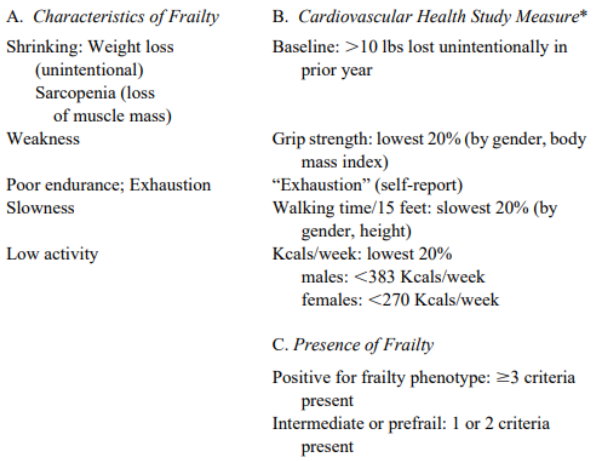
Approach to measuring grades of frailty	Components
The phenotype model[a]	Exhaustion
	Low physical activity
	Weakness
	Slow walking
	Unintentional weight loss
The frailty index of deficit accumulation[b]	Deficits of symptoms and signs
	Comorbidities
	Deficits of activities of daily living
	Deficits of social relations and social support

[a]he phenotype model is based on five physical indicators
[b]The frailty index of deficit accumulation is calculated from a variety of individual health deficits

Figure 2 - Components of the phenotype model and the frailty index of deficit accumulation

[Li et al. (2017), An overview of osteoporosis and frailty in the ederly, BMC Musculoskeletal Disorders]

The **Frailty Phenotype** was proposed by Fried et al. It defines frailty and pre-frailty based on the presence of at least 3 and 1 or 2 out of 5 components, respectively (Figures 2 and 3). The evaluated components include unintentional weight loss of at least 4.5 kg or 5% of total body weight in the previous month, subjective complaints of fatigue, muscle weakness (assessed using a hand-grip dynamometer), low level of physical activity (evaluated through weekly energy expenditure in kilocalories), and the need for an extended period of time to walk 4.6 meters (after 2 meters of acceleration followed by 2 meters of deceleration) (Figure 3). (6)



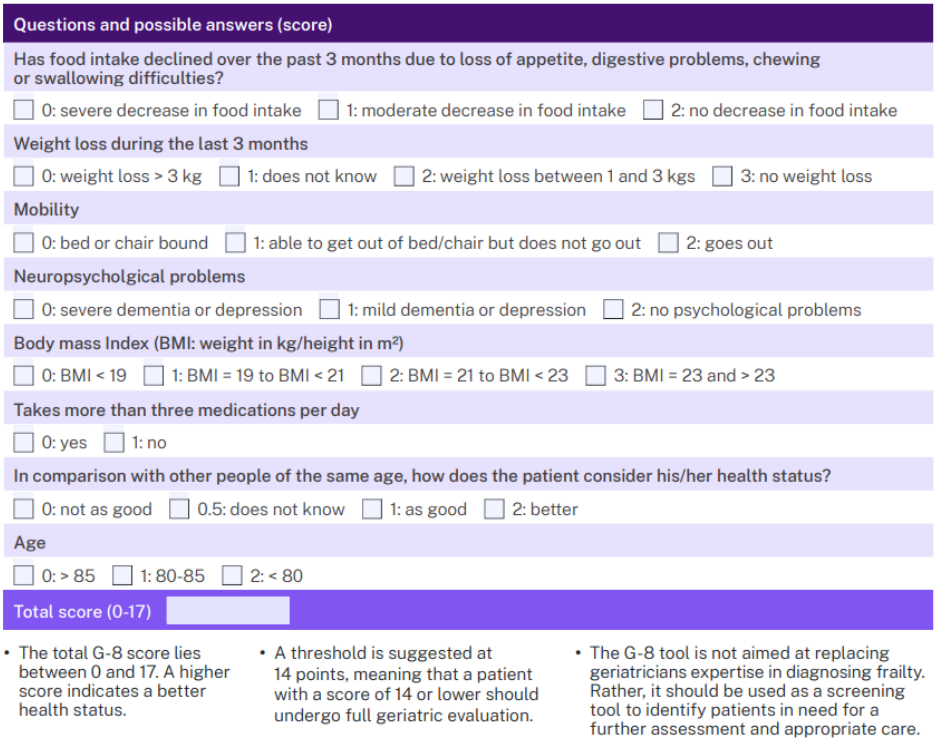
A. *Characteristics of Frailty*	B. *Cardiovascular Health Study Measure**
Shrinking: Weight loss (unintentional) Sarcopenia (loss of muscle mass)	Baseline: >10 lbs lost unintentionally in prior year
Weakness	Grip strength: lowest 20% (by gender, body mass index)
Poor endurance; Exhaustion	"Exhaustion" (self-report)
Slowness	Walking time/15 feet: slowest 20% (by gender, height)
Low activity	Kcals/week: lowest 20% males: <383 Kcals/week females: <270 Kcals/week
	C. *Presence of Frailty*
	Positive for frailty phenotype: ≥3 criteria present
	Intermediate or prefrail: 1 or 2 criteria present

Figure 3 - Operationalizing a Phenotype of Fraity

[Fried et al. (2001), Frailty in Older Adults: Evidence for a Phenotype, Journal of Gerontology]

On the other hand, the **Frailty Index of Deficit Accumulation**, developed by Rockwood et al., helps identify individuals with unhealthy aging. It is based on 52 items distributed across 4 main domains (Figure 2). To assess cognitive and physical function, there are 22 items; for self-reported vitality and health problems, there are 7 items; for assessing mental health, there are 6 items and finally there are 17 items to evaluate patient comorbidities, the presence of polypharmacy (defined by the use of more than three medications per day), and healthcare service usage. (9)

Originally developed to identify elderly cancer patients with poor prognosis, the **G8 Screening Tool** emerged (Figure 4). This tool encompasses seven features of the patient, including food intake, weight loss, mobility, neuropsychological conditions, BMI, the number of prescribed medications, and self-perception of health status. Through a quick application of this score, ranging from 0 to 17, it became possible to identify patients with poor prognosis when score is 14 or less (Figure 4). (10)



Questions and possible answers (score)
Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
☐ 0: severe decrease in food intake ☐ 1: moderate decrease in food intake ☐ 2: no decrease in food intake
Weight loss during the last 3 months
☐ 0: weight loss > 3 kg ☐ 1: does not know ☐ 2: weight loss between 1 and 3 kgs ☐ 3: no weight loss
Mobility
☐ 0: bed or chair bound ☐ 1: able to get out of bed/chair but does not go out ☐ 2: goes out
Neuropsycholgical problems
☐ 0: severe dementia or depression ☐ 1: mild dementia or depression ☐ 2: no psychological problems
Body mass Index (BMI: weight in kg/height in m²)
☐ 0: BMI < 19 ☐ 1: BMI = 19 to BMI < 21 ☐ 2: BMI = 21 to BMI < 23 ☐ 3: BMI = 23 and > 23
Takes more than three medications per day
☐ 0: yes ☐ 1: no
In comparison with other people of the same age, how does the patient consider his/her health status?
☐ 0: not as good ☐ 0.5: does not know ☐ 1: as good ☐ 2: better
Age
☐ 0: > 85 ☐ 1: 80-85 ☐ 2: < 80
Total score (0-17)

- The total G-8 score lies between 0 and 17. A higher score indicates a better health status.
- A threshold is suggested at 14 points, meaning that a patient with a score of 14 or lower should undergo full geriatric evaluation.
- The G-8 tool is not aimed at replacing geriatricians expertise in diagnosing frailty. Rather, it should be used as a screening tool to identify patients in need for a further assessment and appropriate care.

Figure 4 - The Geriatric 8 (G8) Screening Tool

[Bellera et al. (2012), Screening Older Cancer Patients: Firs Evatuation of the G-8 Geriatric Screening Tool, Annals of Oncology]

Another score that emerged in oncology is the **Eastern Cooperative Oncology Group (ECOG) Performance Status** (Zubrod Scale), which contributes to evaluating the functionality of these patients and deciding whether a particular patient is fit for standard intensive therapy compared to other patients with higher scores (10).

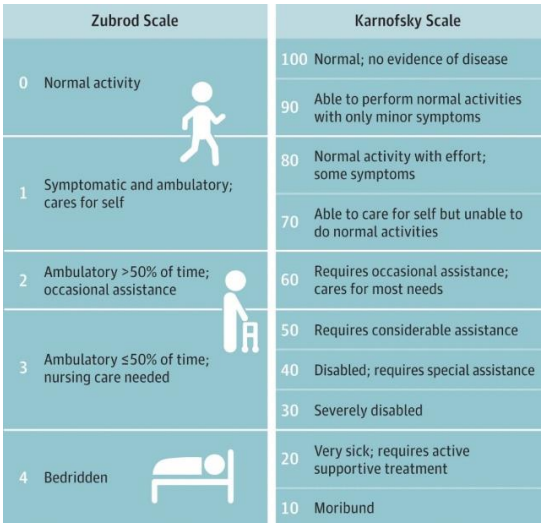


Figure 5 - Commonly used performance status assessment tools

[Beg et al. (2017), Embracing Electronic Tools to Improve Patient Outcomes, UT Southwestern]

In clinical practice, the ECOG Performance Status classifies patients according to their level of activity and ability to perform activities of daily living and instrumental activities. This scale ranges from ECOG 0, representing a patient who is fully active, to ECOG 5, representing the patient's death (Figure 5). (11)

Amongst all the scores previously mentioned, de Groot at al. (2003) mention that **age-adjusted Charlson Comorbidity Index** (Figure 6) is better suited for evaluating multimorbidity in the elderly (12). It is through assessing the various comorbidities in geriatric patients and thus their greater burden of chronic diseases that individuals over 65 with a higher risk of associated mortality are identified (Figure 6)(13).

Table 1. Comorbidity distribution based on the age-adjusted Charlson comorbidities, *n* = 156,151.

Variable	Point	Number of patients (%)
Age		
40≧Age	0	11317(7.2)
50≧Age>40	1	30094(19.3)
60≧Age>50	2	41781(26.8)
70≧Age>60	3	33897(21.7)
80≧Age>70	4	27706(17.7)
Age>80	4	11356(7.3)
Myocardial infarction	1	305(0.2)
Congestive heart failure	1	966(0.6)
Peripheral vascular disease	1	167(0.1)
Cerebrovascular disease	1	1726(1.1)
Dementia	1	193(0.1)
Chronic pulmonary disease	1	3143(2.0)
Rheumatic disease	1	220(0.1)
Peptic ulcer disease	1	6414(4.1)
Mild liver disease	1	5184(3.3)
Diabetes mellitus without end-organ damage	1	7775(5.0)
Diabetes mellitus with end-organ damage	2	732(0.5)
Hemiplegia	2	118(0.1)
Renal disease	2	1053(0.7)
Any malignancy*	2	10737(6.9)
Lymphoma	2	267(0.2)
Leukemia	2	95(0.1)
Moderate liver disease	3	846(0.5)
Metastatic solid tumor	6	6135(3.9)
Acquired immunodeficiency syndrome (AIDS)	6	2(0.0)

*Patients with more than one type of cancer in this study population.
Renal disease: chronic glomerulonephritis; nephritis and nephropathy; chronic renal failure.
Mild liver disease: chronic hepatitis; alcoholic cirrhosis; biliary cirrhosis. Moderate liver disease: liver diseases with cirrhosis-related complications.

Figure 6 – Age-adjusted Charlson Comorbidity Index

[Chang et al. (1987), Adjusted Age-Adjusted Charlson Comorbidity Index Score as a Risk Measure of Perioperative Mortality before Cancer Surgery, PLoS ONE]

This score allows us to categorize patients with scores of 1-2, 3-4, and ≥5 as being at low, moderate, and high risk of mortality in 10 years, respectively, with a score of 0 corresponding to patients who do not have any conditions evaluated by this score (Figures 7 and 8) (13).

Table 5. Percentage 1-yr mortality among patients who survived hospitalization according to illness severity and weighted index of comorbidity*

	Weighted index of comorbidity			
Severity	"0"	"1–2"	"3–4"	"> 5"
Not to mildly ill	7 (97)	16 (87)	41 (17)	64 (22)
Moderately ill	6 (47)	17 (63)	39 (25)	76 (17)
Severely ill	12 (25)	30 (57)	50 (18)	100 (15)
Total	7 (169)	21 (207)	43 (60)	78 (54)

*Reason for admission was not a significant predictor of mortality in this group of patients.
$\chi^2 = 139$; $df = 2$; $R = 0.301$; log $(h_i/h_o) = 0.36$ $(+0.09)$ severity $+ 0.42$ (± 0.03) weighted comorbidity score.

Figure 7 - Percentage 1-yr mortality among patients who survided hospitalization according to ilness severity and weighted index of comorbidity

[Charlson et al. (1987), A New Method of Classifying Prognostic Comorbidity in Longitudinal Studies: Development and Validation, Pergamon Journals Ltd]

Table 6. Ten-year actual and predicted survival according to age–comorbidity in the testing population

Comorbidity–age combined risk score*	Number of patients	Actual 10-yr survival (%)	Predicted 10-yr survival† (%)
0	213	99	99
1	156	97	96
2	136	87	90
3	109	79	77
4	42	47	53
5	29	34	21

*Each comorbidity rank was equivalent to one decade of age, with 40 yr taken as the zero rank for age (e.g. a patient who was 50 who had a comorbidity index of 2 would have a score of 3). The beta coefficient for the age–comorbidity combined score was 0.9 (e.g. <40 coded as 0, 50 as 1, 60 as 2, 70 as 3, etc.).
†The predicted survival was calculated from the 10-yr survival of a theoretical low risk population (0.983). Thus for a score of 70 the calculation was $0.983^{14.8}$, where $14.8 = e^{2.7} = e^{0.9(3)}$.

Figure 8- Ten-year actual and predicter survival according to age-comorbidity in the testing population

[Charlson et al. (1987), A New Method of Classifying Prognostic Comorbidity in Longitudinal Studies: Development and Validation, Pergamon Journals Ltd]

Lastly, the **Clinical Frailty Scale** was also introduced by Rockwood et al. with the aim of identifying individuals in this age group who meet frailty criteria, originally developed for patients with heart failure (Figure 9). Through this scale, the level of frailty can be

quantified on a scale of 1 to 9, corresponding respectively to a very fit individual and one who is terminally ill. Thanks to this scale and its correlation with the prognosis of elderly patients, it has become possible to identify a group of older adults with low survival and a greater need for institutional care, particularly through a score of at least 4 points. (15) Thus, in addition to patients with scores between 1 and 3 being at low risk of complications from their underlying diseases and generally being independent, we can also distinguish patients with the following characteristics (16):

- **Scores of 4 to 5**: These patients require some assistance with activities of daily living and have a slightly increased risk of complications.
- **Scores of 6 to 8**: These patients need significant assistance with daily activities and are highly vulnerable to complications due to their health condition. Palliative care might be advised.
- **Score of 9**: These patients have a limited life expectancy and require palliative care during their follow-up.

Figure 9 - Clinical Frailty Scale

[Rockwood et al. (2005), A global clinical measure of fitness and frailty in elderly people, Canadian Medical Association Journal]

1.4. Short Physical Performance Battery (SPPB)

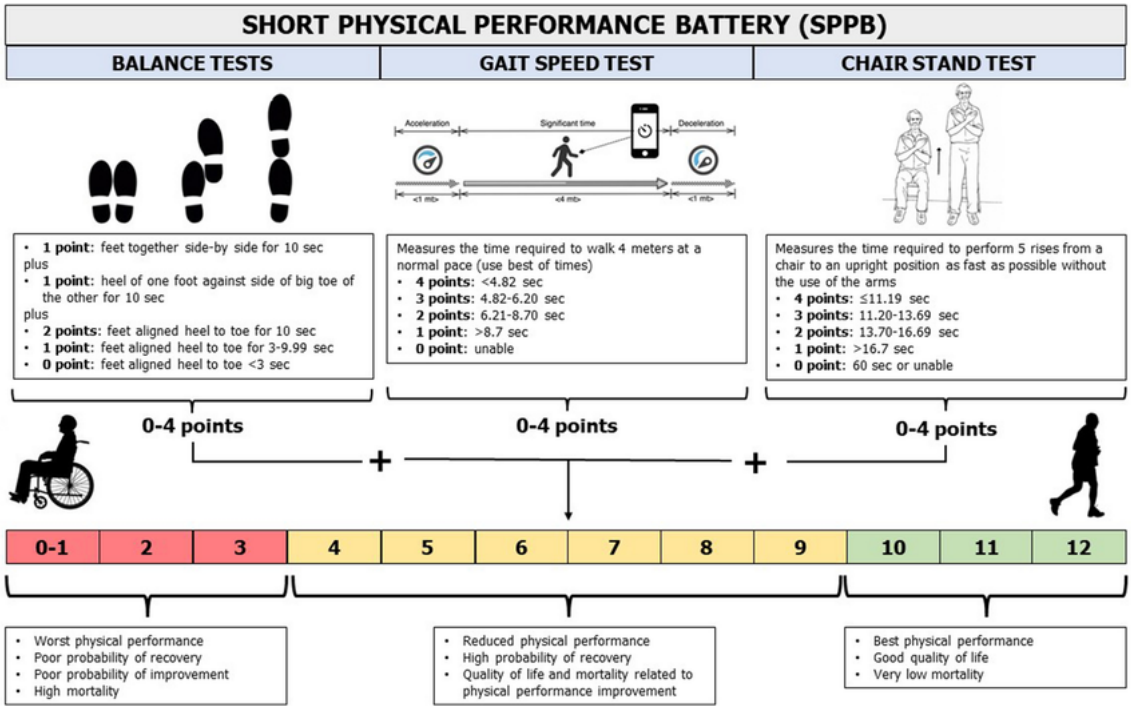


Figure 10 - Description and Interpretation of SPPB scale

[Tonet et al. (2023), Multi-domain lifestyle intervention in older adults after myocardial infarction: rationale and design of the PIpELINe randomized clinical trial, Aging Clinical and Experimental Research]

Functional ability and performance capacity are as important as or even more important than patient diagnoses themselves. In a context where treatment extends beyond merely identifying diseases, it is a patient's ability to perform daily activities and maintain quality of life that truly defines therapeutic success. Thus, valuing and prioritizing functionality means adopting a more holistic and effective approach, where each step in recovery is measured by the individual's capacity to live fully and with dignity.

In this context, the Short Physical Performance Battery (SPPB) emerged from the work of Guralnik et al. with the purpose of screening individuals at risk of disability, institutionalization, and eventually death (5)(15). However, several studies have been conducted aiming to establish correlations between SPPB scores and patient pour outcomes, as well as certain conditions, such as falling, infections, venous thrombosis

and immobility. This is not only due to its value and relevance as a geriatric score comprising various functional aspects but also because of its rapid application, low costs, and assessment of such complex patients as the geriatric individuals (Figure 10).

In that manner, the SPPB aims to address the functionality of the elderly in its wholeness and complexity, or at least as fully as possible. Thus, it does not assess just one aspect of the patient's physical function; rather, it is based on three sub-tests that evaluate three different domains: balance, strength, and gait (Figure 10)(5).

Each of these tests assesses a characteristic that is gradually lost with aging and senescence, through which all individuals will inevitably pass. With advancing age, there will be a gradual loss of balance, strength, and independence in gait. (5)

Regarding balance, due to the loss of muscle mass and decreased neuromotor reactions, there is not only a loss of homeostatic maintenance but also a loss of the elderly individual's ability to react adaptively to oscillations and changes in their standing position. The loss of muscle mass also plays an important role in the decline of strength, affecting not only their autonomy in activities of daily living (ADLs) but also their ability to maintain independent gait, as well as other more complex activities. (5)

Of the three components of the SPPB, balance is evaluated in three different positions, each of which the patient must maintain for 10 seconds. Firstly, the patient must maintain balance in an upright position with feet together, then with one foot slightly in front of the other, and finally with one foot fully in front of the other. In turn, the SPPB evaluates the strength and gait of the patient through the following two tests, assessing the time it takes for the patient to rise from a chair five times and to walk a distance of 4 meters, respectively (5).

Each of these subtests is scored from 0 to 4 points, depending on the individual's ability to perform the tasks, with 0 indicating an inability to complete the tasks and 4 representing maximum performance for each test (Figure 10) (5)(6).

Since the SPPB yields a score ranging from 0 to 12, there are also values that can be used to classify an individual as frail or in a pre-frail state. These values are not consistent across all studies, but most consider a patient frail when they have a score of 9 or less

on the SPPB. However, other studies subdivide patients with 9 or fewer points on the SPPB as pre-frail with scores between 7 and 9, and frail when they have a score between 0 and 6 (6).

1.5. SPPB in infectious respiratory disease

The purpose of this study in determining the applicability of the SPPB in individuals with infectious respiratory disease. Considering the information that has emerged in recent years regarding respiratory infections, particularly COVID-19, it seemed important to address the frailty of the elderly associated with respiratory infections, given the impact this has also had on functionally of geriatric population.

Additionally, it is known that the increase in respiratory infections like pneumonia in this age group can predispose to chronic inflammation, which may ultimately lead to the production of pro-inflammatory cytokines that can lead to muscle atrophy. One of the reasons why the number of respiratory infections increases in geriatric patients is also related to the impairment of the cough mechanism, reduction in the mass and function of the muscles involved in swallowing, and the risk of aspiration in patients requiring nutritional support and immunological senescence. (17)

Furthermore, it is also acknowledged that hospitalization for pneumonia can be highly debilitating for the individual's functionality, including cognitive impairment, and depression. In these patients, muscle atrophy can also be exacerbated by hypoxia, malnutrition, and inactivity associated with hospitalization, all of which may have a negative impact on neuronal degradation. (17)(18)

Another condition with a significant impact on the functionality of this individuals is Chronic Obstructive Pulmonary Disease (COPD), notably due to decreased exercise tolerance, muscle function, physical activity, individual quality of life, and mortality (18)(19). During exacerbations, there could be a worsening of muscle dysfunction and diminished peripheral muscle strength, which is also associated with increased mortality in moderate to severe COPD (20).

With the progression of this disease, the quality of life of these patients may deteriorate, mainly due to the development of chronic hypoxemic or hypercapnic respiratory failure, which may eventually necessitate long-term oxygen therapy or non-invasive ventilation (19).

Despite exacerbations of COPD complicating the assessment of the functional status of these patients, it is indeed important to facilitate future referrals for pulmonary rehabilitation, aiming to improve symptoms, functional capacity, and quality of life (18). The COPD Foundation also recommends the use of the SPPB (21).

2. Methods

2.1. Study Design and Protocol

To conduct this analytical cross-sectional study, a sample of 20 patients was selected. These patients were admitted on an Internal Medicine ward of Santa Maria Hospital (Lisbon, Portugal) with infectious respiratory diseases, falling within the geriatric age range.

The individuals were selected based on patients admitted to the aforementioned Internal Medicine Department from February to May 2024. They had to meet the inclusion criteria (Table 1) of age and infectious respiratory disease, based on clinical criteria, plus evidence on a Chest X-Ray or a thoracic CT scan or/and increased inflammatory markers. For this study, individuals were considered geriatric if they were at least 65 years old. Additionally, pneumonia, including bacterial and/or viral, lobar and interstitial pneumonia and bronchopneumonia, tracheobronchitis, and/or exacerbation of chronic obstructive pulmonary disease (eCOPD) were included as infectious respiratory pathologies.

Inclusion Criteria

• Age (≥60 years)
• Infectious respiratory disease
  ○ Pneumonia (bacterial and/or viral, lobar and interstitial pneumonia and bronchopneumonia)
  ○ Tracheobronchitis
  ○ And/or exacerbation of Chronic Obstructive Pulmonary Disease

Table 1 - Inclusion Criteria

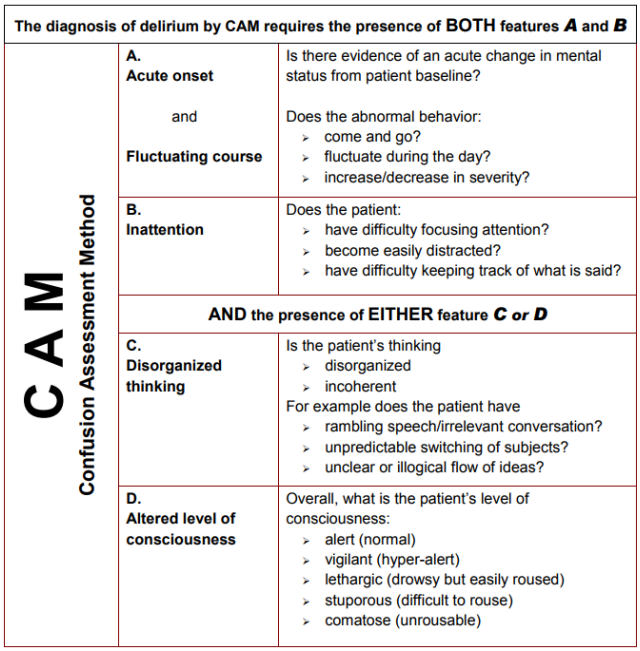
Exclusion criteria (Table 2) were defined as patients presenting with mental/cognitive disturbances or impaired comprehension, to ensure that these aspects did not influence the application of the intended geriatric scores or the clinical outcomes to be evaluated in this study, and patients with reduced mobility. The Confusion Assessment Method

(CAM) was also applied to exclude patients with delirium, compromised consciousness, inattention and impaired logical thinking (Figure 11).

Exclusion Criteria
• Mental/Cognitive Disturbances or Impaired Comprehension
• Reduced Mobility
• Delirium, Compromised Consciousness, Inattention and Impaired Logical Thinking (CAM)

Table 2 - Exclusion Criteria

During their hospitalization for infectious pathology, oral consent was obtained from the patients. This consent allowed for the consultation of clinical information related to their hospitalization and the application of various geriatric assessment scores, namely the G8 Geriatric Tool, the Charlson Comorbidity Index, the Clinical Frailty Scale, the ECOG Performance Status, and the Short Physical Performance Battery (SPPB) (Figures 4, 5, 6, 9 and 10).



The diagnosis of delirium by CAM requires the presence of BOTH features ***A*** and ***B***		
C A M Confusion Assessment Method	**A.** **Acute onset** and **Fluctuating course**	Is there evidence of an acute change in mental status from patient baseline? Does the abnormal behavior: ➢ come and go? ➢ fluctuate during the day? ➢ increase/decrease in severity?
	B. **Inattention**	Does the patient: ➢ have difficulty focusing attention? ➢ become easily distracted? ➢ have difficulty keeping track of what is said?
	AND the presence of EITHER feature *C or D*	
	C. **Disorganized thinking**	Is the patient's thinking ➢ disorganized ➢ incoherent For example does the patient have ➢ rambling speech/irrelevant conversation? ➢ unpredictable switching of subjects? ➢ unclear or illogical flow of ideas?
	D. **Altered level of consciousness**	Overall, what is the patient's level of consciousness: ➢ alert (normal) ➢ vigilant (hyper-alert) ➢ lethargic (drowsy but easily roused) ➢ stuporous (difficult to rouse) ➢ comatose (unrousable)

Figure 11- Confusion Assessment Method (CAM)

(The Critical Care Practitioner, accessed 11 August 2024, https://www.criticalcarepractitioner.co.uk/delirium-critical-care/confusion-assessment-method-cam/)

Relevant clinical outcomes selected for evaluation in these patients included the Charlson Comorbidity Index, the presence of polypharmacy, partial or total respiratory failure during hospitalization, the maximum dose of oxygen therapy administered, the need for invasive mechanical ventilation or high-flow mask use, and the development of sepsis during hospitalization.

2.2. Data Collection

To obtain the data for this study, information regarding the patients' clinical conditions and previous hospitalizations was retrieved from the computerized clinical records.

To address any missing information and calculate the utilized scores and indices, data were collected directly from the patients. Subsequently, the tests comprising the Short Physical Performance Battery were conducted, assessing the patients' balance, strength, and gait.

2.3. Study Outcomes

The primary outcome was defined as the impact of acute disease, comorbidities and clinical outcomes on SPPB and patient frailty, as biomarkers of performance capacity and functionality.

The secondary outcome corresponds to the possible interaction between the SPPB results and each of the other applied geriatric scores in this population.

2.4. Statistical analysis

Regarding the statistical analysis itself, the first phase involved assessing whether the data followed a normal distribution, in order to determine the use of parametric or non-parametric tests.

To study the data from our population and establish whether there was an association between these parameters and the SPPB, given the non-normality of the data and the small sample size of the study, the Fisher's Exact Test was used.

In addition, we aimed to establish whether each of the scores were useful in evaluating the geriatric population, despite assessing different components from the SPPB.

Upon assessing normally distributed data, such as the G8 Geriatric Tool and the Clinical Frailty Scale, along with the normally distributed SPPB, the first step was to determine if the association between each of these scores and the SPPB exhibited a linear distribution, which is a prerequisite for using Pearson's Correlation Coefficient. However, as this linearity was not observed, Spearman's Rank Correlation Coefficient was used instead.

As the results of the Charlson Comorbidity Index and the ECOG Performance Status were not normally distributed, Spearman's Rank Correlation Coefficient was directly computed for these variables.

Ultimately, the aim was to determine whether the SPPB data influenced the predefined clinical outcomes: Charlson Comorbidity Index, presence of polypharmacy, occurrence of partial or total respiratory failure during hospitalization, maximum dose of administered oxygen therapy, need for invasive mechanical ventilation or use of high-flow mask, and development of sepsis during hospitalization. Since none of these variables followed a normal distribution, Spearman's Rank Correlation Coefficient was used to assess the desired associations.

Due to the small sample size and the results of the statistical analysis conducted, it was decided to subsequently perform a descriptive analysis of the obtained data. This included using the median for continuous or discrete variables, which were not symmetrically distributed in this case, and using absolute values and percentages for categorical variables.

3. Results

During the data collection period, 20 elderly patients were identified after inclusion and exclusion criteria were applied.

The obtained data were analysed to assess demographic characteristics, respiratory pathology, the relationship of the Short Physical Performance Battery (SPPB) on predefined clinical outcomes, and potential interactions between the SPPB and each of the other geriatric scores applied in the sample.

3.1. Demographic Characterization and Infectious Respiratory Diseases

3.1.1. Demografic Characterization

Overall, based on the classification of the population according to SPPB scores, no patients met the criteria for frailty (Table 3). However, approximately 20% of our sample exhibited pre-frailty criteria, and around 80% met the criteria for frailty (Table 3).

	Number of Patients
Non-Frail	0 (0%)
Pre-Frail	4 (20%)
Frail	16 (80%)

Table 3: Frailty of the Sample

Regarding the demographic characterization of the sample used, a total sample consisting of 60% **male** and 40% **female patients** was observed. Among these patients, while all female patients met the criteria for frailty (SPPB 0-6), 20% were male who met the criteria for pre-frailty (SPPB 7-9), and 40% were male patients with frailty (Table 4).

The **median age** of the sample in this study was 84.5 years. When discriminate between patients with pre-frailty (SPPB 7-9) and frailty (SPPB 0-6), the medians were 70 years and 85 years, respectively. Additionally, approximately 50% of the patients in this sample were 85 years or older, which impacts at least 45% of the patients who met the criteria for frailty (9 patients in the age group ≥85 years) (Table 4).

Regarding the **educational level**, about 10% had no formal education, all of them were all classified as frail. While approximately 5% and 10% of patients who had completed three educational years met the criteria for pre-frailty and frailty, respectively, it was more common for patients to have completed four educational years, representing 65% of the sample. Of these, 10% were pre-frail and 55% were frail. Lastly, only 10% of patients had attended higher education ("Bachelor's degree"), with half of these patients meeting the criteria for pre-frailty (5%) and the other half meeting the criteria for frailty (5%) (Table 4).

Categorizing the **number of previous hospitalizations** among the evaluated patients, only 15% had more than 7 prior hospitalizations, and all met criteria for frailty. Among patients with fewer prior hospitalizations, approximately 35% had fewer than 5 hospitalizations, with 10% of these patients meeting the criteria for pre-frailty and 40% meeting the criteria for frailty. For patients with between 5 and 7 prior hospitalizations, about 10% were classified as pre-frail and 40% as frail (Table 4).

		SPPB Values		
		Non-frail (10-12)	*Pre-frail (7-9)*	*Frail (0-6)*
Gender	*Male*	0 (0%)	4 (20%)	8 (40%)
	Female	0 (0%)	0 (0%)	8 (40%)
Age (years)	*65-74*	0 (0%)	3 (15%)	2 (10%)
	75-84	0 (0%)	0 (0%)	5 (25%)
	≥85	0 (0%)	1 (5%)	9 (45%)
Scholarity	*None*	0 (0%)	0 (0%)	2 (10%)

	Three Years	0 (0%)	1 (5%)	2 (10%)
	Four Years	0 (0%)	2 (10%)	11 (55%)
	Bachelor	0 (0%)	1 (5%)	1 (5%)
Previous Hospitalizations (number)	*< 5*	0 (0%)	2 (10%)	5 (25%)
	5-7	0 (0%)	2 (10%)	8 (40%)
	>7	0 (0%)	0 (0%)	3 (15%)

Table 4: Demografic Characterization

3.1.2. Infectious Respiratory Diseases

Regarding the acute infectious respiratory diseases of this sample, only 5% (1 patient) had a diagnosis of **tracheobronchitis**, compared to 90% and 40% of patients who had diagnoses of **pneumonia** and/or **exacerbation chronic obstructive pulmonary disease** (eCOPD), respectively. It is noteworthy that among patients with diagnoses of pneumonia or eCOPD, approximately 35% had both diagnoses at the time of hospitalization (Table 5).

Concerning the criteria for pre-frailty and frailty in these patients, it is observed that there is a higher percentage of patients classified as "frail" within each pathology compared to those classified as "pre-frail" (Table 5).

None of the patients meeting pre-frailty criteria had only one of the evaluated diseases, while about 5%, 55%, and 30% of patients met the criteria for frailty and had respectively a diagnosis of tracheobronchitis, pneumonia and eCOPD (Table 5).

	SPPB Values		
	Non-frail (10-12)	*Pre-frail (7-9)*	*Frail (0-6)*
Tracheobronchitis	0 (0%)	0 (0%)	1 (5%)

Pneumonia	0 (0%)	0 (0%)	11 (55%)
eCOPD	0 (0%)	0 (0%)	1 (5%)
Pneumonia + eCOPD	0 (0%)	2 (10%)	5 (25%)

Table 5: Acute Infectious Respiratory Diseases

3.2. Relationship between SPPB values and Clinical Outcomes

Regarding the clinical outcomes defined for this study, despite no patients having a null or low mortality risk according to the **Charlson Comorbidity Index** (Figures 7 and 8), a moderate mortality risk was observed in 10% of "Pre-frail" patients and 15% of "Frail" patients, while a high risk was observed in 10% and 13% of these patients, respectively (Table 6).

Approximately 75% of the patients were on **polypharmacy** (Table 6). Among this group, about 5% met the criteria for pre-frailty and 70% for frailty. Among patients who did not meet the criteria for polypharmacy, 15% were classified as "Pre-frail" and 10% as "Frail."

The occurrence of **hipoxemic and hipercapnic respiratory failure** was also assessed (Table 6). Approximately 60% developed hipoxemic respiratory failure during hospitalization, and about 10% developed hipercapnic respiratory failure. Among patients with hipoxemic respiratory failure, all had SPPB scores consistent with frailty. Of the 40% who did not develop hipoxemic respiratory failure, half were in a state of pre-frailty, and the other half were in a state of frailty. Conversely, 2 of the patients who developed hipercapnic respiratory failure, met the criteria for pre-frailty. Among those who did not develop hipercapnic respiratory failure, 6 were "Pre-frail" and 2 were "Frail."

Regarding the need **for invasive mechanical ventilation**, none of the patients in the evaluated sample required this intervention (Table 6).

The need for **high-flow mask** use was also evaluated (Table 6). Only 30% required high-flow masks, with 5% having an SPPB score of 7-9 ("Pre-frail") and 25% with scores of 0-

6 ("Frail"). Of the remaining patients, approximately 15% met the criteria for pre-frailty and 55% for frailty.

Only one patient (5%) developed **sepsis** during hospitalization; this patient was in a state of frailty. Of the remaining patients, about 4 could be classified as "Pre-frail" and 15 as "Frail" (Table 6).

		SPPB Values		
		Non-frail (10-12)	*Pre-frail (7-9)*	*Frail (0-6)*
Charlson Comorbidity Index	*None*	0 (0%)	0 (0%)	0 (0%)
	Low Risk	0 (0%)	0 (0%)	0 (0%)
	Moderate Risk	0 (0%)	2 (10%)	3 (15%)
	High RIsk	0 (0%)	2 (10%)	13 (65%)
Polypharmacy	*Yes*	0 (0%)	1 (5%)	14 (70%)
	No	0 (0%)	3 (15%)	2 (10%)
Parcial Respiratory Failure	*Yes*	0 (0%)	0 (0%)	12 (60%)
	No	0 (0%)	4 (20%)	4 (20%)
Total Respiratory Failure	*Yes*	0 (0%)	2 (10%)	0 (0%)
	No	0 (0%)	2 (10%)	16 (80%)
Invasive Mechanical Ventilation	*Yes*	0 (0%)	0 (0%)	0 (0%)
	No	0 (0%)	4 (20%)	16 (80%)
High-Flow Mask	*Yes*	0 (0%)	1 (5%)	5 (25%)
	No	0 (0%)	3 (15%)	11 (55%)

Sepsis	*Yes*	0 (0%)	0 (0%)	1 (5%)
	No	0 (0%)	4 (20%)	15 (75%)

Table 6: Influence of SPPB values on Clinical Outcomes

The **maximum oxygen therapy flow** required by patients during hospitalization was also assessed in this sample. The median oxygen support for patients with pre-frailty criteria was 2 L/min, whereas for patients with frailty criteria, it was 3 L/min (Chart 1).

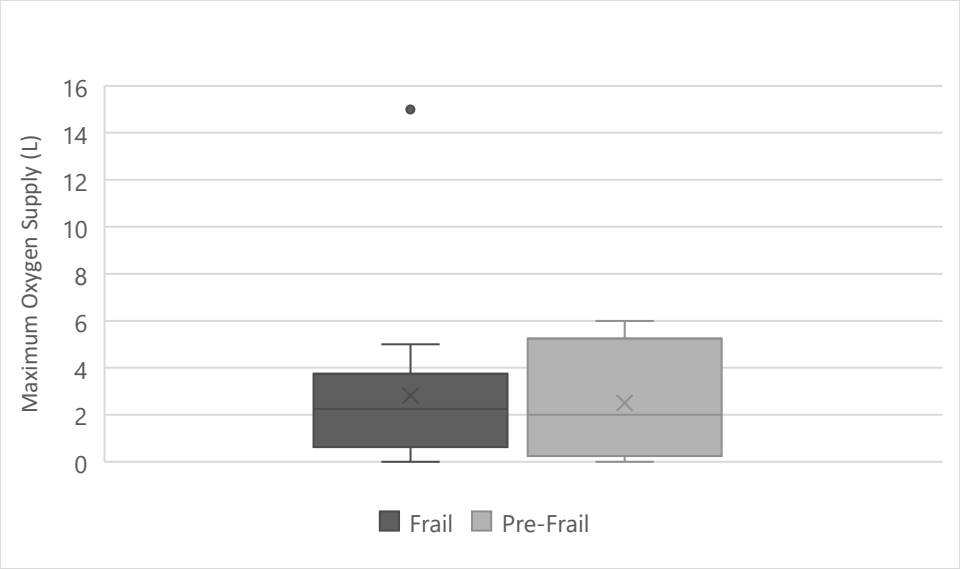


Chart 1 - Maximum Oxygen Supply of the sample

3.3. Assessment of the relationship between various geriatric scoring systems

The relationship between each score and the corresponding SPPB values will be discussed here (Table 7).

A Poor Prognosis on the **G8 Geriatric Tool** corresponded to 15% and 75% of patients with pre-frailty and frailty criteria, respectively, whereas a Good Prognosis corresponded to 5% of patients in both categories (Table 7).

Results related to the **Charlson Comorbidity Index** can also be found in the table below and are described in the previous subsection (Page 24).

No patients were identified with a **Clinical Frailty Score** of 6 to 9, probably because of the exclusion criteria (Table 2) used in this study, which excluded impaired mobility, mental/cognitive disturbances and delirium, compromised consciousness, inattention and impaired logical thinking and therefore more physically dependent patients. However, approximately 75% of patients had scores between 1 and 3, and about 25% had scores between 4 and 5. Among the 75% with scores of 1 to 3, about 10% were classified as "Pre-Frail" and 65% as "Frail." Of the 25% with scores of 4 or 5, approximately 10% were classified as "Pre-Frail" and 15% as "Frail" (Table 7).

Lastly, concerning the **ECOG Performance Status** (Table 7), 35%, 5%, 25%, 20% and 5% had ECOG classification of 0, 1, 2, 3 and 4, respectively. Among the patients of the sample, 5% and 15% met pre-frail criteria and had an ECOG-0 and ECOG-2 respectively. About 30%, 5%, 10%, 20% and 5% met frail criteria and had an ECOG classification of 0, 1, 2, 3 and 4.

		SPPB Values		
		Non-frail (10-12)	*Pre-frail (7-9)*	*Frail (0-6)*
G8 Geriatric Tool	*Poor Prognosis*	0 (0%)	3 (15%)	15 (75%)
	Good Prognosis	0 (0%)	1 (5%)	1 (5%)
Charlson Comorbidity Index	*None*	0 (0%)	0 (0%)	0 (0%)
	Low Risk	0 (0%)	0 (0%)	0 (0%)
	Moderate Risk	0 (0%)	2 (10%)	3 (15%)
	High RIsk	0 (0%)	2 (10%)	13 (65%)

Clinical Frailty Score	*Score 1-3*	0 (0%)	2 (10%)	13 (65%)
	Score 4-5	0 (0%)	2 (10%)	3 (15%)
	Score 6-8	0 (0%)	0 (0%)	0 (0%)
	Score 9	0 (0%)	0 (0%)	0 (0%)
ECOG Performance Status	*ECOG 0*	0 (0%)	1 (5%)	6 (30%)
	ECOG 1	0 (0%)	0 (0%)	1 (5%)
	ECOG 2	0 (0%)	3 (15%)	2 (10%)
	ECOG 3	0 (0%)	0 (0%)	4 (20%)
	ECOG 4	0 (0%)	0 (0%)	1 (5%)

Table 7: Interaction between various geriatric scoring systems

4. Discussion

Since the data obtained do not present statistical significance that allows us to establish relationships between them. A descriptive analysis was conducted, so we can attempt to verify whether the values are similar to those obtained by other authors in different studies.

4.1. Frailty in the Elderly

Regarding the descriptive analysis conducted in this study, there is information we can obtain about the target sample, specifically concerning gender, age, educational level, and previous hospitalizations of the patients included in this sample.

In this study, we only had male individuals meeting the criteria for pre-frailty, so there is limited information available to compare the distribution of this classification between genders. However, among the patients classified as "Frail," the distribution by gender was equal, with 40% of male patients and 40% of female patients meeting the criteria for frailty. This information does not seem to align with other studies, including those involving patients with infectious respiratory diseases, specifically COVID-19 pneumonia (22) and COPD (21), where there appeared to be a higher likelihood of female patients having lower SPPB scores (21). In other words, patients with frailty criteria were more commonly associated with the female gender.

Another insight from the obtained results is that, according to the median ages of the sample, frail patients have a median age 15 years higher than that of pre-frail patients, with median ages of 85 and 70 years, respectively. This suggests a trend where progressively older patients tend to have worse SPPB scores until they are classified as frail. Mohan et al. (2020) also established a relationship between SPPB scores and the age of each subgroup. Specifically, patients with an SPPB score below 7, corresponding to the criteria used in our study to classify patients as "Frail," had a median age of 70 years, while patients with SPPB scores between 7 and 9 ("Pre-frail") had a median age

of 68.5 years (21). Although these ages are lower than the median ages in our sample, it is evident that there is a higher median age for frail patients in both studies.

Opposite to expectations, there does not appear to be a concrete relationship between educational level and the degree of frailty among patients. This is evidenced by the higher percentage of "frail" individuals in the group who completed four educational years, compared to the percentages of individuals with no education, those who completed three educational years, or those with a bachelor's degree. However, if we break down the percentage of patients with an educational status below the university level, we may find results comparable to other studies that conclude this group of patients is independently associated with frailty, regardless of other variables (23).

It is also noteworthy that frailty seems to affect more the category of patients who reported 5 to 7 previous hospitalizations, rather than the groups with fewer than 5 or more than 7 previous hospitalizations. Once again maybe this values are due to the applied exclusion criteria of this study and therefore the exclusion of more dependent and fragile patients (Table 2).

These conclusions are not exactly what we expected according to the literature, particularly since it is known that frail patients are more likely to be hospitalized for any cause (24)(25)(26). Additionally, Pavasini et al. (2016) also mention that the implementation of SPPB to tailor intervention choices reduces the risk of short-term rehospitalizations and identifies which patients benefit more from certain more invasive therapies (25).

4.2. Influence of SPPB values on Clinical Outcomes

During the development of this study, the primary outcome was defined as the impact of acute disease, comorbidities and clinical outcomes on SPPB and patient frailty, as biomarkers of performance capacity and functionality.

The used clinical outcomes were the Charlson Comorbidity Index, polypharmacy, partial and total respiratory failure, the use of invasive mechanical ventilation and high-flow mask during hospitalization, and the development of sepsis.

According to the data obtained, approximately 25% and 75% of patients with pre-frailty or frailty criteria respectively presented a moderate and high risk of mortality, based on the assessment of their comorbidities through the **Charlson Comorbidity Index**. When these data were evaluated according to the distinction between the pre-frail and frail patient populations, about 10% of the pre-frail patients were classified as having a moderate risk and another 10% as having a high risk according to this score. However, when these data were compared with frail patients, we see that these percentages rise to 15% of patients with a moderate risk and 65% of patients with a high risk. Indeed, this information not only indicates that patients with pre-frailty and frailty criteria are associated with higher mortality risks, but also that this risk is greater in patients meeting frailty criteria as opposed to pre-frailty criteria.

These conclusions are not consistent with all studies. Although Park et al. concluded that frailty upon admission in patients with SARS-CoV-2 pneumonia was associated with higher mortality (27), other studies have not found a direct relationship between patient frailty and mortality risk (28). However, it is consistent across studies that this relationship is more dependent on the patient's chronic pathology and clinical complexity, which is a factor to consider in the development of the Charlson Comorbidity Index (28). Some studies in COVID-19 patients have also established and identified comorbidities that may influence this increased mortality, namely dementia, chronic kidney disease, cardiovascular disease, heart failure, diabetes mellitus, and previous acute myocardial infarction (29).

Another factor that appears to be reflected in the SPPB values is the presence of **polypharmacy** among the patients included in this study, with approximately 70% of all patients meeting frailty criteria and reporting polypharmacy during the conducted interview. In Europe, research has demonstrated a significant association between polypharmacy and frailty. Studies have shown that frail individuals are associated with three times the rate of polypharmacy compared to the general population, while pre-frail individuals are associated with twice the rate of polypharmacy (30). These findings are consistent with other studies worldwide (31)(32).

Regarding the development of **respiratory failure** during hospitalization, approximately 60% of patients meeting frailty criteria developed hipoxemic respiratory failure. It can also be noted that pre-frail patients may exhibit some degree of respiratory failure, with only 10% of these patients developing hipercapnic respiratory failure in this study. Additionally, it is evident that both pre-frail and frail populations may have comorbidities or intrinsic characteristics that contribute to the development of respiratory failure to varying degrees. Other studies have shown that frailty is highly prevalent in patients with respiratory failure requiring non-invasive ventilation, and this condition is associated with poorer clinical outcomes, with a one-year mortality risk of approximately 60% (33).

In our study, no patients required **invasive mechanical ventilation** during their hospitalization, even those who were admitted to the ICU. Although it is not possible to perform any statistical analysis on these patients to draw conclusions about the use of invasive mechanical ventilation in the frail geriatric population, this association has also not been clear in recent studies on this topic.

Peñuelas et al. (2024) established a statistically significant relationship (p-value=0.008) between the use of invasive mechanical ventilation (IMV) and frailty. This study concluded that the necessity for this intervention was associated with frailty six months post-discharge, regardless of other factors assessed (34).

However, other studies have not found a statistically significant difference between groups with and without frailty criteria concerning the use of IMV or ICU admission (35)(36). Despite these findings, Muscedere et al. (2017) note that frail patients may be more prone to difficulties in weaning from invasive mechanical ventilation due to their clinical characteristics, such as weakness, sarcopenia, and reduced oxygen uptake as factors that may influence the difficulty of weaning from this therapy (36).

Additionally, the potential relationship between frailty and two other interventions for the patients in this study was evaluated, specifically the need for **high-flow nasal cannula** (HFNC) and the **maximum oxygen flow** administered during hospitalization.

About 5% of the total patients, corresponding to 25% of pre-frail patients, required high-flow nasal mask, while another 25% of the overall sample, corresponding to approximately 31% of frail patients, required the same intervention. On the other hand, the median oxygen flow in the "pre-frail" patient category was 2L/min, while in the "frail" patient category, it was 3L/min.

These values appear to be consistent with the notion that patients meeting frailty criteria may likely require high-flow nasal cannula or higher oxygen flows more frequently than patients who only meet pre-frailty criteria. Despite this, there are still few studies that relate the use of high-flow nasal cannula (HFNC) and oxygen flux in this population to their frailty. Steenkiste et al. (2021) was the first study to describe the use of HFNC as a rescue intervention in the geriatric population, specifically in patients not eligible for invasive mechanical ventilation (37). However, despite being a promising study, it was conducted with a small cohort, and the authors could not establish this association or its relationship with the survival of the addressed patients (37).

Only one of the "frail" patients included in this study developed **sepsis** during hospitalization, making it difficult to draw significant conclusions about the relationship between the development of sepsis and a lower SPPB score.

It is a fact that there are few studies exploring this relationship. Even so, the retrospective analysis by Li et al. (2024) provided some insights into the complexity of the sepsis process. Not only can the immunocompromised state of frail patients contribute to their increased vulnerability to severe infections, but elevated inflammatory markers intrinsic to frailty can also be observed in patients admitted to the ICU with sepsis, particularly those with prolonged hospitalization. Thus, this highlights the increased risk of frail patients developing sepsis during their hospital stays. (38)

4.3. Interaction between SPPB and other Geriatric Scores

The aim of the secondary outcome of this study is to explore whether there is a relationship between the different geriatric scores applied to the sample, in order to

understand the overall role of the SPPB in the management of frail patients and potential implications for future approaches to this population. The data related to the Charlson Comorbidity Index were discussed in the previous subsection, so we will now proceed to discuss the remaining data before moving on to a comprehensive discussion of all the findings.

In terms of the prognosis of the evaluated patients, and according to the division of **G8 Geriatric Tool** scores discussed in the theoretical introduction, 90% of the sample has a poor prognosis, with 15% meeting the criteria for pre-frailty and 75% meeting the criteria for frailty. Thus, among the observed patients, all of whom had some level of pre-frailty or frailty, nearly all exhibit a poor prognosis. This outcome is expected, given that an increase in intrinsic frailty of patients is associated with a worsening clinical condition and consequently a deterioration in their prognosis.

To assess the patient's functionality and the risk of complications from their underlying comorbidities, it is important to use the **Clinical Frailty Scale**, which we will attempt to correlate with the SPPB values. The fact that no patients with scores above 5 were found also indicates that our sample did not include highly vulnerable, severely ill, or terminally ill patients. Among the rest, the majority (75%) had a low risk of complications and some level of independence, while the remaining 25% required some assistance and had a slightly increased risk of complications. Although there were no differences in the percentages of patients in these categories, within the "pre-frail" patients, most of the "frail" patients (approximately 81%) were in the score range of 1 to 3, indicating a lower risk of complications. At first glance, it would be expected that more frail patients would exhibit higher degrees of dependency and an increased risk of complications with the progression of their underlying pathologies. However, in this sample, there does not appear to be a higher level of dependency and complications.

The functionality of the patients can also be assessed using the **ECOG Performance Status** and categorized according to the predefined subcategories. It was expected that there would be no patients with an ECOG score of 5, as none of them died during the study.

About half of the patients maintained functionality (ECOG 0 or 1), indicating they could be candidates for more invasive therapies if necessary. Frailty features were found in approximately 90% of these patients (45% of the total sample). Subsequently, about 25% of the sample were suitable for moderately aggressive treatments based on their clinical characteristics (ECOG 2), while another 25% were considered suitable for palliative therapy due to reduced functionality. Notably, all patients with the lowest functionality met frailty criteria, aligning with the initial assumptions before starting this work.

Based on these results, we can infer that patients with higher levels of frailty as measured by the SPPB tend to have more comorbidities, which are associated with a worse prognosis and reduced functionality, according to their relationships with the Charlson Comorbidity Index, G8 Geriatric Tool, and ECOG Performance Status. However, the included sample does not seem to show that increasing frailty is associated with increased dependence and decreased functionality when evaluated by Clinical Frailty Score.

As Cano-Escalera et al. (2023) noted, frailty is a syndrome closely associated with comorbidities and disability. They confirmed that certain pathologies, such as congestive heart failure, deep vein thrombosis, cerebrovascular disease, and diabetes, are linked to an increased risk of mortality in patients with pre-frailty and frailty criteria. (39) These conditions were also considered in our study, for example, during the application of the Charlson Comorbidity Index.

According to Brighton et al. (2023), there are significant differences between frail and non-frail populations, particularly in that frail patients are older, have more comorbidities, reduced functional capacity, greater dependence in daily living activities, and lower quality of life (40).

4.4. Limitations

This study has several limitations. Firstly, one of the main limitations is indeed the small sample size, comprising only 20 patients after inclusion and exclusion criteria were

applied (Tables 1 and 2). This limited sample size does not allow for statistically significant analysis. This limitation could also be related to the fact that this work was developed between February and May and not during the winter, a period when there is a higher incidence of such infectious pathologies in an Internal Medicine ward.

Additionally, this study only included patients from one Internal Medicine ward at Hospital Santa Maria, which may not be fully representative of the broader patient population that frequents this Hospital. The exclusion of confused patients and patients with decreased mobility, after CAM were applied, had also negatively influenced the less representative sample.

Moreover, it was not possible to draw conclusions about certain evaluated variables due to the absence of patients with specific characteristics necessary for such inferences, such as the need for invasive mechanical ventilation, sepsis, or even the simple classification of patients as non-frail according to the SPPB.

Furthermore, the long-term evaluation of patients to understand the implications of a reduced SPPB on the evaluated variables was only carried out during the period these patients were hospitalized in the Internal Medicine II B Service.

5. Conclusions

The results of this study highlight important trends and relationships regarding frailty in the elderly, despite the lack of statistically significant findings. Through descriptive analysis, several key observations were made with the development of this work.

Among frail patients, the gender distribution was equal and no clear relationship was found between educational level and frailty, with a higher percentage of frail individuals among those with lower educational attainment. Frail patients were notably older, most with a median age of 85 years compared to 70 years for pre-frail patients, and reported 5 to 7 previous hospitalizations, which is an unexpected finding as literature suggests frail patients typically have higher hospitalization rates for various reasons.

The study found that a significant portion of frail patients, about 75%, had a high risk of mortality based on the Charlson Comorbidity Index and about 70% of the sample reported the use of multiple medications, consistent with European and global studies linking polypharmacy to frailty.

Frail patients exhibited a higher incidence of partial respiratory failure (60%) during hospitalization, though no patients required invasive mechanical ventilation. Use of high-flow nasal cannula and higher oxygen flows were more common in frail patients, highlighting their greater respiratory support needs.

Nearly all patients had poor prognoses based on the G8 Geriatric Tool, with a higher prevalence of poor prognoses among frail individuals. Functional assessment via ECOG Performance Status showed that about half of the patients retained sufficient functionality for invasive treatments, with frailty characteristics present in the majority of these patients.

Clinical Frailty Score indicated that the majority of patients had low to moderate risk of complications, contradicting expectations that frail patients would have higher dependency and complication rates.

In conclusion, while the data did not provide statistically significant results, the descriptive analysis reveals important patterns. Frailty is significantly associated with

older age, higher mortality risk, increased polypharmacy, and greater respiratory support needs. The findings underscore the complexity of frailty and its multifaceted impact on elderly patients, suggesting that comprehensive geriatric assessments and targeted interventions are crucial for this vulnerable population.

Further research with larger sample sizes and more robust statistical analyses is needed to confirm these trends and inform clinical practice. It may also be important to consider studies with more flexible exclusion criteria in order to draw conclusions about more frail and debilitated patients. Despite the challenges of conducting this type of study in bedridden, confused, or agitated patients, long-term follow-up of these patients could be useful in applying geriatric scores during a stage of the disease when the patient is more stable, potentially recovered and able to participate.

6. References

1) Beyen MB, Visvanathan R, Amare AT. Intrinsic Capacity and Its Biological Basis: A Scoping Review. 2024. The Journal of Frailty & Aging. doi: 10.14283/jfa.2024.30
2) Pan Y, Li X, Zhang L, Li Y, Tang Z, Ma L. Declined intrinsic capacity predicts long-term mortality in Chinese older adults: Beijing Longitudinal Study of Aging. 2024. Maturitas. doi: 10.1016/j.maturitas.2024.108082
3) Castilho I, Rocha E, Magalhães S, Vaz Z, Costa ALG. Polifarmácia e Utilização de Medicação Potencialmente Inapropriada no Idoso com Idade Igual ou Superior a 75 Anos: O Caso de uma Unidade de Saúde Familiar. 2020. Ata Médica Portuguesa. doi: 10.20344/amp.13320
4) Patrizio E, Calvani R, Marzetti E, Cesari M. Physical Functional Assessment in Older Adults. The Journal of Frailty & Aging. 2021. doi: 10.14283/jfa.2020.61
5) Silva CFR, Ohara DG, Matos AP, Pinto ACPN, Pegorari MS. Short Physical Performance Battery as a Measure of Physical Performance and Mortality Predictor in Older Adults: A Comprehensive Literature Review. International Journal of Environmental Research and Public Health. 2021. doi: 10.3390/ijerph182010612
6) Perracini MR, Mello M, Máximo RO, Bilton TL, Ferriolli E, Lustosa LP, Alexandre TS. Diagnostic Accuracy of the Short Physical Performance Battery for Detecting Frailty in Older People. Physical Therapy & Rehabilitation Journal. 2019. doi: 10.1093/ptj/pzae066
7) Negm AM, Kennedy CC, Pritchard J, Ioannidis G, Vastis V, Marr S, Patterson C, Misiaszek B, Woo TKW, Thabane L, Papaioannou A. The Short Performance Physical Battery is Associated with One-Year Emergency Department Visits and Hospitalization. Canadian Journal on Aging. 2019. doi: 10.1093/geronj/49.2.m85.
8) Jung HW, Baek JY, Jang IY, Guralnik JM, Rockwood K, Lee E, Kim DH. Short Physical Performance Battery as a Crosswalk Between Frailty Phenotype and Deficit Accumulation Frailty Index. Journals of Gerontology: Medical Sciences. 2021. doi: 10.1093/gerona/glab087
9) Río SG, Plans-Beriso E, Ramis R, Ortolá R, Pastor R, Sotos-Prieto M, Castelló A, Requena RO, Moleón JJJ, Félix BMF, Muriel A, Miret M, Mateos JLA, Choi YH,

Rodríguez-Artalejo F, Fernández-Navarro P, García-Esquinas E. Exposure to residential traffic and trajectories of unhealthy ageing: results from a nationally-representative cohort of older adults. Environmental Health. 2024. doi: 10.1186/s12940-024-01057-3

10) Takahashi M, Takahashi M, Komine K, Yamada H, Kasahara Y, Chikamatsu S, Okita A, Ito S, Ouchi K, Okada Y, Imai H, Saijo K, Shirota H, Takahasi S, Mori T, Shimodaira H, Ishioka C. The G8 screening tool enhances prognostic value to ECOG performance status in elderly cancer patients: A retrospective, single institutional study. PLoS OME. 2017. doi: 10.1371/journal.pone.0179694
11) Oken MM, Creech RH, Tormey DC, Horton J, Davis TE, McFadden ET, Carbone PP. Toxicity and response criteria of the Eastern Cooperative Oncology Group. 1982. American Journal of Clinical Oncology. doi: 10.1097/00000421-198212000-00014
12) de Groot V, Beckerman H, Lankhorst GJ, & Bouter LM. How to measure comorbidity. A critical review of available methods. Journal of Clinical Epidemiology. 2003. doi:10.1016/s0895-4356(02)00585-1
13) Newman MG, Porucznik C, Date AP, Abdelrahman S, Schliep KC, VanDerslice JA, Smith KR, Hanson HA. Generating Older Adult Multimorbidity Trajectories Using Various Comorbidity Indices and Calculation Methods. Oxford University Press. 2023. doi: 10.1093/geroni/igad023
14) Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. Journal of Chronic Diseases. 1987. doi: 10.1016/0021-9681(87)90171-8
15) Yuguchi T, Nakajima K, Takaoka H, Shimokawa T. Usefulness of Clinical Frailty Scale for Comprehensive Geriatric Assessment of Older Heart Failure Patients. Circulation Reports. 2024. doi: 10.1253/circrep.CR-24-0009
16) Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, Mitnitski A. A global clinical measure of fitness and frailty in elderly people. 2005. Canadian Medical Association Journal. doi: 10.1503/cmaj.050051
17) Komatsu R, Okasaki T, Ebihara S, Kobayashi M, Tsukita Y, Nihei M, Sugiura H, Niu K, Ebihara T, Ichinose M. Aspiration Pneumonia Induces Muscle Atrophy in the

Respiratory, Skeletal, and Swallowing Systems. Journal of Cachexia, Sarcopenia and Muscle. 2018. doi: 10.1002/jcsm.12297

18) Dacydow DS, Hough CL, Levine DA, Langa KM, Iwashyna TJ. Functional Disability, Cognitive Impairment, and Depression Following Hospitalization for Pneumonia. Am J Med. Author manuscript. 2013. doi: 10.1016/j.amjmed.2012.12.006

19) Gephine S, Mucci P, Grosbois JM, Maltais F, Saey D. Physical Frailty in COPD Patients with Chronic Respiratory Failure. International Journal of Chronic Obstructive Pulmonary Disease. 2021. doi: 10.2147/COPD.S295885

20) Lau CW. Leung SY, Wah SH, Yip CW, Wong WY, Chan KS. Effect on Muscle Strength after Blood Flow Restriction Resistance Exercise in Early In-Patient Rehabilitation of Post-Chronic Obstructive Pulmonary Disease Acute Exacerbation, a Single Blinded, Randomized Controller Study. Chronic Respiratory Disease. 2023. doi: 10.1177/14799731231211845

21) Mohan D, Benson VS, Allinder M, Galwey N, Bolton CE, Cockcroft JR, MacNee W, Wilkinson IB, Singer RT, Polkey MI. Short Physical Performance Battery: What Does Each Sub-Test Measure in Patients with Chronic Obstructive Pulmonary Disease?. Journal of the COPD Foundation. 2020. doi: 10.15326/jcopdf.7.1.2019.0144

22) Mandora E, Comini L, Olivares A, Fracassi M, Cadeia MG, Paneroni M, Marchina L, Suruniuc A, Luisa A, Scalvini S, Corica G, Vitacca M. Patients recovering from COVID-19 pneumonia in sub-acute care exhibit severe frailty: Role of the nurse assessment. Journal of Clinical Nursing. 2021. doi: 10.1111/jocn.15637

23) Varan HD, Kilic MK, Kizilarlanoglu MC, Dogrul RT, Arik G, Kara O, Guner G, Aycicek GS, Can B, Halil M, Cankurtaran M, Yavuz BB. Frailty and its Correlates in Older Adults: A Challenging and Preventable Geriatric Syndrome. 2019. Erciyes Med J. doi: 10.14744/etd.2019.26504

24) Kolle AT, Lewis KB, Lalonde M, Backman C. Reversing frailty in older adults: a scoping review. 2023. BMC Geriatrics. doi: 10.1186/s12877-023-04309-y

25) Pavasini R, Guralnik J, Brown JC, di Bari M, Cesari M, Landi F, Vaes B, Legrand D, Verghese J, Wang C, Stenholm S, Ferrucci L, Lai JC, Bartes AA, Espaulella J, Ferrer M, Lim JY, Ensrud KE, Cawthon P, Turusheva A, Frolova E, Rolland Y, Lauwers V, Corsonello A, Kirk GD, Ferrari R, Volpato S, Campo G. Short Physical Performance

Battery and all-cause mortality: systematic review and meta-analysis. 2016. BMC Medicine. doi: 10.1186/s12916-016-0763-7

26) Pritchard JM, Kennedy CC, Karampatos S, Ioannidis G, Misiaszek B, Marr S, Patterson C, Woo T, Papaioannou A. Measuring frailty in clinical practice: a comparison of physical frailty assessment methods in a geriatric out-patient clinic. 2017. BMC Geriatrics. doi: 10.1186/s12877-017-0623-0

27) Park CM, Kim W, Rhim HC, Lee ES, Kim JH, Cho KH, Kim DH. Frailty and hospitalization-associated disability after pneumonia: A prospective cohort study. 2021. BMC Geriatrics. doi: 10.1186/s12877-021-02049-5

28) Pasin L, Boraso S, Golino G, Fakhr BS, Tiberio I, Trevisan C. The impact of frailty on mortality in older patients admitted to an Intensive Care Unit. 2020. Medicina Intensiva (Engl Ed). doi: 10.1016/j.medin.2020.05.019

29) Subramaniam A, Shekar K, Afroz A, Ashwin S, Billah B, Brown H, Kundi H, Lim ZJ, Reddy MP, Curtis JR. Frailty and mortality associations in patients with COVID-19: a systematic review and meta-analysis. 2022. Internal Medicine Journal. doi: 10.1111/imj.15698

30) Midão L, Brochado P, Almada M, Duarte M, Paúl C, Costa E. Frailty Status and Polypharmacy Predict All-Cause Mortality in Community Dwelling Older Adults in Europe. 2021. International Journal of Environmental Research and Public Health. doi: 10.3390/ijerph18073580

31) Gutiérrez-Valencia M, Izquierdo M, Cesari M, Casas-Herrero A, Inzitari M, Martínez-Velilla N. The relationship between frailty and polypharmacy in older people: A systematic review. 2018. British Journal of Clinical Pharmacology. doi: 10.1111/bcp.13590

32) Merchant RA, Chen MZ, Tan LWL, Lim MY, Kwee H, van Dam RM. Singapore Healthy Older People Everyday (HOPE) Study: Prevalence of Frailty and Associated Factors in Older Adults. 2017. Journal of the American Medical Directors Association. doi: 10.1016/j.jamda.2017.04.020

33) Stefan M, Asghar A, Shieh M, Demir-Yavuz S, Steingrub JS. The Association of Frailty With Long-Term Outcomes in Patients With Acute Respiratory Failure Treated With Noninvasive Ventilation. 2022. Cureus. doi: 10.7759/cureus.33143

34) Peñuelas O, Lomelí M, Campo-Albendea LD, Toledo SI, Arellano A, Chavarría U, Marín MC, Rosas K, Merlos MAG, Mercado R, García-Lerma HR, Monares E, González D, Pérez J, Esteban-Fernández A, Muriel A, Frutos-Vivar F, Esteban A. Frailty in severe COVID-19 survivors after ICU admission. A prospective and multicenter study in Mexico. 2024. Medicina Intensiva (Engl Ed). doi: 10.1016/j.medine.2024.03.002

35) Martí-Pastor A, Moreno-Perez O, Lobato-Martínez E, Valero-Sempere F, Amo-Lozano A, Martínez-García M, Merino E, Sanchez-Martinez R, Ramos-Rincon J. Association between Clinical Frailty Scale (CFS) and clinical presentation and outcomes in older inpatients with COVID-19. 2023. BMC Geriatrics. doi: 10.1186/s12877-022-03642-y

36) Muscedere J, Waters B, Varambally A, Bagshaw SM, Boyd JG, Maslove D, Sibley S, Rockwood K. The impact of frailty on intensive care unit outcomes: a systematic review and meta-analysis. 2017. Intensive Care Medicine. doi: 10.1007/s00134-017-4867-0

37) van Steenkiste J, van MC, Weller D, van den Bout CJ, Ruiter R, den Hollander JG, el Moussaoui R, Verhoeven GT, van Noord C, van den Dorpel MA. High-flow Nasal Cannula therapy: A feasible treatment for vulnerable elderly COVID-19 patients in the wards. 2021. Heart & Lung: The Journal of Acute and Critical Care. doi: 10.1016/j.hrtlng.2021.04.008

38) Li X, Tang Y, Deng X, Zhou F, Huang X, Bai Z, Liang X, Wang Y, Lyu J. Modified frailty index effectively predicts adverse outcomes in sepsis patients in the intensive care unit. 2024. Intensive and Critical Care Nursing. doi: 10.1016/j.iccn.2024.103749

39) Cano-Escalera G, Graña M, Irazusta J, Labayen I, Gonzalez-Pinto A, Besfa A. Mortality Risks after Two Years in Frail and Pre-Frail Older Adults Admitted to Hospital. 2023. Journal of Clinical Medicine. doi: 10.3390/jcm12093103

40) Brighton LJ, Nolan CM, Barker RE, Patel S, Walsh JA, Polgar O, Kon SSC, Gao W, Evans CJ, Maddocks M, Man WDC. Frailty and Mortality Risk in COPD: A Cohort Study Comparing the Fried Frailty Phenotype and Short Physical Performance Battery. 2023. International Journal of Chronic Obstructive Pulmonary Disease. doi: 10.2147/COPD.S375142

41) Bavaro DF, Diella L, Fabrizio C, Sulpasso R, Bottalico IF, Calamo A, Santoro CR, Brindicci G, Bruno G, Mastroianni A, Buccoliero GB, Carbonara S, Lo Caputo S, Santantonio T, Monno L, Angarano G, Saracino A. Peculiar clinical presentation of COVID-19 and predictors of mortality in the elderly: A multicentre retrospective cohort study. 2021. International Journal of Infectious Diseases. doi: 10.1016/j.ijid.2021.03.021

42) Dakroub F, Fakhredine S, Yassine M, Dayekh A, Jaber R, Fadel A, Akl H, Maatouk A. A retrospective analysis of 902 hospitalized COVID-19 patients in Lebanon: clinical epidemiology and risk factors. 2021. Journal of Clinical Virology Plus. doi: 10.1016/j.jcvp.2021.100048

43) Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA, Wallace RB, A Short Physical Performance Battery Assessing Lower Extremity Function: Association with Self-Reported Disability and Prediction of Mortality and Nursing Home Admission. J. Gerontol. 1994. doi: 10.1093/geronj/49.2.m85

44) Quadflieg K, Machado A, Haesevoets S, Daenen M, Thomeer M, Ruttens D, Spruit MA, Burtin C. Physical Tests Are Poorly Related to Patient-Reported Outcome Measures during Severe Acute Exacerbation of COPD. Journal of Clinical Medicine. 2021. doi: 10.3390/jcm11010150

45) Ramírez-Vélez R, Asteasu MLS, Morley JE, Cano-Gutierrez DA, Izquierdo M. Performance of the Short Physical Performance Battery in Identifying the Frailty Phenotype and Predicting Geriatric Syndromes in Community-Dwelling Elderly. Journal of Nutrition, Health and Aging. 2021. doi: 10.1007/s12603-020-1484-3

7. Appendices

	Kolmogorov-Smirnov (p-value)	Shapiro-Wilk (p-value)
SPPB	0,200	0,267
Gender	0,200	0,482
Age	< 0,001	< 0,001
Schorality	< 0,001	< 0,001
Previous Hospitalizations	< 0,001	< 0,001
Charlson Comorbidity Index	0,049	0,014
Polypharmacy	< 0,001	< 0,001
Parcial Respiratory Failure	< 0,001	< 0,001
Total Respiratory Failure	< 0,001	< 0,001
Maximum Oxygen Supply	0,012	< 0,001
Invasive Mechanical Ventilation	-	-
High-Flow Mask	< 0,001	< 0,001
Sepsis	< 0,001	< 0,001
G8 Geriatric Tool	0,200	0,456

Clinical Frailty Scale	0,188	0,081
ECOG Performance Status	0,016	0,012

Table 8: Normality Test of the Data

		Two-tailed test (p-value)
Fisher's Exact Test	*Gender*	0,192
	Age	0,085
	Schorality	0,439
	Previous Hospitalizations	1,000

Table 9: Demografic Characterization through Fisher Exact Test

		Two-tailed test (p-value)
Clinical Outcomes	*Charlson Comorbidity Index*	0,206
	Polypharmacy	0,073
	Parcial Respiratory Failure	0,045
	Total Respiratory Failure	0,472
	Maximum Oxygen Supply	0,668

	Invasive Mechanical Ventilation	-
	High-Flow Mask	0,214
	Sepsis	0,733
Other Geriatric Scores	*G8 Geriatric Tool*	0,288
	Charlson Comorbidity Index	0,217
	Clinical Frailty Score	0,217
	ECOG Performance Status	0,805

Table 10: Spearman's Correlation Coefficients