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Original Article

Is handgrip strength a useful tool to detect slow walking speed in older Indian adults: A cross-sectional study among geriatric outpatients in a tertiary care hospital in South India

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Abstract

Objectives: To determine whether handgrip strength can be used as a proxy for detecting slow walking speed in older adults. Measuring walking speed in older adults can be challenging as cognitive and functional decline may have a significant impact on test performance. **Methods**: Hundred subjects aged >/= 60 were recruited. Slow walking speed was defined as walking speed <1.0 m/s. Handgrip strength was measured using handheld dynamometer. Multiple linear regression analysis was used to determine the relationship between the two. **Results**: The mean age of the study participants was 67.8±6.2 years. There were 63 males and 37 females. The mean handgrip strength of the participants was 23±5.9 kgs. Older subjects had slow gait speed (r=-0.40, p<0.001) while patients with higher BMI (r=0.36, p<0.001), handgrip strength (r=0.72, p<0.001) and appendicular lean mass (r=0.53, p<0.001) had normal gait speed. On multiple linear regression analysis, only handgrip strength (OR 0.71; 95% CI 0.58-0.87, p=0.001) and nutritional status (OR 8.60; 95% CI 1.98 - 37.40, p=0.004) were found to have a significant association with walking speed. **Conclusions**: Our study shows that handgrip strength assessment can be used as a surrogate indicator for detecting slow walking speed. Large population studies are warranted to examine its validity.

Keywords: Frailty, Gait, Handgrip strength, Sarcopenia, Walking speed

Introduction

The world's population is ageing and almost every country in the world is experiencing growth in the number and proportion of older adults. According to data from World Population Ageing 2019 by United Nations, there were 703 million persons aged 65 years or older[1]. A report by the Technical Group on Population Projections for India and States 2011-2036 stated that there were nearly 138 million elderly persons in India in 2021 constituting around 10% of the whole population in the country[2]. With this dramatic increase in the ageing population all over the world and in India, frailty has become an important health concern among older adults.

Frailty is defined as loss of biological reserves associated with ageing and related syndromes of physiological decline. It has become a significant issue among older adults due to its increasing prevalence and adverse health outcomes like falls, increased hospitalizations, procedural complications, disability and death[3]. Thus, the evaluation of frailty in community dwelling older adults assumes great importance for public health.

The most cited and validated physical frailty screening tool, the Fried frailty tool comprises of five key criteria of

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which Hand grip strength and Walking speed forms the core components of frailty assessment[4].

Walking speed test, a component of frailty assessment is a reliable and sensitive measure of physical performance. Although multiple tests comprising various distances have been proposed in literature, the most recommended are the 4 metre and 6 metre walking speed tests. European Working Group of Sarcopenia in 2019 defined a 4-metre walking speed of ≤0.8 m/s as a cut off value for detection of low physical performance suggestive of severe sarcopenia[5]. Similarly, the Asian Working Group of Sarcopenia in 2019 defined a 6-metre walking speed of <1.0 m/s as a cut off value for detection of low physical performance[6]. Despite standard guidelines, measuring walking speed in older adults particularly in individuals with cognitive and functional decline can be challenging to perform[7]. Hence there is a need for a proxy to identify slow walking speed especially in this population.

Hand grip strength is a simple, quick, easily available and inexpensive tool which reflects muscle strength. It is also well known to be associated with malnutrition, osteoporosis, multimorbidity, mobility limitation and increased risk of all cause and cardiovascular mortality[8]. Considering ease of use, availability and high clinical reliability, it is intuitive to consider the use of hand grip strength as a proxy for the detection of slow walking speed in the assessment of frailty. Furthermore, in a busy outpatient setting which is often also riddled with time and space constraints, performing a six metre walk test may not always be feasible. Also, there are patients in whom, the walking may be impaired due to musculoskeletal factors like arthritis, degenerative conditions afflicting the joints, neuropathies, past fractures of the lower limbs, neurodegenerative conditions and other such conditions. In such patients, the walking speed may not necessarily be reflective of frailty.

Although hand grip strength has been proposed as a method to identify slow walking speed in literature, the cut off values vary according to sex, race and there is a dearth of data on community dwelling older Asian populations and older Indian adults based on the AWGS 2019 criteria. In a cross-sectional study by Yen Huai et al in Taiwan that included 301 older participants, the cut-off value for hand grip strength in the detection of slow walking speed was 35.10 kg for men and 17.93 kg for women[7]. Apart from the lack of data, it is also unclear whether hand grip strength is the best surrogate for the detection of slow walking speed based on AWGS 2019 criteria. Hence, there is a compelling need to examine the magnitude of association between hand grip strength and slow walking speed and to determine a optimal cut-off value for hand grip strength to predict slow walking speed in older Indian adults based on the AWGS 2019 updated criteria.

The primary aim of this study was to examine the association between handgrip strength and walking speed in community-dwelling older adults in relation to other potential confounding variables such as age, sex, physical activities, comorbidities, body mass index, muscle mass and to determine the optimal cut-off values for handgrip strength to detect slow walking speed based on the Asian working group of Sarcopenia updated criteria in 2019.

Materials and Methods

Participants

This cross-sectional study was conducted from May 2020 to October 2021 among the patients visiting the Geriatric outpatient clinic in Christian medical college and hospital, Vellore. Consenting participants aged 60 years or above attending the Geriatric Outpatient department who were able to perform both handgrip strength test and 6 metre walking speed test were recruited. Participants with peripheral vascular disease, muscle and neurological disorders affecting test performance (strokes, Parkinsonism, ataxias, motor neuron diseases, peripheral neuropathies and myopathies etc.), severe osteoarthritis, stroke and recent acute illness were excluded. The sociodemographic characteristics including age, sex, body mass index and socioeconomic status were obtained. The Socioeconomic status was characterised in our study based on the Modified Kuppuswamy scale – 2019 which includes three parameters (Education, occupation and income) and each parameter is further classified into subgroups and scores have been allotted to each subgroup. The total score ranges from 3-29 and it classifies families into 5 groups, "upper class, upper middle class, lower middle class, upper lower and lower socio-economic class". In our study to further simplify it the study population was classified into two groups comprising of upper, upper middle and lower middle in one group and upper lower and lower in the other[9].

In addition, study participants who had past or present use of alcohol/smoking was documented. The information on duration of intake, number of pack years of smoking or the amount and type of alcohol was not collected during the study. The study participants were also classified into individuals with normal activities and sedentary lifestyle based on their daily physical activities. Individuals who do routine exercises, walking, jogging, running, swimming and actively involved in outdoor games were classified into normal activities. Individuals with low levels of movements, desk-based office work, driving a car, and watching television for more time were considered to have sedentary lifestyle. Self-reported comorbidities like diabetes, hypertension, heart and lung diseases was also collected. Anthropometric measurements including height, weight, and body mass index were measured. Appendicular skeletal muscle mass and total fat mass of the body was measured using Bioelectrical impedance analysis machine (Jawon Medical, Ioi353, Multifrequency Body composition analyser, Korea). Appendicular lean mass/height^2 was calculated by dividing the appendicular lean mass by height in metre square.

Nutritional status was assessed using the Mini nutritional

Characteristics	Total n (%)	6 - Meter Walking speed (m/sec) Slow walking speed (<1m/sec)		p-value
		Yes- n (%)	No- n (%)	
Age(years)				
<70	67	31(46.3)	36(53.7)	0.148
>70	33	22(66.7)	11(33.3)	
Sex				
Men	63	30(47.6)	33(52.4)	0.159
Women	37	23(62.2)	14(37.8)	
Body mass index (kg/m²)				
<18.5	8	7(87.5)	1(12.5)	0.006
18.5-22.9	35	24(68.6)	11(32.4)	
>23	57	22(38.6)	35(61.4)	
Socioeconomic status				
Upper and middle	25	13(52.0)	12(48.0)	0.671
Lower	75	40(53.4)	35(46.6)	
Physical activities				
Sedentary	58	35(60.3)	23(39.7)	0.084
Normal activities	42	18(42.9)	24(57.1)	
Smoking status				
Non-smoker	58	35 (60.3)	23 (39.7)	0.033
Current/Ex-smoker	42	18 (42.9)	24 (57.1)	
Alcoholic status				
Non-drinker	80	43 (53.7)	37 (46.3)	0.553
Current/Ex-drinker	20	10 (50.0)	10 (50.0)	
Diabetes mellitus				
Yes	49	20 (40.8)	29 (59.2)	0.017
No	51	33 (64.7)	18 (35.3)	
Hypertension				
Yes	53	27 (50.9)	26 (49.1)	0.662
No	47	26 (55.3)	21 (44.7)	
Heart diseases				
Yes	17	9 (52.9)	8 (47.1)	0.996
No	83	44 (53.0)	39 (50.0)	
Vitamin D insufficiency				
Yes	14	8 (57.1)	6 (42.9)	0.332
No	13	5 (38.5)	8 (61.5)	
Mini nutritional assessment				
12-14	55	15 (27.2)	40 (72.7)	<0.001
<12	45	38 (84.4)	7 (15.6)	

Table 1. Association between 6-meter walking speed and sociodemographic lifestyle characteristics of participants (n=100).

Variables	Correlation coefficient (r)	p-value
Age (years)	-0.40	<0.001
Height (cms)	0.12	0.22
Weight(kg)	0.50	<0.001
Body mass index (kg/m^2)	0.36	<0.001
Handgrip strength (kg)	0.72	<0.001
Appendicular lean mass	0.53	<0.001
ALM/h^2	0.61	<0.001
Fat mass	0.06	0.53

Table 2. Pearson coefficient correlation between 6 metre walking speed and other variables.

assessment (MNA) screening which is a validated nutrition screening and assessment tool used to identify older subjects who are at risk of malnutrition or malnourished. It comprises of 6 questions with scores ranging from 0-14. (Scoring system: 0-7 malnourished, 8-11 At risk of malnutrition 12-14: Normal nutritional status)[10]. Handgrip strength (kg) was assessed using a Digital Smedley handheld dynamometer (MG 4800 Charder handgrip dynamometer, Taiwan). The study participant was made to stand with full elbow extension and the grip strength of the dominant hand was assessed twice in a maximum effort isometric contraction state with a 2-minute break in between the trials. The highest reading was taken as the final estimate of hand grip strength for analysis. For the 6-metre walking test, study participants were made to walk a distance of 6 metres at their usual pace and the time taken to walk the distance was calculated in seconds. An additional 2 metres for acceleration and deceleration was given to maintain a consistent walking speed over the measured distance. A walking speed of <1.0 m/s was defined as slow as per the Asian working group of sarcopenia updated criteria 2019.

Statistical analysis

We used the AUC model to calculate sample size required for the study. A sample size of 85 was needed to estimate AUC of hand grip strength in predicting slow walking speed with 95% confidence interval and 5% precision for an expected AUC 0.92. Data was summarized as mean (SD) or median (Range) for continuous variables. Categorical variables were reported as number and percentages. Karl-Pearson coefficient was used to determine the relationship between walking speed, anthropometric measurements, and hand grip strength. Chi square test was used to test association between slow walking speed and other related variables. Logistic regression was used to test the association between slow walking speed and grip strength after adjusting for other confounding factors. Clinically important variables were included in the multiple logistic regression analysis to determine the variables that correlated with walking speed. The effect size was presented as odds ratios and their 95% Confidence interval. Receiver operating characteristics was used to determine the optimal cut off for handgrip strength that best correlated with slow walking speed. Youden's index (sensitivity+specificity -1) from the ROC curve was used to determine cut-off values. All reported *p*-values were two sided, and the statistical significance level was set at $p<0.05$. Analyses was performed using Stata for Windows (version 16.1, Stata Corp LLC, College Station, TX).

Results

A total of 100 participants were included in the study of which 63 were men and 67 participants were aged less than 70 years. Study participants with low and normal body mass index (p=0.006), non-smokers (p=0.033), non-diabetics (p=0.017) and MNA score less than 12 (p<0.001) were significantly associated with slow gait speed (Table 1).

Correlation coefficient analyses revealed a significant negative correlation between age and gait speed. Positive correlation was ascertained between weight, body mass index, handgrip strength and skeletal muscle mass (Table 2). There was moderately strong positive correlation between handgrip strength and gait speed in both women and men separately (Figure 1).

Univariate logistic regression analysis among the variables showed low body mass index (OR=4.76; 95% CI 1.8-12.3), non-diabetics (OR=0.37; 95% CI 0.16-0.84), poor nutritional status (OR=14.5; 95% CI 5.3-39.4), skeletal muscle mass (OR=0.72; 95% CI 0.62-0.84) and low handgrip strength (OR=0.71; 95% CI 0.64-0.81) were significantly associated with slow gait speed. On multivariate analyses after adjusting for potential confounding factors like age, sex, physical activities, comorbidities, anthropometric measurements and skeletal muscle mass, only low handgrip strength (OR 0.71; 95% CI 0.58-0.87) and lower nutritional status (OR 8.60; 95% CI 1.98-37.40) were found to be significantly associated with slow walking speed (Table 3).

For detecting slow walking speed, a handgrip strength cut off value of 28kg in men had a sensitivity of 84%,

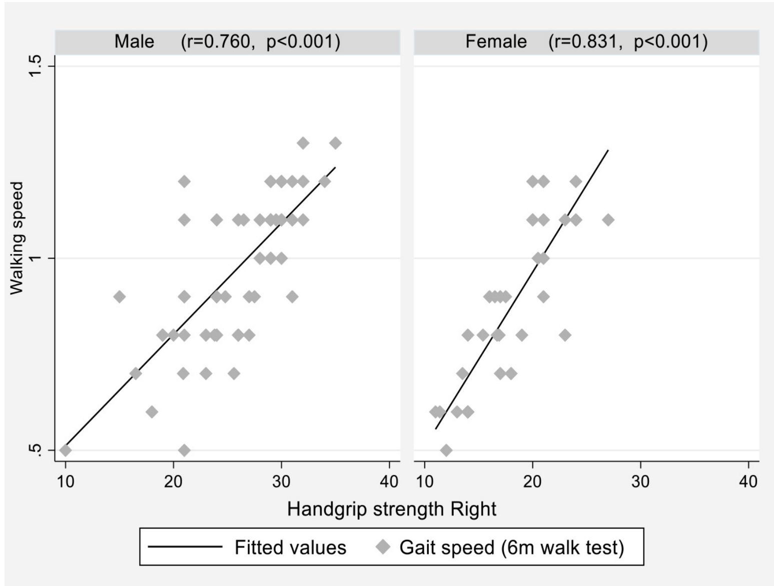

Figure 1. Scatter plot between handgrip strength and walking speed.

Variables	Univariate analysis		Multivariate analysis P value
	Odds ratio (95% CI)	p-value	
Age (<70vs>70yrs)	2.32(0.97 - 5.53)	0.057	0.964
Females vs males	1.80 (0.78-4.13)	0.161	-
Socioeconomic status	1.06 (0.61-1.86)	0.824	-
Body mass index			
<23	4.76 (1.84-12.31)	0.001	0.379
23-24.9	1.51 (0.49-4.58)	0.466	0.519
Sedentary lifestyle	2.02 (0.90-4.54)	0.085	0.245
Current and ex-smoker	0.49 (0.22-1.10)	0.085	-
Current and ex-consumer of alcohol	0.83 (0.31-2.23)	0.723	-
Diabetes mellitus	0.37 (0.16-0.84)	0.018	0.296
Hypertension	0.83 (0.38-1.84)	0.662	-
Heart disease	0.99 (0.35-2.83)	0.996	-
ALM Mass	0.72 (0.62-0.84)	<0.001	0.971
ALM/h^2	0.22 (0.01-0.40)	<0.001	-
Fat mass	0.97 (0.92-1.02)	0.236	-
Mini nutritional assessment	14.47 (5.32-39.38)	<0.001	0.004
Grip strength	0.71 (0.64-0.81)	<0.001	0.001

Table 3. Univariate and multivariate Logistic regression analysis between slow walking speed and associated factors.

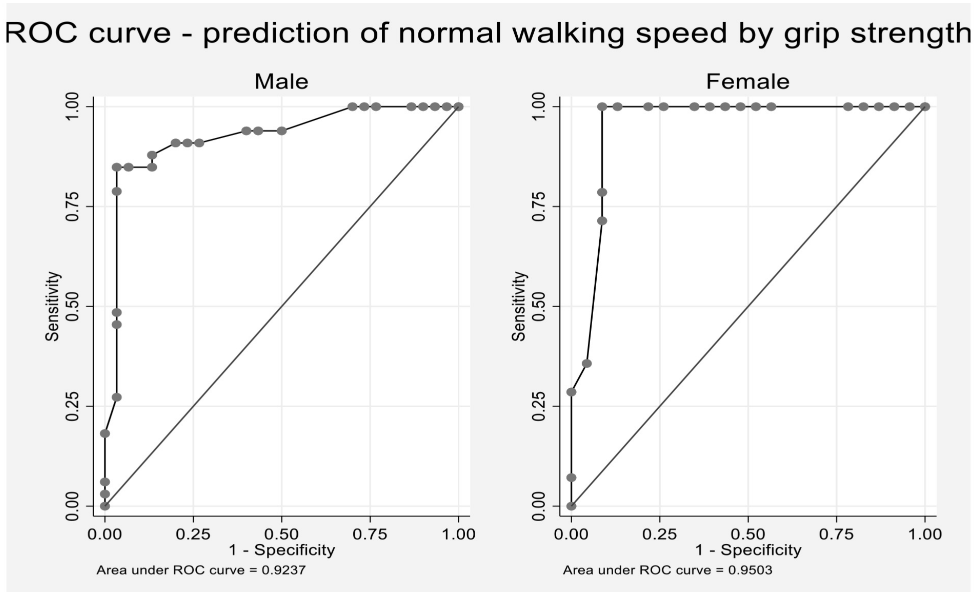

Figure 2. Receiver operating characteristic curve analysis for optimal cut-offs of hand grip strength in detecting slow walking speed for men and women among study participants.

Variables	Men	Women
Handgrip strength (kg) cut-off	28	20
Sensitivity	0.84 (68.1,94.9)	1.00 (76.8,100)
Specificity	0.96 (82.8,99.9)	0.91 (72.0,98.9)
Area under curve	0.92	0.95
P-value	<0.001	<0.001
Accuracy rate (%)	90%	94%

Table 4. Receiver operating characteristic curve analysis for optimal cut-offs of hand grip strength in detecting slow walking speed.

specificity of 96%, with an AUC of 0.92 and an accuracy rate of 90%. Similarly in women, a handgrip strength cut off value of 20 kg had a sensitivity of 100%, specificity of 91%, with an AUC of 0.95 and an accuracy rate of 94% (Figure 2), (Table 4).

Discussion

To the best of our knowledge, this is the first study assessing the correlation between handgrip strength and gait speed among community dwelling older Indian adults. We found that hand grip strength and nutritional status was significantly associated with slow walking speed. Handgrip strength was the only variable associated with slow walking speed in both men and women after adjusting for various confounding factors like age, sex, physical activities, comorbidities, anthropometric measurements and skeletal muscle mass in this population of community dwelling older adults. Using a cut off value of <1.0 m/sec, we found that 53 adults had a slow gait speed.

The prevalence of slow walking speed has varied across different studies mainly because of the definition used (0.8 vs 1.0 m/s) and the differing study designs. Several studies have used a cut-off value of <0.8 m/s to define slow walking speed which could have led to an underestimation of its true prevalence. We used the revised Asian working group of sarcopenia 2019 updated guidelines where the cut-off for slow walking speed was increased from <0.8 m/sec to <1.0 m/sec. In view of this recent change in the cut off for walking speed, it was necessary to determine the optimal cut-off of handgrip strength to detect slow walking speed. In a cross-sectional study conducted by Yen-Huai Lin et al among 301 Taiwan study participants using these guidelines, the prevalence of slow walking speed was found to be 57%[7]. These results are consistent with our study findings. The slightly higher prevalence reported in the Taiwan study could be due to the higher mean age of their study participants (74 vs 67 years).

Muscle strength rather than muscle mass has been frequently reported to be independently associated with walking speed in previous studies[11,12]. Our study also showed similar findings and supports the use of handgrip strength as a proxy for detecting slow walking speed.

Alley et al conducted a pooled cross-sectional data analysis involving 21,000 older men and women and reported that a hand grip strength of less than 16 kg in women and 26 kg in men was associated with slow walking speed[13]. The Health and Retirement Study by Duchowny et al found hand grip strength cut-off values for the detection of slow walking speed to be <35 kg in men and <22 kg for women[14]. Another cross-sectional study by Delinocente et al involving 7783 participants found that a handgrip strength of <32 kg for men and <21 kg for women demonstrated reasonable accuracy for predicting slow walking speed with 49% sensitivity and 80% specificity in men and 59% sensitivity and 73% specificity in women[15]. However, the participants in all these studies were predominantly non-Asians and a walking speed <0.8 m/s was considered as slow walking speed.

Compared with a Taiwan population study which defined <1.0 m/sec as slow walking speed and a handgrip strength cut off value of 35.10 kg for men (sensitivity: 92%, specificity: 42%, area under the curve: 0.70, accuracy: 66.4%) and 17.93 kg for women (sensitivity: 62%, specificity: 80%, area under the curve: 0.76, accuracy: 67.9%), our study showed a handgrip strength cut off value of 28 kg for men (sensitivity: 84.9%, specificity: 96.7%, area under the curve: 0.92, accuracy: 90%) and 20 kg for women in predicting slow walking speed (Sensitivity: 100%, specificity: 91%, area under the curve: 0.95, accuracy: 94%)[7].

Our study has provided sex specific cut offs for hand grip strength for the detection of slow walking speed although the AWGS 2019 does not recommend it. Women were found to have a higher sensitivity while men were found to have a higher specificity. Using hand grip strength may identify many individuals at risk of having slow walking speed and further studies are warranted.

Several studies have shown a positive association between diabetes mellitus and slow gait speed and other gait characteristics[16,17]. However, we found that subjects without diabetes mellitus and non-smokers had slower gait speed. A study done by Verlinden et al. in the Rotterdam study of over 2000 subjects found that current smokers had slower gait[18]. Our participants were relatively younger, glycemic control and smoking characteristics were not assessed which could partly explain the conflicting results in our study.

Our study has several strengths and limitations. It is the first study till date among community dwelling older Indians following the AWGS 2019 recommendations assessing the association between handgrip strength and gait speed. Several potential confounding variables like sociodemographic and lifestyle characteristics, anthropometric measurements, muscle mass and fat mass were included in the analysis to identify the best proxy to detect slow walking speed that may be especially helpful in older adults with functional and cognitive disabilities. A major limitation of our study was the small sample size and therefore, it may not be possible to extrapolate these findings to the general population. Studies among institutionalised older adults and those with cognitive decline or physical disabilities needs further examination. Another limitation was we used a digital dynamometer for assessing the handgrip strength instead of the standard Jamar dynamometer as it was cheaper and easier to use.

Conclusions

Handgrip strength assessment appears to be a useful surrogate indicator for detecting slow walking speed in older adults. Large population-based studies are required to further examine the validity of using hand grip strength as a proxy for gait speed assessment while assessing frailty especially in older adults with functional and cognitive limitations.

Ethics approval

The study protocol was approved by the institutional review board of Christian medical college, Vellore. (IRB No.12410).

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Supplementary Tables

Modified Kuppuswamy Scale	
Education of head of family Score	
Professional degree	7
Graduate or postgraduate	6
Intermediate or post high school diploma	5
High school certificate	4
Middle school certificate	3
Primary school certificate	2
Illiterate	1
Occupation of head of family Score	
Professional	10
Semi-professional	6
Clerical, shop owner/farm	5
Skilled worker	4
Semi-skilled worker	3
Unskilled worker	2
Unemployed	1
Monthly income of the family (Rs) Score	
≥ 52,734	12
26,355-52,733	10
19,759-26,354	6
13,161-19,758	4
7,887-13,160	3
2,641-7886	2
≤ 2,640	1
Socioeconomic class Total score	
I Upper	26-29
II Upper middle	16-25
III Lower middle	11-15
IV Upper lower	5-10
V Lower	1-4

Mini nutritional assessment (MNA)
1. 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
2. Weight loss during the last 3 months 0 = weight loss greater than 3 kg (6.6 lbs) 1 = does not know 2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs) 3 = no weight loss
3. Mobility 0 = bed or chair bound 1 = able to get out of bed / chair but does not go out 2 = goes out
4. Has suffered psychological stress or acute disease in the past 3 months? 0 = yes 2 = no
5. Neuropsychological problems 0 = severe dementia or depression 1 = mild dementia 2 = no psychological problems
6. Body Mass Index (BMI) (weight in kg)/(height in m) 2 0 = BMI less than 19 1 = BMI 19 to less than 21 2 = BMI 21 to less than 23 3 = BMI 23 or greater
MNA Screening score ranges from 0 - 14 points 12-14 points: Normal nutritional status 8-11 points: At risk of malnutrition 0-7 points: Malnourished