Figure 13: Bland-Altman Plot

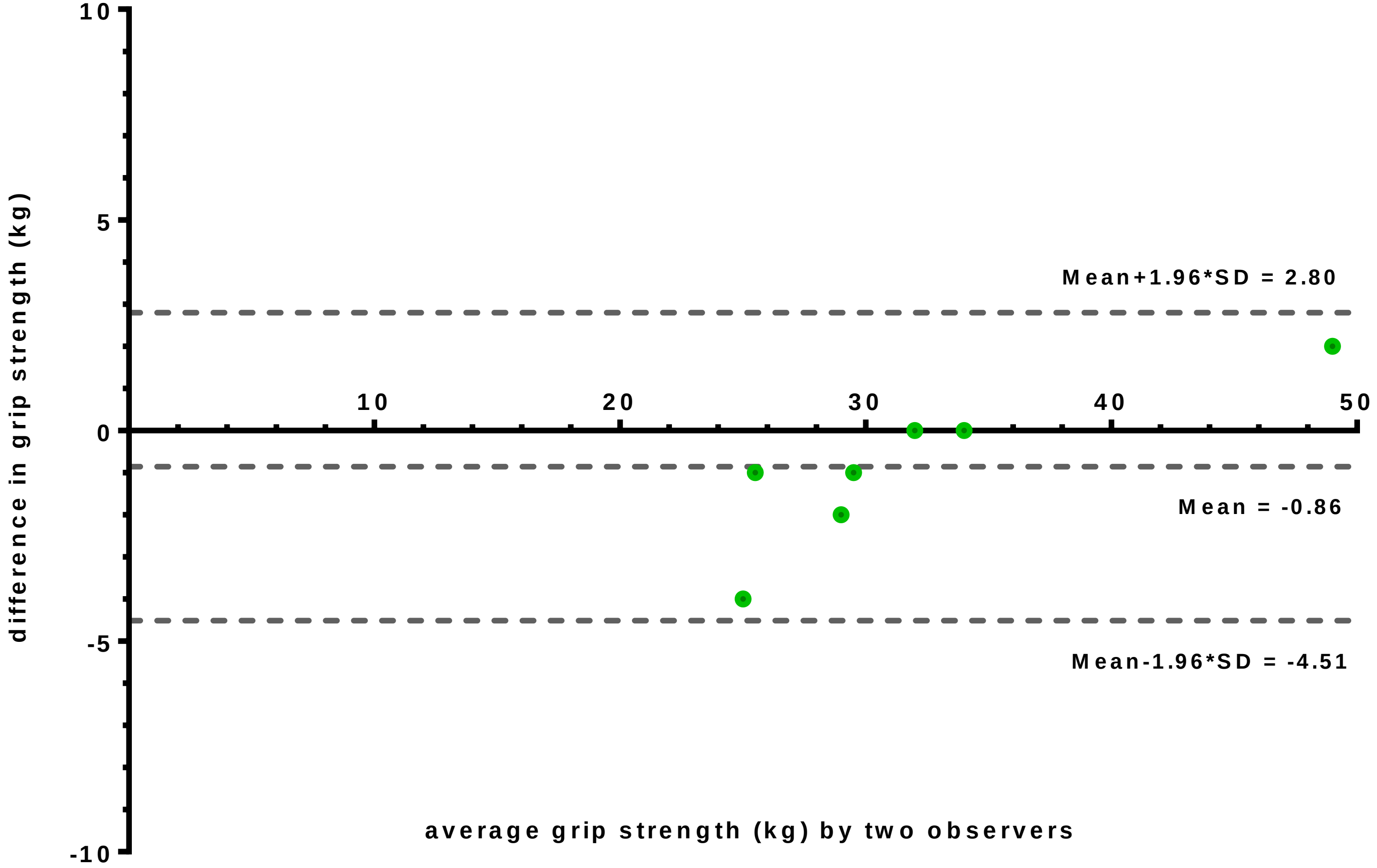


Table 4: Co-morbidities and medications of participants

	Men (n=20)	Women (n=30)
Number of co-morbidities [b]	5.5(5, 7)	5(5,7)
Falls in past year [c]	13(65)	25(83.3)
Cardiovascular [c]	12(60)	20(66.7)
Diabetes [c]	4(20)	7(23.3)
Arthritis [c]	6(30)	15(50)
Malignancy [c]	10(50)	3(10)
Hypertension [c]	15(75)	16(53.3)
Osteoporosis [c]	1(5)	12(40)
Depression [c]	3(15)	2(6.7)
Number of Medications [b]	7(5,8.75)	9(6,11)

Footnote

[b] Median (IQR); [c] Number (%) n: number

Table 6: Lung function tests

	Men (n=20)	Women (n=30)	p values
FEV1 (l) [a]	1.7 (0.5)	1.0 (0.3)	*0.018*
FVC (l) [a]	2.1 (0.7)	1.4 (0.4)	*0.010*
FEV1/FVC (%) [a]	77.6 (14.3)	73.6 (12.2)	*0.881*
PEF (l) [a]	262.1 (102.5)	148.1 (57.5)	*0.004*
SVC (l) [a]	2.1 (0.9)	1.2 (0.4)	*0.003*

Footnote

[a] Mean (SD) using T test

p values calculated using T test

Table 7: Association of grip strength with lung function in recruited participants

	Men				Women			
	Unadjusted		**Adjusted***		**Unadjusted**		**Adjusted***	
Lung Function	**β**	**P**	**β**	**p**	**β**	**p**	**β**	**p**
FEV1	0.032	*0.047*	0.043	*0.062*	0.018	*0.242*	0.018	*0.267*
FVC	0.039	*0.072*	0.060	*0.065*	0.020	*0.334*	0.020	*0.350*
FEV1/FVC	0.078	*0.869*	-0 .138	*0.850*	0.170	*0.785*	0.167	*0.788*
PEFR	4.606	*0.163*	6.597	*0.152*	6.881	*0.013*	6.938	*0.018*
SVC	0.032	*0.249*	0.042	*0.341*	0.052	*0.028*	0.050	*0.048*

Footnote

Adjusted results for age, height and weight

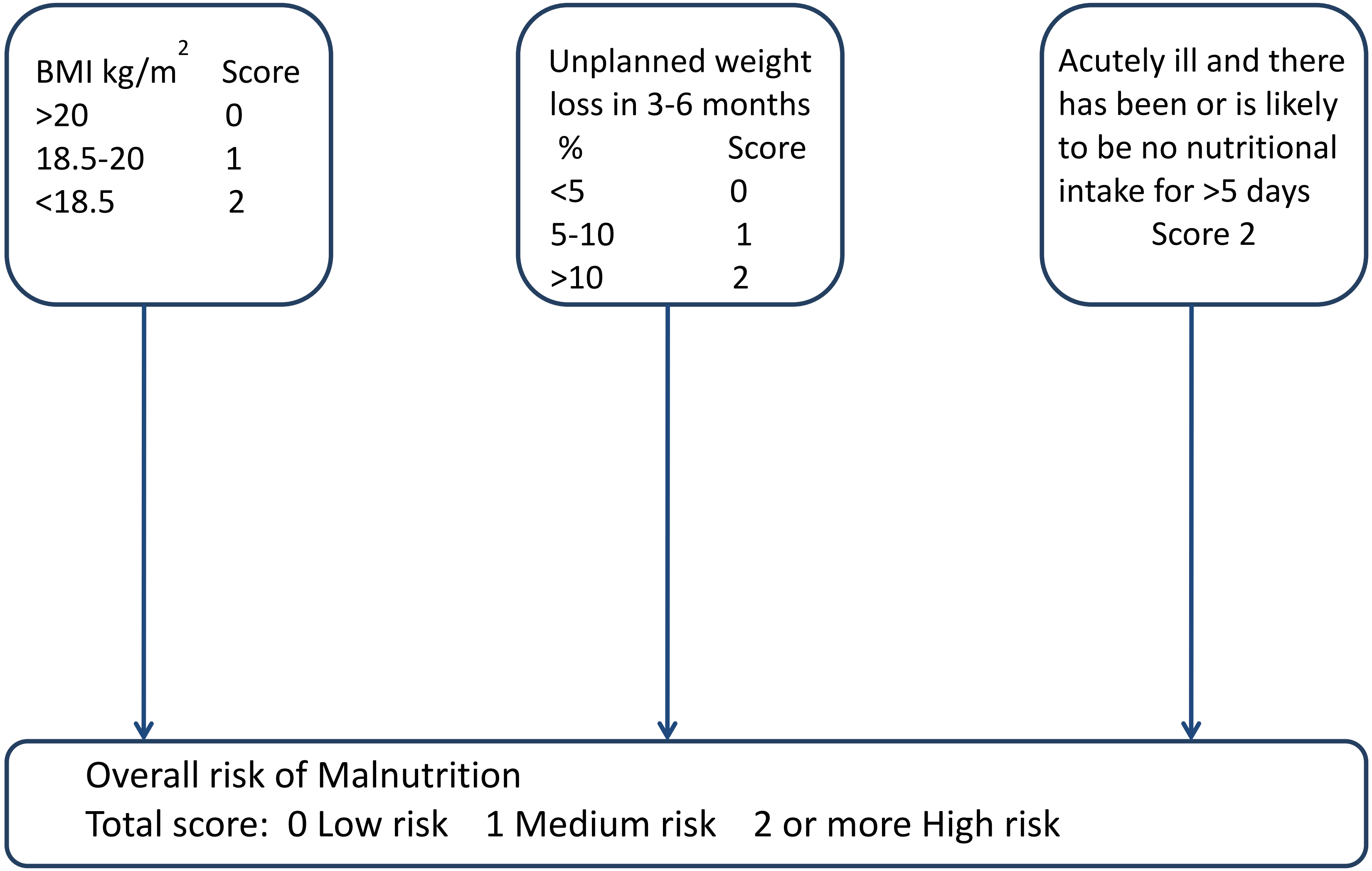
β Beta coefficient

p probability value calculated using SPSS

Appendix 6.4 Log book of case records

Recruitment number	Date of contact	Date screened	Patient's name	Date of birth	Hospital number	Recruited yes/no	Date Recruited	Reason if not recruited

Appendix 6.5 Adapted from the Malnutrition Universal Screening Tool (115)



Appendix 6.9 UHS Translational Research Conference Poster

Sarcopenia and obstructive airways in the older patient without lung disease

Holmes S[1,2], Allen S[2,3] and Roberts H[1]

[1]Academic Geriatric Medicine, University of Southampton, UK and [2]The Royal Bournemouth Hospital and [3]Bournemouth University, UK

Background

The ratio of forced expiratory volume in 1 second (FEV1) to forced vital capacity (FVC) declines with age. This is attributed to airway compliance changes leading to an increase in obstruction to airflow during forced expiration.

Many older people meet the prevailing spirometric definitions for obstructive airways disease despite having no evidence of lung pathology. Older people particularly those with indicators of frailty may be unable to generate and sustain sufficient expiratory pressure to reach and hold maximum flow as lung volume falls from total lung capacity (TLC) to residual volume (RV) particularly in the initial phase of expiration when flow is more effort dependent. This may be secondary to expiratory muscle weakness. Therefore, expiratory muscle weakness may be an expression of the more generalized sarcopenia often found in frail older people.

Aim

The overall study aim is to determine if there is an association between grip strength (as a marker of expiratory muscle strength) and lung function in older people.

At this stage, the two aims were to establish the proportion of patients that would be recruitable to take part in this study, and to establish baseline characteristics of this group including grip strength and FEV1/FVC ratios.

Box 1 Inclusion Criteria

1) age > 75 years
2) never smoked or trivial smoking (<1 year)
3) no history, symptoms or signs of respiratory disease and negative for bronchial obstruction on the ECAT questionnaire
4) MMSE ≥ 24
5) willing and able to consent to participate
6) able to perform hand grip and forced spirometry

Method

Patients over the age of 75 years on the Medicine for Older People's Unit at the University Hospital Southampton NHS Foundation Trust were screened using the inclusion criteria in Box 1.

Those eligible and recruited had the best of 3 measurements of grip strength using a Jamar dynamometer and the best of 5 attempts of spirometry taken using a portable Microlab spirometer with the patient sitting out at their bedside.

Each patient was asked to perform mini-mental state examination (MMSE) which included the drawing of intersected pentagons. Additionally age, estimated height, actual height where possible, weight and BMI were recorded.

Results

379 patients were screened over a 5 month period, 56 met the inclusion criteria and 30 were recruited. Reasons for ineligibility are shown in Figure 1.

Figure 1 Patients ineligible for study

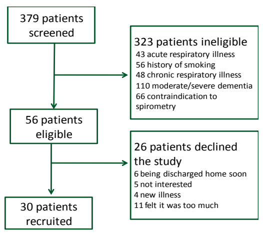


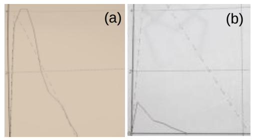
Table 2 shows the baseline characteristics of patients recruited into the study.

Table 1 Characteristics of enrolled patients

	Men; n = 12 mean (SD)	Women; n = 18 mean (SD)
Age (years)	86.8 (4.63)	85.9 (5.41)
Estimated height (cm)	174.5 (8.08)	154.3 (7.52)
Weight (kg)	72.8 (13.4)	63.7 (16.1)
BMI (kg/m²)	23.9 (7.95)	26.5 (6.16)
Maximum grip strength (kg)	18.1 (6.21)	12.7 (3.99)
Maximum FEV1/FVC (%)	74.8 (5.5)	71.1 (12.4)

Spirograms obtained in this study varied in appearance between recruited participants (Figure 2).

Figure 2 Sample spirograms showing normal spirometry (a) and an obstructive picture (b)



Discussion

There were a large number of patients that could not be recruited. This is primarily because of acute illness, advanced dementia and chronic respiratory disease. Baseline grip strength was similar to results in older people in other studies.

Most patients had difficulty replicating spirometry results. Factors contributing to inability to replicate results included short expiratory blow, fatigability and cognitive function. It was expected that there would be some variability between patients because of differing levels of frailty and recovery from acute illness. However we tried to exclude factors that might affect spirometry through the ECAT questionnaire.

Few studies have looked at spirometry in frail older people and expected values in this population are largely unprecedented. Therefore, the predicted values applied to all spirometry results may not be a true reflection of this frail older group. It will be necessary to consider all these factors in further statistical analysis.

Currently we have established the recruitable proportion of older hospitalised patients for this study at 8% (30/379 patients). We have also been able to establish the baseline levels of FEV1/FVC and grip strength for men and women in this cohort. Finally, we have established a number of other factors that will need to be considered during more complex statistical analyses that will be undertaken once more patients have been recruited.

Acknowledgements

We are particularly grateful to the British Geriatric Society for providing a 'Start-up Grant' in support of this study. We also wish to thank the Respiratory Biomedical Research Unit and Nutrition Biomedical Research Centre at the University Southampton Hospital NHS Foundation Trust for the use of the spirometer and dynamometer.

Appendix 6.11 BGS Autumn Meeting Poster

UNIVERSITY OF Southampton | Medicine
University Hospital Southampton NHS
NHS Foundation Trust

MRC Lifecourse Epidemiology Unit

BU Bournemouth University
The Royal Bournemouth and Christchurch Hospitals NHS Foundation Trust

IS GRIP STRENGTH ASSOCIATED WITH LUNG FUNCTION IN OLDER HOSPITALISED PATIENTS?

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Introduction

Many older people meet the spirometric criteria for chronic obstructive airways disease (COPD) despite no clinical evidence of lung pathology and consequently may be started on unnecessary treatment.

Expiratory flow decreases with ageing and is thought to be secondary to reduced expiratory muscle strength (EMS) (which decreases at a similar rate to skeletal muscle with ageing) and increased airways resistance. Older people may be unable to generate and sustain sufficient expiratory pressure to reach and hold maximum flow particularly in the initial phase of expiration which is more effort dependent.

Objective

Hand grip strength (GS), a standardised tool to measure skeletal muscle strength and spirometry, a standardised tool to measure lung function (LF) were used to indirectly assess the contribution of EMS to expiratory flow in older people.

Method

Over a six month period, patients on four acute Medicine for Older People wards were recruited.

Inclusion criteria: Age > 70 years, never smoked, no history, symptoms or signs of respiratory disease, Mini Mental State Examination (MMSE) ≥ 24, willing and able to consent to participate, able to perform hand grip strength and forced spirometry. Those not meeting the inclusion criteria were excluded.

Figure 1 (a) Jamar Dynamometer (b) Portable Micro lab spirometer

Participant characteristics were collected. The best of 3 measurements of grip strength in each hand using a Jamar dynamometer and the best of up to 5 attempts of spirometry using a portable Micro lab spirometer were recorded (Figure 1). Outcome measure was LF (FEV1, FVC, FEV1/FVC, peak expiratory flow rate (PEFR) and slow vital capacity (SVC), covariates were GS, age, weight, height. Unadjusted and adjusted (for age, height, weight) linear regressions were used for analysis.

Results

50 patients, 20 male and 30 females, were recruited to the study.

Table 1 Participant Characteristics

Characteristics	Men(n=20)	Women(n=30)	p value
Age, y [a]	86.3(4.92)	87.5(4.76)	*0.438*
Height, m [a]	1.71(0.68)	1.60(0.65)	*0.806*
Weight, kg [a]	74.9(15.1)	66.0(16.4)	*0.643*
BMI, kg/m² [a]	25.6(5.25)	26.0(6.36)	*0.364*
MUST (%) [c]			*0.133*
0	18(90)	23(77)	
1	0(0)	3(10)	
2	2(10)	4(13)	
Barthel score [b]	**87.5(62.5,100)**	**65(47,79)**	***0.001***
MMSE [b]	**25.5(24,27.8)**	**26.5(25,29)**	***0.036***

[a] Mean (SD); [b] Median (IQR); [c] Number (%); y: year; m: metres; kg: kilograms; BMI: body mass index; kg/m²; kilogram/metre²; MUST: malnutrition universal screening tool.

There were no significant differences in number of co-morbidities (p = 0.959) nor number of medication (p = 0.062) between genders.

Table 2 Co-morbidities and medications

	Men (n =20)	Women (n = 30)
Number of co-morbidities [b]	5.5 (5, 7)	5(5,7)
Falls in past year [c]	13 (65)	25 (83.3)
Cardiovascular [c]	12(60)	20 (66.7)
Diabetes [c]	4(20)	7(23.3)
Arthritis [c]	6(30)	15(50)
Malignancy [c]	10(50)	3(10)
Hypertension [c]	15(75)	16(53.3)
Osteoporosis [c]	1(5)	12(40)
Depression [c]	3(15)	2(6.7)
Number of Medications [b]	7(5,8.75)	9(6,11)

[a] Mean (SD); [b] Median (IQR); [c] Number

GS was significantly stronger (p = 0.026) in male (19.5 (7.21) kg) compared to female participants (12.4 (3.73) kg).

Significant relationships were found in men between GS and FEV1 although attenuated after adjustment (Table 3), in women between GS and PEFR and between GS and SVC after adjustment. No other significant relationships were found. FEV1, FVC and SVC were significantly larger in male compared to female participants.

Table 3 Unadjusted/Adjusted LF for GS

	Male				Female			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
LF	**β**	**P**	**B**	**p**	**B**	**P**	**β**	**P**
FEV1	**0.032**	***0.047***	0.043	*0.062*	0.018	*0.242*	0.018	*0.267*
FVC	0.039	*0.072*	0.060	*0.065*	0.020	*0.334*	0.020	*0.350*
FEV1/FVC	0.078	*0.869*	- .138	*0.850*	0.170	*0.785*	0.167	*0.788*
PEFR	4.606	*0.163*	6.597	*0.152*	**6.881**	***0.013***	**6.938**	***0.018***
SVC	0.032	*0.249*	0.042	*0.341*	**0.052**	***0.028***	**0.050**	***0.048***

Discussion

GS in men was significantly stronger than in women reflecting greater skeletal muscle strength expected given larger body stature. All LF in men were greater than in women reflecting increased size in intra-thoracic cage, lung volume, body stature and greater EMS.

FEV1 was significantly associated with GS in men but attenuated after adjustment for age-height-weight. PEFR may be underestimated in participants with weaker EMS due to an inability to generate and sustain sufficient expiratory pressure to reach and hold maximum flow particularly in the initial phase of expiration. The relationship of GS with PEFR and SVC in women might reflect stronger patients generating higher intra-thoracic pressure at the start of spirometry and pushing harder against thoracic cage recoil at end-expiration.

Conclusion

No significant relationship was found with FEV1/FVC and GS in this small study. Further research is needed to evaluate the relationship between LF and GS.

We would like to acknowledge the British Geriatric Society for the SPR Start-up Grant awarded to Sarah Holmes, and Lindsay Welch and Gemma Rood from the NIHR Biomedical Research Centre Southampton for training in the use of the spirometer and dynamometer.