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Musculoskeletal health and life-space mobility in older adults: Findings from the Hertfordshire Cohort Study

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ABSTRACT

This study explores the relationship between musculoskeletal conditions of ageing and life-space mobility (LSM) in 1110 community-dwelling older adults from the Hertfordshire Cohort Study. LSM is a novel measure which captures ability to mobilise within the home, locally and more widely. Among men, older age, care receipt, not driving a car, lower wellbeing, and reduced physical function were associated with lower LSM, while in women only driving status and physical function were associated with LSM. Osteoporosis, arthritis, and fractures had no significant associations with LSM in either gender. These findings provide support for sex-specificity in the determinants of LSM and inform novel approaches to improving mobility and health in older age.

1. Introduction

Life-space mobility (LSM) is defined as the capacity to access various areas, from the room where the person sleeps to locations outside the town one lives in (Peel et al., 2005), and it is thus different from physical mobility, intended purely as the ability to move freely. LSM is fundamental for individuals to engage in a diverse range of activities (Portegijs et al., 2015; Rosso et al., 2013). Indeed, LSM plays a vital role in every aspect of daily life and is critical to maintaining independence in older age (Giannouli et al., 2019; Seinsche et al., 2023; Münch et al., 2019). However, LSM tends to decrease in older age (Hallal et al., 2012; Peel et al., 2005), and is associated with a number of adverse health outcomes such as poor physical functioning (Takemoto et al., 2015), cognitive decline (Caldas et al., 2020), low quality of life (Rantakokko et al., 2016), reduced social engagement (Rantakokko et al., 2016), nursing home admission (Sheppard et al., 2013), and mortality (Mackey et al., 2014).

LSM is important as traditional measures of daily activities and physical function usually provide information concerning physical capability and motor function only and may not be sufficient for fully capturing an individual's mobility within and between different geo-spatial areas. For example, Giannuoli and colleagues demonstrated, in a small sample of German community-dwelling older adults with a mean (SD) age of 72.5 (5.9) years, that measures of mobility related to capacity were only weakly associated with real-life mobility (i.e. in-home as well as out-of-home mobility which include the use of assistive devices as well as passive means of transportation, such as cars) (Giannouli et al., 2016).

LSM is therefore an important recently developed measure of mobility that assesses the range, frequency, and level of independence of movements over a given period of time, beyond physical capacity to move (Baker et al., 2003; Peel et al., 2005). Various factors, including physical, cognitive, psychosocial, environmental, and financial elements, have been recognised as determinants influencing LSM in older adults, with gender emerging as a critical crosscutting influence across all categories (Webber et al., 2010). Specifically in older age, musculoskeletal diseases, falls, and fractures are prevalent (Rudnicka et al., 2020), and these may further restrain older adults' ability and confidence to move across different geo-spatial areas.

Given this burden of musculoskeletal disorders in older age (Edwards et al., 2015), it is notable that, to the best of our knowledge, previous studies have not considered whether poor musculoskeletal health may be associated with LSM in older adults. Therefore, the aim of this cross-sectional study was to investigate, in a cohort of English community-dwelling older adults, risk factors and musculoskeletal conditions associated with LSM and to examine any potential sex

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differences among participants. We hypothesised that in this sample, osteoarthritis, prior falls, and previous fractures may be linked to lower LSM, with these associations potentially being more pronounced in women compared to men, considering the higher prevalence of musculoskeletal conditions in women compared to men (Overstreet et al., 2023), and recognising the acknowledged significance of female sex as a risk factor for declining LSM (Webber et al., 2010; Phillips et al., 2015; Malouka et al., 2023).

2. Methods

The Hertfordshire Cohort Study (HCS) is a population-based sample of men and women born between 1931 and 1939 in Hertfordshire, UK, a predominantly rural county which includes a number of urban cities, towns, and major conurbations (Department For Environment, 2014). Participants were originally recruited to examine the relationship between growth in infancy and risk of adult diseases (Syddall et al., 2005). Potential participants were first identified through historical ledgers at the Hertfordshire county office. These ledgers contained data on birth weight, illnesses, development, and infant feeding from birth to one year of age (Syddall et al., 2005). Approximately 3000 of these identified individuals agreed to participate in a baseline study conducted between 1998 and 2003 and have been consistently followed up since (Syddall et al., 2005, 2019). Between 2013 and 2016, a subset of the HCS took part in the Vertical Impact and Bone in the Elderly study and a total of 279 participants completed a postal questionnaire. Subsequently (2016–2017), the questionnaire was extended to 831 additional HCS participants. Data for this cross-sectional analysis were therefore available for a total of 1100 participants (563 men and 547 women).

LSM was assessed using a revised version of the University of Alabama Life Space Assessment (LSA), which was originally introduced by Baker and colleagues (Baker et al., 2003, 2016). The questionnaire assesses a person's LSM and level of dependence. Participants were asked to report whether, during the previous four weeks, they had been: to other rooms/inside their house (level 1); outside their house/within the garden (level 2); in the neighbourhood (level 3); outside the neighbourhood/inside the town (level 4). Positive answers to these questions were assigned weights ranging from 1 (level 1) to 4 (level 4). In addition, respondents were asked to state how often they had been in each life-space level [less than 1 time per week (score = 1), 1–3 times per week (score = 2), 4–6 times per week (score = 3), or daily (score = 4)]. Independence level was assessed by asking whether participants needed aids, equipment, or help from another person to move within a life-space level [personal assistance (score = 1), equipment only (score = 1.5), or neither equipment nor personal assistance (score = 2)]. Scores for individual levels were computed by multiplying the level weight, the frequency with which the level was visited, and the degree of independence. The total LSA score was then calculated by summing individual scores, with higher scores being indicative of greater mobility.

The original LSA tool designed by Baker and colleagues includes a fifth level (i.e. visiting places outside town) (Baker et al., 2003). In our population sample, this level was available only for the first subset consisting of 279 participants. In order to make our measure of LSA comparable with what reported in other studies, we derived the 5-item domain based on the 4-item LSA domain. We firstly ran a regression on the smaller subset, using the 4-domain score to predict the full 5-domain score. Then, we applied the regression equation obtained in step one to the 4-domain score to derive the final LSA score.

2.1. Covariates

Receipt of formal or informal care was assessed by self-report, asking the question: 'Do you receive help at home from a member of the household/someone from outside?'. Participants were also asked whether they drove a car and this was used as a binary variable in the models.

Comorbidities were self-reported. Participants were presented with a list of conditions (lung disease, cardiovascular disease, peripheral arterial disease, diabetes, stroke, cancer, osteoporosis, arthritis, liver or kidney disease, overactive thyroid/parathyroid gland, coeliac disease/malabsorption) and were asked to indicate whether they had received a formal diagnosis from a doctor for any of them. A composite comorbidity score was calculated by summing participants' responses. This score was then categorised into the following groups: none, 1 comorbidity, 2 or more comorbidities, with 'none' used as the reference category.

Body mass index (BMI) was calculated using self-reported height and weight. Smoker status was dichotomised into 'never smoked' and 'ever-smoked' or 'current smoker' depending on the participants' answers to the questions 'Are you a current smoker?' and 'Have you ever smoked cigarettes regularly?'. Participants were asked how often they used to drink different types of alcohol (beer, wine, spirits, etc.) and how much they normally drank each time. This was used to estimate their alcohol consumption in units per week.

Physical activity was assessed by asking participants about their weekly sports and activity engagement, noting frequency and average duration. A physical activity score was calculated by assigning values based on activity frequency and duration (0 for 0–1 h/week, 4 for >4 h/week) and summing across all activities.

Participants were asked to rate their current health status from very poor to very good. This measure of self-rated health (SRH) was then dichotomised into 'fair/poor/very poor' and 'good/very good'. Falls in the previous 12 months and doctor-diagnosed fractures since age of 45 years were self-reported.

Well-being was assessed using the Warwick–Edinburgh Mental Well-being Scale (Tennant et al., 2007), which consists of 14 items (e.g. 'I've been feeling optimistic about the future', 'I've been feeling useful') provided with a 5-point Likert scale ranging from 1 ('none of the time') to 5 ('all of the time'). A well-being score is calculated by summing the scores across all items; higher scores are indicative of better mental well-being. The WEMWBS has been shown to have a high internal reliability for a general population sample (Cronbach's $\alpha = 0.91$) (Tennant et al., 2007). Self-reported physical function was assessed using the SF-36 PF (Short Form-36 Physical Function) scale (Syddall et al., 2009). Lastly, we gathered demographic data. Marital status was dichotomised into 'living with someone' and 'living alone', based on the categories provided by participants (single, married, divorced or separated, registered partnership, co-habiting, or widowed). Home ownership status was determined by asking participants whether their accommodation was owned, mortgaged, rented, or other. Responses were dichotomised into 'owned (with/without mortgage)' and 'rented/other'.

2.2. Statistical methods

Participant characteristics were described using means (SD), medians (IQR), and N (%), depending on the nature of the variables. Men and women were analysed separately throughout. The decision was made *a priori* because studies have shown that LSA and most of the risk factors analysed in the study tend to differ across genders (Webber et al., 2010; Katsumata et al., 2011; Phillips et al., 2015; Malouka et al., 2023). Moreover, recognised sex differences in musculoskeletal measures and health prompted us to conduct sex-stratified analyses. For example, women typically exhibit lower hand grip strength (Liao, 2014) and a higher prevalence and severity of neck pain, back pain, osteoarthritis, and rheumatoid arthritis compared to men (Overstreet et al., 2023).

Sex differences were tested with Chi-squared tests, t-tests, or Mann-Whitney tests. Linear regression models were performed upon having transformed LSA scores in SD scores. Firstly, all risk factors were entered in separate models with adjustment for age only. Subsequently, factors significant at 5 % level only were retained and entered in a mutually adjusted model. For women, we presented two separate mutually adjusted models, one including individual comorbidities (peripheral arterial disease, osteoporosis, and arthritis) and another reporting the number of comorbidities.

We conducted a complete-case analysis and all analyses were conducted using Stata statistical software (version 17.0).

3. Results

Table 1 provides the participant characteristics. The mean age of men and women was approximately 80 years. Compared to women, men had significantly higher LSA scores. Women were more likely than men to live alone, receive personal care, report osteoporosis or arthritis, and to have broken at least a bone since the age of 45 years. However, there was no significant difference in the number of comorbidities or in the occurrence of falls between sexes. Men were more likely to drive a car, to be current or ex-smokers and reported consuming higher amounts of alcohol and engaging in more physical activity compared to women. They were also more likely to report cardiovascular disease, peripheral arterial disease, and stroke. Finally, men reported significantly higher wellbeing and physical function scores than women.

Most participants reported mobility within each of the LSA levels, with 94 % of our sample reporting that they went outside of their neighbourhood and in town (level 4). Among men and women older age was associated with lower LSA scores. Among men, after conducting adjustment for age only, several factors were found to be significantly associated with lower LSA scores (Table 2). These factors included being a recipient of personal care, not driving a car, reporting fair/poor/very poor SRH, having had falls in the previous year, lower levels of wellbeing, poorer physical function, and lower engagement in physical activity. However, upon further analysis with mutual adjustment for all these factors, only older age, not driving a car, personal care, wellbeing, and physical function retained their significance in relation to LSA in men. Having experienced a fall in the past year was of borderline significance.

The age-adjusted estimates among women showed a negative association between LSA and higher BMI, not owning one's home, receiving personal care, not driving a car, fair/poor/very poor SRH, higher number of comorbidities, peripheral arterial disease, osteoporosis, and arthritis (Table 2). In addition, lower levels of physical activity as well as lower wellbeing and physical function scores were associated with lower LSA scores. However, most of these associations were not robust to mutual adjustment and being a recipient of personal care, not driving a car and physical function were the only factors to remain significant in their association with LSA score when specific co-morbidities were entered in the model. In the model where the number of comorbidities was used as an adjustment factor, only not driving a car and physical function retained their significance.

All analyses were repeated using the 4-domain score with very similar results obtained (data not shown).

Table 1
Characteristics of participants at the time of the questionnaire.

	Men (n = 563)	Women (n = 547)	P*
Age, years mean (SD)	80.2 (2.7)	80.2 (2.6)	0.87
BMI kg/m^2, mean (SD)	26.2 (3.5)	26.1 (4.6)	0.64
Living alone, N (%)	142 (25.2)	267 (48.8)	<0.001
Does not own home, N (%)	75 (13.3)	96 (17.6)	0.05
Drive a car, N (%)	471 (83.7)	282 (51.6)	<0.001
Total physical activity score (median (IQR)) (range 0–27)	7 (3,11)	6 (3,9)	0.004
Current/ex-smoker, N (%)	323 (57.4)	171 (31.3)	<0.001
Alcohol consumption units, median (IQR)	5 (1, 13.8)	1 (0, 5)	<0.001
Receiving personal care, N (%)	141 (25.0)	217 (40.0)	<0.001
Fair/poor/v poor SRH, N (%)	225 (40.0)	199 (36.4)	0.30
Peripheral arterial disease, N (%)	18 (3.0)	5 (0.9)	0.03
Cardiovascular disease, N (%)	116 (20.6)	66 (12.1)	0.001
Stroke, N (%)	52 (9.2)	26 (4.8)	0.01
Osteoporosis, N (%)	31 (5.5)	119 (21.8)	<0.001
Arthritis, N (%)	195 (34.6)	282 (51.6)	<0.001
Number of comorbidities, N (%)			
0	128 (22.7)	113 (20.7)	0.21
1	223 (39.6)	194 (35.5)	
2+	209 (37.1)	237 (43.3)	
Any falls in the past year, N (%)			
No	368 (65.3)	336 (61.4)	0.39
Yes	184 (32.7)	200 (36.6)	
Broken any bones since age of 45, N (%)			
No	481 (85.4)	345 (63.1)	<0.001
Yes	72 (12.8)	181 (33.1)	
Wellbeing score, mean (SD) (range 14–70)	54.1 (10.0)	52.8 (9.6)	0.04
SF36 Physical function, median (IQR) (range 0–100)	75 (55,90)	65 (35,85)	<0.001
Life Space Assessment (LSA) score, (median (IQR)) (range 0–120)	86.4 (70.2,97.2)	78.3 (59.4,89.1)	<0.001

*p-value from Chi2-test, *t*-test, or Man-Whitney test. Missing values differ for each variable and their prevalence is not shown in the table.

4. Discussion

In this study, we explored whether musculoskeletal conditions of ageing, falls, fractures, and other factors were associated with LSM among community-dwelling older adults. We also explored whether these associations differed by sex, based on previous studies reporting female sex as a risk factor for declining LSM (Webber et al., 2010; Phillips et al., 2015; Malouka et al., 2023). Consistent with these studies was our finding that women had lower LSA scores than men in our population sample.

In men, we found that older age, receiving personal care, and having experienced at least one fall in the previous year were associated with lower LSA scores. Age has been previously identified as a risk factor for low LSM (Hallal et al., 2012; Peel et al., 2005). This could be attributed to the fact that an ageing population has resulted in a higher prevalence of chronic diseases and frailty (Beard et al., 2016; Prince et al., 2015), which may hamper mobility. However, we did not observe a comparable association in women in the adjusted models, although comparisons across sexes may be difficult due to the different set of predictors used for men and women. The lack of significant association between age and LSA among women might also be due to lack of power, nevertheless this requires further validation in other cohorts.

Previous fractures were not associated with LSA score in neither men nor women. While experiencing a fracture can hamper physical function and thus mobility, most fractures occurred several years before and ceased to have a potential impact. Furthermore, we did not report the specific site of the fracture: different fractures could potentially impact an individual's mobility to varying degrees (for instance, hip fractures may have a more detrimental effect on mobility compared to wrist fractures). This may have prevented us from observing an association between fractures and LSA score.

Osteoporosis and arthritis were associated with lower LSA scores in women only, but this association was removed in the mutually adjusted models. Vertebral fractures are often silent and may not have been reported by participants (Jones et al., 2020). Spinal kyphosis might therefore account for the association with a diagnosis of osteoporosis as vertebral fractures are much more common in women than men (Harvey et al., 2010).

The association between receipt of care and lower LSA scores is expected, as the need for receiving care may be indicative of loss of independence. In men the association remained significant in the mutually adjustment model. It is possible that this was due to factors not accounted for in our study. For instance, sarcopenia (the age-related decline in muscle mass) has been previously associated with loss of independence and need to care placement (Dos Santos et al., 2017; Steffl et al., 2017), and a number of studies have reported that this condition is more prevalent in men than in women (Di Monaco et al., 2012;

Table 2
Associations between predictors and LSA.

Predictors	Men		Women		
	Age adjusted	Mutually adjusted	Age adjusted	Mutually adjusted	
				Model 1	Model 2
	β (95 %CI)		*β (95 %CI)*		
Age, years	**−0.13 (-0.18, -0.09)**	**−0.08 (-0.13, -0.03)**	**−0.10 (-0.14, -0.06)**	−0.02 (−0.06,0.02)	−0.02 (−0.06,0.02)
BMI, kg/m^2	−0.02 (−0.05, 0.02)		**−0.05 (-0.07, -0.02)**	0.001 (−0.02,0.02)	−0.002 (−0.02,0.02)
Living alone (vs with someone)	−0.22 (−0.50, 0.05)		0.04 (−0.18, 0.26)		
Rented house (vs owned)	−0.15 (−0.50, 0.19)		**−0.37 (-0.64, -0.09)**	−0.11 (−0.40,0.17)	−0.11 (−0.39,0.18)
Does not drive (vs drive)	**−0.92 (-1.26, -0.58)**	**−0.45 (-0.83,-0.07)**	**−0.52 (-0.73, -0.31)**	**−0.32 (-0.55, -0.10)**	**−0.33 (-0.55,-0.11)**
Total physical activity score	**0.06 (0.03, 0.08)**	0.01 (−0.02, 0.03)	**0.10 (0.07, 0.12)**	0.02 (−0.009,0.04)	0.02 (−0.01,0.05)
Receiving personal care (vs not)	**−0.89 (-1.16, -0.63)**	**−0.43 (-0.74, -0.12)**	**−0.72 (-0.94, -0.51)**	**−0.23 (-0.47,0.00)**	−0.20 (−0.43,0.03)
Fair/poor/very poor vs good/very good SRH	**−0.71 (-0.95, -0.48)**	−0.06 (−0.36,0.24)	**−0.84 (-1.05, -0.62)**	−0.06 (−0.34,0.21)	−0.08 (−0.35,0.19)
Peripheral arterial disease	−0.61 (−1.28, 0.06)		**−1.28 (-2.40, -0.16)**	−0.29 (−1.49, 0.91)	
Osteoporosis	−0.23 (−0.75, 0.29)		**−0.29 (-0.55, -0.04)**	0.07 (−0.19,0.33)	
Arthritis	−0.24 (−0.48, 0.12)		**−0.40 (-0.61, -0.19)**	−0.05 (−0.28,0.17)	
Number of comorbidities					
1 (vs none)	0.05 (−0.26,0.37)		−0.24 (−0.53,0.05)		0.15 (−0.14,0.45)
2+ (vs none)	−0.17 (−0.49,0.15)		**−0.62 (-0.90, -0.34)**		−0.08 (−0.38,0.21)
Any falls past year (vs No)	**−0.50 (-0.75, -0.25)**	−0.25 (−0.51, 0.02)	−0.06 (−0.29,0.16)		
Broken bones since age 45 (vs No)	0.19 (−0.17,0.54)		0.04 (−0.19,0.27)		
Wellbeing score	**0.04 (0.03, 0.05)**	**0.02 (0.01,0.03)**	**0.03 (0.02, 0.04)**	0.01 (0.001,0.02)	0.01 (0.0002,0.02)
SF36 Physical function	**0.02 (0.01,0.02)**	**0.01 (0.004,0.02)**	**0.02 (0.02,0.02)**	**0.02 (0.01,0.02)**	**0.02 (0.01,0.02)**

The β coefficients represent the SD difference in LSA score according to each predictor. Estimates provided in the column "Age adjusted" are from separate models adjusted for age only. In the case of "Age", the estimates are from a univariate model instead. Bold means significant at 5% level.
Mutually adjusted: adjusted for all covariates significant in the model adjusted only for age.
Model 1: specific comorbidities (significant when age-adjusted) added to the mutually adjsuted model, but number of comorbidities left out.
Model 2: number of comorbidities included but specific conditions excluded.
N. in the mutually adjusted models = 440 for men; N = 390 for women.

Iannuzzi-Sucich et al., 2002; Du et al., 2019). In women, instead, the association was removed when we considered the number of comorbidities but not when the model included individual conditions in the adjustment.

In men we also found that falling within the previous 12 months was associated with lower LSA score, although the association was of borderline significance. This is in line with a study conducted among community-dwelling Americans aged approximately 65 year: in this study's population, falls (whether followed by injury or not) were independently associated with a decline in LSA score after six months (Lo et al., 2014). Falls can indeed result in functional decline, fear of falling, increased healthcare utilisation and increased mortality (Friedman et al., 2002; Kelsey et al., 2012), and therefore can easily have a negative impact on older adults' mobility. However, we did not find the same association in women. It is possible that men and women might experience and cope with the aftermath of a fall in distinct ways: for instance, a study conducted among community-dwelling older adults from Japan aged 65 years and older found that fear of falling was associated with disability among men but not women (Katsumata et al., 2011). Nevertheless, there may still exist residual confounding factors that have not been fully accounted for. As a result, further investigation into this sexual dimorphism is warranted and necessary.

Higher well-being scores were associated with higher LSA scores in men, but not in women in the fully adjusted models. A study by Rantakokko and colleagues conducted with Finnish community-dwelling adults aged 65 years and over found that a decline in LSM was associated with a decline in quality of life (Rantakokko et al., 2016), and it is plausible that such an association can be bidirectional. A positive evaluation of one's own life may indeed facilitate participation in out-of-home activities. However, in the case of women, this association was no longer significant after adjusting for other relevant factors. This finding seems to suggest that while wellbeing plays a crucial role, it may not solely determine LSM for older women if other health-related circumstances are not adequately met. Further qualitative work might consider this sexual dimorphism further.

Not driving was significantly associated with lower LSA scores in both men and women, and this association retained its significance in the mutually adjusted models. This finding was expected, considering that driving has been previously identified as the predominant and preferred means of community mobility among older adults in westernised countries (Turcotte, 2012). Notably, a study involving over 12,000 adults aged ≥65 years from the Canadian Longitudinal Study on Aging identified driving as one of the most significant correlates of LSM (Kuspinar et al., 2020). Possession of a driving licence and a car in older age has been previously associated with greater social participation (Pristavec, 2018), while ceasing to drive has been linked not only to decreased engagement in out-of-home activities (Marottoli et al., 2000), but also to adverse outcomes such as poorer health status, depression, and increased mortality (Edwards et al., 2009a, 2009b; Fonda et al., 2001). Our findings further highlight the importance of maintaining access to transportation for preserving LSM in later life.

Lastly, we found that higher physical function scores were associated with higher LSA scores in both men and women. This finding was unsurprising, as higher physical function (i.e. fewer limitations to physical activities) can facilitate participation in out-of-home activities and thus contribute to greater LSM. Several studies have examined the relationship between physical function and LSM: limitations to activities of daily life (Fontenele et al., 2020), slow walking speed and poor grip strength (Kuspinar et al., 2020), and poor physical performance (Peel et al., 2005; Portegijs et al., 2015) were found to be associated with reduced LSM.

In summary, our findings highlight the importance of considering relevant psychosocial and lifestyle factors, such as driving status, receipt of care, and wellbeing, for a comprehensive and accurate assessment of the correlation between musculoskeletal health and LSM. Our study does of course have some limitations. Our sample may not be entirely representative of the wider UK population, as all participants were born in Hertfordshire, a predominantly rural area, where they were still living in their homes, and were all Caucasian. It has been previously reported that both urbanicity and race are important contributors to LSM (Clevenger et al., 2023; Choi et al., 2016). However, it has been previously demonstrated that the HCS is representative of the general population in terms of anthropometric body build and lifestyle factors (e.g. smoking and alcohol intake) (Dik et al., 2014), although a 'healthy' responder bias is evident in this cohort (Syddall et al., 2005). Additionally, most variables were self-reported, therefore, recall bias cannot be ruled out. In particular, self-reported physical activity is known to overestimate the true level of physical activity, however reassuringly we have previously validated the self-reported physical activity in this cohort (Deere et al., 2016; Bloom et al., 2021). Importantly due to the cross-sectional design adopted, we cannot assess whether the associations between risk factors and LSA are causal nor the direction of association. One of the domains of the LSA score was not available for most of the sample therefore we had to derive it based on the 4-domain score. However, when we replicated the analyses using the 4-domain score, we were reassured to see that results were comparable to what obtained with the 5-domain score (data not shown). In this study, we only assessed sex assigned at birth and have no information on gender identity. Lastly, although no association between osteoporosis and LSA score was found in men, the low prevalence of this condition among men had possibly prevented us from detecting a significant association.

Our study has also a number of strengths. LSM was measured using the LSA, which is a widely adopted and validated tool with good psychometric properties (Ullrich et al., 2022). The LSA has been found to predict morbidity, mortality, and use of healthcare with greater accuracy than performance-based measures (Mackey et al., 2014, 2016; Johnson et al., 2020; Kennedy et al., 2019; Lo et al., 2014). Similarly, wellbeing and physical function were also assessed using validated tools (Tennant et al., 2007; Syddall et al., 2009). Lastly, our study sample comprises community-dwelling older adults who have been extensively phenotyped and comprehensively characterised with regard to lifestyle and past medical history.

5. Conclusions

In men, factors associated with lower LSA score included older age, receipt of care, not driving a car, lower levels of wellbeing and poorer physical function. Average LSA scores were lower in women than men, and in women only not driving a car and poorer physical function were associated with lower LSA score. These findings, using a multidimensional construct to assess mobility, provide support for sex-specificity in the determinants of LSM and thus inform novel approaches to improving mobility and health in older age. A potential association between lower LSA and impaired physical performance requires further research with a longitudinal design to determine direction of association.

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Ethical approval

Ethical approval for work conducted in HCS was granted by the East of England—Cambridgeshire and Hertfordshire Research Ethics Committee, reference number 11/EE/0196. All participants provided informed consent prior to participation in this study. All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

CRediT authorship contribution statement

Gregorio Bevilacqua: Writing – original draft, Writing – review & editing. **Stefania D'Angelo:** Formal analysis, Writing – original draft, Writing – review & editing. **Leo D. Westbury:** Formal analysis, Project administration, Writing – review & editing. **Nicholas C. Harvey:** Supervision, Writing – review & editing. **Elaine M. Dennison:** Conceptualization, Funding acquisition, Investigation, Project administration, Supervision, Writing – review & editing.

Declaration of competing interest

NCH reports personal fees, consultancy, lecture fees and honoraria from Alliance for Better Bone Health, AMGEN, MSD, Eli Lilly, UCB, Kyowa Kirin, Servier, Shire, Theramex, Consilient Healthcare and Internis Pharma, outside the submitted work. EMD has received speaker honoraria from UCB, Pfizer, Lilly and Viatris. GB, SD, and LDW have no relevant interests to declare.

Data availability

Data will be made available on request.

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