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### **The Life-Space Assessment Measure of Functional Mobility has Utility in Community-Based Physical Therapist Practice in the United Kingdom**

**Citation for published version:**

McCrone, A, Smith, A, Hooper, J, Parker, R & Peters, A 2019, 'The Life-Space Assessment Measure of Functional Mobility has Utility in Community-Based Physical Therapist Practice in the United Kingdom', *Physical Therapy*. <https://doi.org/10.1093/ptj/pzz131>

**Digital Object Identifier (DOI):**

[10.1093/ptj/pzz131](https://doi.org/10.1093/ptj/pzz131)

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Peer reviewed version

**Published In:**

Physical Therapy

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**TITLE: The Life-Space Assessment Measure of Functional Mobility Has Utility in Community-Based Physical Therapist Practice in the United Kingdom**

**RUNNING HEAD:** Validity and Utility of the Life-Space Assessment

**TOC CATEGORY:** Measurement

**ARTICLE TYPE:** Original Research

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**KEYWORDS:** Mobility, Physical Therapists, Measurement, Balance

**ACCEPTED:** April 28, 2019

**SUBMITTED:** August 22, 2018

**Background.** The Life-Space Assessment (LSA) has demonstrable validity and reliability among people sampled from nonclinical settings. Its properties in clinical settings, especially physical therapy services, are less well established.

**Objective.** The aim of this study was to test the construct/convergent validity, responsiveness, and floor/ceiling effects of the LSA among patients who had musculoskeletal, orthopedic, neurological, or general surgical presentations and were receiving individually tailored, community-based physical therapist interventions to address gait/balance impairments in an urban location in the United Kingdom.

**Design.** A prospective, repeated-measures, comparative cohort design was used.

**Methods.** Two hundred seventy-six community-dwelling, newly referred patients were recruited from 3 cohorts (outpatients; domiciliary, nonhospitalized; and domiciliary, recent hospital discharge). Data were collected from the LSA and the Performance-Oriented Mobility Assessment (POMA1) at initial assessment and discharge. Two hundred twenty-eight participants were retained at follow-up.

**Results.** The median age was 80.5 years, 73.6% were women, and the median number of physical therapist contacts over 53 days was 5. LSA scores at assessment and changes over treatment distinguished between cohorts, even after adjustment for covariates. Weak correlations (0.14–0.41) were found between LSA and POMA1 scores. No LSA floor/ceiling effects were found. Significant improvements in the LSA score after the intervention were found for each cohort and for the sample overall. For the whole sample, the mean change in the LSA score was 10.5 points (95% CI = 8.3–12.8).

**Limitations.** The environmental demands participants faced were not measured. Caregivers answered the LSA questions on behalf of participants when necessary. Assessors were not always masked with regard to the measurement point.

**Conclusions.** The LSA has utility as an outcome measure in routine community-based physical therapist practice. It has satisfactory construct validity and is sensitive to change over a short time frame. The LSA is not a substitute for the POMA1; these measures complement each other, with the LSA bringing the added value of measuring real-life functional mobility.

Physical activity such as walking outdoors is an important health-protective factor<sup>1</sup> especially for older people.<sup>2</sup> Reduced functional mobility is associated with depression,<sup>3–5</sup> cognitive impairment,<sup>6,7</sup> and shorter life expectancy.<sup>8,9</sup>

Patients referred to Edinburgh Community Physiotherapy Service are frequently elderly. Rehabilitation interventions addressing balance, gait, coordination, muscle strength, and indoor/outdoor mobility are commonly provided on an outpatient or domiciliary basis.

The identification of a valid and reliable measure of functional mobility, which is responsive to changes in mobility, both indoors and out, would enable physical therapists and other health care staff to measure meaningful clinical change and provide grounds for giving evidence-based feedback to patients regarding their progress in mobility.

The Panel on Prevention of Falls in Older Persons<sup>10</sup> noted that the Performance-Oriented Mobility Assessment<sup>11</sup> (POMA) is one of the most commonly used mobility measures. POMA assesses balance and gait in a controlled indoor environment and has been shown to be predictive of falls risk.<sup>12</sup> The validity and reliability of the most frequently used version, POMA1, has been established for those with osteoarthritic knees<sup>13</sup> and for people with Parkinson disease.<sup>14</sup> Among samples of older adults POMA1 has been shown to be responsive to intervention effects at the group level,<sup>15</sup> especially among those with lower baseline scores.<sup>16</sup> However, POMA1 scores might not correlate strongly with actual functional mobility.<sup>17</sup> Factors beyond gait and balance,<sup>17</sup> such as fear of falling when walking outdoors<sup>18</sup> and the availability of resources, such as personal assistance, are likely to be important in this respect.

The Life-Space Assessment<sup>19</sup> (LSA), a self-report measure, requires respondents to quantify how far and how often they have mobilized with or without assistance during the last 4 weeks. The items are repeated for each of the 5 “Life-Space Levels,” which represent increasing distances from the room in which the respondent sleeps (Appendix). *Life-space* has been described as the area in which a person moves purposefully in a specific time period.<sup>20</sup> Although LSA is not a direct measure of factors such as fear of falling and the availability of resources it is plausible that LSA scores of mobility will partly reflect these, and to a greater extent than would be reflected in POMA1 scores.

Based on its face validity, published psychometric properties, and apparent ease of administration we tested the suitability of the LSA as a measure in routine clinical practice by conducting a preliminary pilot study of staff members’ experiences of administering the measure within our service.<sup>21</sup> The LSA was found to be quick and easy to administer by both physical therapists and their assistants.

The LSA has been shown to be a valid and reliable instrument among people sampled from nonclinical settings across a range of cultures.<sup>3,7,22–32</sup> Evidence for validity has been found in a small number of studies involving clinical groups<sup>33–41</sup> where mean baseline LSA composite scores<sup>19</sup> are often markedly lower than in other studies. Several studies provide evidence that floor/ceiling effects are absent or negligible<sup>19,25,36,39,40</sup> and there is no contrary evidence. There is evidence supporting the responsiveness of LSA to interventions likely to affect mobility, although the number of studies is small,<sup>41–45</sup> and only 3 of these have used LSA as an outcome measure in the context of a physical therapy/exercise intervention.<sup>42–44</sup> There are no studies of any kind using LSA which were conducted in the United Kingdom; an unmet clinical need for health services including physical therapy which are publicly

funded, free at point of need, and therefore accessed by the broad spectrum of the general population.

The aim of this study was to evaluate the validity and utility of the LSA during routine physical therapist treatment provided at home or in outpatient clinics in urban Scotland for patients with gait and balance problems secondary to a range of primary conditions. Specifically, the objective of this study was to evaluate the construct validity (differences between groups and convergent validity) and responsiveness over treatment.<sup>46</sup> In the absence of a gold standard, the criterion validity of the LSA was not tested.

## **[H1] Methods**

### ***[H2] Setting and Participants***

The domiciliary and outpatient services of Edinburgh Community Physiotherapy Service, and West Lothian Domiciliary Physiotherapy Service were the settings for this study. Lothian NHS Board in Scotland, United Kingdom, is the publicly funded provider of these services. Participants were newly referred, consecutively assessed patients of these services. Patients were referred to the service by community-based general practitioners or allied health professionals, and hospital-based medical, surgical, or allied health professionals. Patients were eligible if they were 16 years old or older, with an improvement in balance and/or gait identified as a primary rehabilitation goal by the patient and treating physical therapist. Participants' primary conditions included musculoskeletal lower limb conditions and injuries, recent lower limb, pelvic, or lumbar vertebral fractures, lower limb joint replacements, recent general (abdominal) surgical interventions, and neurological conditions. Exclusion criteria were: having no potential to bear weight, being a nursing home resident, having a diagnosis of terminal illness, chronic lung disease, lymphedema, or

cognitive impairment to a degree precluding capacity to consent. Clinical physical therapists in the services assessed new patients on their caseload for eligibility, provided study information, and carried out the informed consent procedure.

## ***[H2] Design***

A prospective, comparative cohort design was adopted. Between January 2016 and March 2017, participants were sampled from subpopulations of patients, defined by clinical presentation, to create 3 study cohorts for comparison purposes: outpatient (OP)—able to make their way independently to attend outpatient appointments; domiciliary, nonhospitalized (DNH)—treated at home with no hospital admission within the previous 4 weeks; and domiciliary, recent hospital discharge (DH)—treated at home after a recent discharge from hospital after having been an inpatient for a minimum of 3 of the previous 4 weeks.

## ***[H2] Therapists and Interventions***

Twenty professionally registered physical therapists provided supervised, individually tailored, graduated, goal-focused, home or clinic-based physical therapist interventions to primarily address balance and gait impairments and, when appropriate, outdoor mobilization including confidence building, to enhance coping with environmental demands. Indoor exercises were based on the tests described in POMA1. Additional patient-specific progressive core strengthening, lower limb joint mobilization, and muscle-strengthening training exercises were performed predominantly in standing according to assessed need. Both indoors and outdoors exercises were tailored to suit each participant's requirements in terms of type, intensity, duration, and provision of mobility aids and/or personal assistance. Participants were encouraged to incorporate their personalized advice and perform their



prescribed exercise program on a daily basis. The details of the exercise programs were determined by the treating physical therapists on a case-by-case basis. The number of sessions provided was determined by attainment of agreed goals in each individual case. Initial assessment sessions were typically of 45 minutes duration, with subsequent treatment sessions lasting 20 to 30 minutes.

## **[H2] Measures**

The principal measures were the LSA and the POMA1. The LSA<sup>19</sup> is a self-report measure of the frequency of independent mobility across 5 Life-Space Levels during the last 4 weeks (Appendix). Level 1 is defined as the area indoors from the bedroom into the rest of the home. Level 2 is the distance beyond the front door as far as the garden boundary or communal hallway. Level 3 is the local neighborhood, as defined by the respondent. Level 4 is the respondent's town or city. Level 5 is the area beyond the town or city. Assistance to mobilize (from another person and/or by use of equipment), if required, is recorded at each level.

Permission was received from the developers to alter the terminology of some of the Life-Space Level descriptors and LSA instructions for cultural relevance in the United Kingdom.\* For respondents living in rural environments the developers recommend using a distance of up to ~0.8 km (0.5 mile) from the home as being equivalent to level 3, up to ~16 km (10 miles) as being equivalent to level 4, and ~16 km or more (10 miles or more) as being

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\* After alteration Life-Space 2 reads as 'An area just outside your home such as your patio, garden path, driveway, garden or communal hallway outside your apartment'; Life-Space 3: 'Places in your immediate neighbourhood beyond your own garden or apartment building'; Life-Space 4: 'Places outside your immediate neighbourhood but within your town/city'; Life-Space 5: 'Places outside your town/city'.

equivalent to level 5. Life-space level scores are summed to produce an LSA composite score with a possible range of 0 to 120. The LSA interview takes approximately 5 minutes to complete.

The LSA was administered by telephone by 1 of 3 researchers who were independent of the investigatory team, had no role in the clinical assessment or treatment of participants, and were not told about the study cohort membership of participants. Where a participant was unable to answer the telephone a caregiver was allowed to assist. To maintain masking, the researchers were trained to request that participants (and caregivers) did not reveal the identity of their treating physical therapist or the location of their treatment during the LSA interviews. Instances in which the researchers were unmasked with regard to cohort membership were recorded. Since the researchers were employed throughout the study and were aware of the study sequence of events no attempt was made to mask them with regard to measurement time point.

There are several versions of the POMA.<sup>47</sup> For this study we chose the most commonly used version: POMA1.<sup>17</sup> This is an objective, clinician-completed measure of performance on a range of tasks allowing the assessment of balance (score range = 0–16) and gait (score range = 0–12) by the physical therapist. Balance and gait scores are summed to produce a total score (range = 0–28). POMA1 assessments take 10 to 15 minutes to complete and in this study were performed by the participant's treating physical therapist.

The LSA and POMA1 score data recorded for analysis purposes were the total scores in each case (for the LSA, this was the LSA composite score<sup>19</sup>).

The treating physical therapists also provided demographic and treatment-related data including age, sex, postal code, main presenting problem, length of treatment, and number of treatment contacts. Postal codes were used to determine level of social deprivation by translation into residential area deprivation ranks defined by the Scottish Index of Multiple Deprivation (SIMD).<sup>48</sup> SIMD combines 7 measures of deprivation (employment, income, health, geographic access to services, crime, housing, and education, skills and training) into 1 index which provides a relative ranking of each geographical “data zone” in Scotland from 1 (most deprived) to 6505 (least deprived).

## ***[H2] Measurement Points***

Measures were administered twice. POMA1 was administered at the patient’s physical therapist assessment (T1) and discharge (T2) appointments as part of normal clinical practice. On receipt of signed informed consent after the initial assessment appointment, the researchers were instructed to conduct the first LSA interview as soon as possible thereafter. A similar triggering process for the second LSA interview was followed on confirmation that discharge from treatment had occurred.

## ***[H2] Specific Hypotheses***

Clinical experience indicated that the study cohorts would differ on average in predictable ways in terms of level of mobility at initial assessment and degree of improvement in mobility over treatment. Specifically, we hypothesized that at the initial assessment, the OP cohort would be more mobile than the DNH cohort, which would be more mobile than the DH cohort, as measured by the LSA, and that over treatment, the DH cohort would show more improvement in mobility than the DNH cohort, which would show more improvement than the OP cohort, as measured by the LSA.

In terms of convergent validity, because the LSA and the POMA1 appear to measure related but nonidentical constructs, we hypothesized that correlations between LSA and POMA1 scores at the initial assessment and between LSA and POMA1 score changes over treatment would be positive but moderate in size ( $0.3 < r < 0.6$ ).

In terms of responsiveness, we hypothesized that there would be an improvement in the LSA score at discharge from physical therapy compared with the initial assessment within each cohort and the sample overall and **that** the lower limit of the 95% CI for the change scores would be  $>0$ .

## **[H2] Sample Size**

Statistical advice was to recruit 77 patients per study cohort, that is, 231 in total. With a 2-group  $t$  test and a 2-sided 5% significance level, this sample size would have 80% power to detect a true difference in the mean LSA score change after treatment of 10 points or greater between any 2 study cohorts, assuming that the common SD was 22. The SD used in this calculation was derived from our pilot data.<sup>21</sup>

## **[H2] Data Management and Analysis**

The telephone researchers were responsible for all LSA data entry. An LSA scoring algorithm (in SPSS [IBM Corp, Armonk, NY, USA], with command syntax provided by the developers) that was used to calculate Life-Space Level scores and the total score was applied to the raw data by A.P.

Data analysis was conducted in a masked fashion with regard to study cohort membership, sex, and main presenting problem by R.A.P. using SPSS Statistics for Windows v21.0 (released in 2012; IBM Corp, Armonk, NY, USA). Analyses included all eligible participants who consented to take part in the LSA study provided that they recorded an LSA score at the initial assessment.

Participant characteristics were summarized overall and stratified by study cohort. Since most variables were not normally distributed, the participant characteristics were compared across cohorts using Kruskal-Wallis tests for continuous data and chi-square tests for categorical data. To determine whether the LSA scores at the initial assessment were significantly different between the 3 cohorts, box plots were constructed and Kruskal-Wallis tests were used. On the basis of the observed validity of the analysis of variance assumptions, a parametric one-way analysis of variance was used to assess whether changes in the LSA scores over treatment were significantly different between the study cohorts, with box plots being used to enable visual comparison. Similarly, box plots and a 1-way analysis of variance were used to compare groups with different main presenting problems. Means and 95% CIs for differences in the LSA scores at the initial assessment and differences in the changes in the LSA scores between cohorts were also calculated.

To investigate the convergent validity of the LSA score, Kendall tau correlation coefficients were calculated between LSA scores and POMA1 scores at the initial assessment. The method of Kendall tau correlation was chosen because our data had frequent occurrences of tied observations. This analysis was conducted both overall and stratified by cohort.

To evaluate responsiveness, mean differences and 95% CIs were calculated for the changes in the LSA scores after treatment within each cohort, with *P* values being calculated on the basis of a paired *t* test. Standardized response means (SRMs) for changes in the LSA and POMA1 scores after treatment were calculated for comparative purposes as the mean difference divided by the SD. To evaluate responsiveness in terms of the longitudinal validity of LSA, Kendall tau correlation coefficients were calculated between LSA and POMA1 score changes over treatment.

According to predefined criteria, floor and ceiling effects were assumed to have occurred if at least 10% of the participants recorded the minimum possible LSA score of 0 and at least 10% of the participants recorded the maximum possible LSA score of 120. These criteria were determined a priori before the start of data collection.

The number and percentage of unmasking events relating to the telephone researchers' becoming aware of participant cohort membership were calculated both overall and within study cohorts.

Analysis was done by "complete cases," assuming that any missing data were missing completely at random irrespective of participant characteristics. To assess the appropriateness of this assumption, we performed a missing data analysis involving fitting a multiple logistic regression model to a binary outcome, taking the value as 1 if a participant had at least 1 LSA or POMA1 score missing at T1 or T2 or taking the value as 0 otherwise. Participant age, sex, study cohort, and LSA score at the initial assessment had no missing data and so were all included as covariates in the model to investigate the probability of missing data varying by these characteristics.

The 5% level was adopted as the criterion for statistical significance unless stated otherwise.

## **[H2] Role of the Funding Source**

This study was funded by the Edinburgh and Lothians Health Foundation (grant ref. no. 10-576); recipients were A. McCrone, A. Smith, J. Hooper, and A. Peters). **The funder played no role in the design, conduct, or reporting of this study.**

## **[H1] Results**

### ***[H2] Descriptive Statistics***

Study recruitment and retention rates are shown in Figure 1. Reasons for withdrawal or loss to follow-up included nonresponse to calls, dropping out of treatment, illness/admission, death, or bereavement.

The demographic, clinical presentation, and treatment characteristics of the cohorts are described in Table 1. The cohorts did not differ significantly in terms of sex, socioeconomic deprivation, length of treatment, or number of physical therapist contacts. There was significant variation between cohorts both in age ( $P = .02$ ) and the frequencies of main presenting problem ( $P < .001$ ). The characteristics of the main presenting problem categories are described in Table 2. These categories differed significantly with respect to age only ( $P < .001$ ), in that patients with neurological problems were younger on average than patients in the other categories.

### ***[H2] Times Between Measures***

The median time difference was 53 days between LSA measurements at T1 and T2 (range = 2–203) and also between POMA1 assessments at T1 and T2 (range = 7–210). These differences did not vary significantly across cohorts ( $P = .17$  for LSA;  $P = .66$  for POMA1). The median lags between POMA1 and LSA measurements were 7 (range = 0–84) days at T1 and 5 (range = 0–117) days at T2. These lags varied significantly between cohorts ( $P < .001$  for both T1 and T2), with the median lag observed in the OP cohort on both occasions being 4 to 7 days greater than those observed in the other cohorts.

## **[H2] Construct Validity**

**[h3] Differences between cohorts.** The hypothesized patterns of LSA scores at the initial assessment and the LSA score changes over treatment for the 3 cohorts were confirmed (ie, LSA scores at initial assessment in the relationship  $OP > DNH > DH$  and LSA score change over treatment in the relationship  $DH > DNH > OP$ ) (Fig. 2). The corresponding descriptive statistics are shown in Table 3.

There was significant variation between cohorts in LSA score at assessment ( $P < .001$ ). Further analysis showed significant mean differences in LSA score at assessment between the OP and DNH cohorts of 14.1 (95% CI = 9.2 to 19.0) points and between the OP and DH cohorts of 17.3 (95% CI = 12.6 to 22.1) points but not between the DNH and DH cohorts (3.3 [95% CI = -0.4 to 6.9] points). These patterns of differences in LSA score between cohorts were, with 1 exception, confirmed by multiple linear regression analysis adjusting for possible confounding variables (see Supplementary Analysis available at <https://academic.oup.com/ptj>). The exception was that the DNH cohort had a significantly higher initial LSA score than the DH group at the initial assessment (mean difference = 4.5 [95% CI = 0.2 to 8.7];  $P = .04$ ) in the multivariable analysis.



Similarly, there was significant variation between cohorts in LSA score change over treatment ( $P < .001$ ). Mean difference analyses indicated significantly greater improvements in the DH cohort than in the OP (11.8 [95% CI = 6.3 to 17.3] points) and DNH (8.1 [95% CI= 2.6 to 13.7] points) cohorts but no significant difference between the DNH and OP cohorts (3.6 [95% CI = -1.4 to 8.7] points). These patterns of differences in LSA change scores between cohorts were confirmed in multiple linear regression analysis adjusting for possible confounding variables (see Supplementary Analysis).

**[H3] Differences between main presenting problems.** Analyses of LSA outcomes by main presenting problem category are described in the Supplementary Analysis. Overall, these analyses show that both LSA score at initial assessment and LSA score change over treatment distinguished between the main presenting problem categories, particularly between patients with musculoskeletal, orthopedic, or neurological presentations. Statistically and clinically significant improvements in LSA score over treatment were found for the musculoskeletal and orthopedic categories but not for the neurological and general surgical categories (although the latter was a very small group comprising 5 patients).

**[H3] Convergent validity.** Relatively weak, positive correlations (Kendall tau-b = 0.21–0.41) for the sample as a whole and within each cohort were observed between the LSA and POMA1 scores at the initial assessment (Tab. 4). These correlations were in the direction hypothesized, if somewhat weaker than expected in most instances.

## **[H2] Responsiveness**

**[H3] Changes after treatment.** Statistically and clinically significant improvements in the LSA score after treatment were found for each of the cohorts and the sample overall. For the whole sample (experiencing a median of 5 physical therapist contacts over a median of 53 days) the mean change in LSA score was 10.5 points (95% CI = 8.3 to 12.8; SRM = 0.60;  $P < .001$ ). This size of improvement equates to the difference between, for instance, having been previously housebound but mobile daily with a walking stick to now visiting the garden 1 to 3 times per week and the neighborhood once a fortnight using a stick. The mean change in the DH cohort was 17.0 points (95% CI = 12.8 to 21.2; SRM = 0.90;  $P < .001$ ), that in the DNH cohort was 8.8 points (95% CI = 5.2 to 12.5; SRM = 0.55;  $P < .001$ ), and that in the OP cohort was 5.2 points (95% CI = 1.8 to 8.7; SRM = 0.34;  $P = .005$ ). This pattern of responses mirrors that of the SRMs of POMA1 score changes over treatment across cohorts, which were 1.52 (DH), 1.13 (DNH), and 1.00 (OP). These comparisons indicate that LSA is responsive but not to the same extent as POMA1 in this sample.

**[H3] Longitudinal validity.** Relatively weak, positive correlations (Kendall tau-b = 0.14–0.32) for the sample as a whole, and within each cohort, were observed between LSA and POMA1 score changes over treatment (Tab 4). Again, these correlations were in the direction hypothesized, if somewhat weaker than expected.

**[H3] Floor and ceiling effects.** No participant scored 0 or 120 on the LSA at either measurement point. Hence, there was no evidence of floor or ceiling effects.

### **[H2] Unmasking of Assessors**

The researchers who conducted the LSA interviews reported becoming unmasked with regard to participant cohort membership on 19 of 276 occasions (6.9%) at T1 and 15 of 231

occasions (6.5%) at T2. The analyses of differences between cohorts on LSA score at assessment and change in LSA score over treatment, as well as the responsiveness analyses, were run again after exclusion of all instances of unmasking. Our conclusions were unchanged after exclusion of these cases.

## **[H2] Missing Data**

A total of 228 participants (82.6%) had complete LSA and POMA1 score data, whereas 48 participants (17.4%) had at least 1 missing LSA or POMA1 score at T1 or T2. We found no statistically significant differences in participant age, sex, study cohort, or LSA score at the initial assessment between these 2 groups in a multiple logistic regression analysis. Therefore, we found insufficient evidence that the probability of missing data depends on participant characteristics or the study cohort, suggesting that the missing-completely-at-random assumption is reasonable.

## **[H1] Discussion**

In this sample of patients receiving community physical therapy in the United Kingdom we have found good evidence to support the construct validity of the LSA. The measure distinguished between 3 cohorts of patients (outpatients; domiciliary, nonhospitalized; and domiciliary, recent hospital discharge) on both score at assessment and change score over treatment comprising 5 contacts over 8 weeks on average. Five of 6 comparisons between pairs of cohorts in adjusted analyses showed statistically and clinically significant mean differences on these 2 outcomes. The directions of all of these differences confirmed our hypotheses based on clinical experience. Both LSA score at assessment and LSA change score distinguished between patients presenting with different primary problems even though all shared the treatment goal of improvement in gait and/or balance. In terms of

convergent validity we found that LSA and POMA1 scores established through assessments conducted, on average, approximately 1 week apart were positively correlated in most analyses, as hypothesized, but the associations were relatively weak and smaller than expected. It is likely that the correlation coefficients reported here are slight underestimates due to the median lags between POMA1 and LSA measurements ranging between 5 and 7 days. Notwithstanding this, the weak correlations support the hypothesis that although the 2 instruments measure something in common, they offer different measurement foci, and therefore cannot be used interchangeably. We also found good evidence for the responsiveness of the LSA as a measure of change in functional mobility over relatively short periods of physical therapy, for the sample as a whole, and within each of our cohorts. However, our analyses indicate that LSA is less responsive than POMA1 in this population, which supports the conclusion that the 2 measures are complementary not interchangeable. This difference in responsiveness probably reflects that improvements on gait/balance tasks (measured by POMA1) are necessary but not always sufficient to lead to improvements in functional mobility behavior (measured by LSA). Further, we found no evidence of floor or ceiling effects constraining the sensitivity of the LSA to changes after treatment.

The key strengths of this study are the clinically grounded hypothesis testing approach, the use of independent assessors who were intended to be masked with regard to cohort membership, and, by virtue of its setting, its relevance to outcome measurement in routine physical therapist practice. One limitation is that we did not attempt to measure the actual environmental demands faced by participants (such as terrain and lighting) which may have differed systematically between cohorts. Another possible limitation is that we allowed caregivers to answer the LSA questions on behalf of participants where necessary. Caution

in using this method has been advised due to limits on the accuracy of caregivers' recall.<sup>49</sup> However, in this study close relatives responded on behalf of only 9 of the 276 participants (3%), so the effect of any bias was likely to be minimal. The time lag between LSA and POMA1 measurements was not consistent across study cohorts, which may have biased the construct validity analyses, although we adjusted for the time lag in regression analyses comparing study cohorts on the 2 main LSA outcomes. Use of the *t* test *P* value (which is primarily an indicator of statistical significance) as a measure of responsiveness could be regarded as a limitation, although we also reported the 95% CIs around the mean response to aid interpretation. Further, the SRM relies on the accuracy of sample-based estimates of the mean and standard deviation, and uncertainty regarding the true value will be greater in small subgroups. Finally, the assessors were not always masked with regard to measurement point, which may have introduced bias.

The need for further study of the clinical applications of LSA has been noted<sup>28</sup> and this study enhances that small body of work, and is the first study of LSA in a United Kingdom setting. Our findings are consistent with those from the most robust clinical population studies in terms of the construct (difference between groups)<sup>35,41,44,45,50</sup> and convergent<sup>26,33–36,38,39,44</sup> validity, responsiveness over treatment,<sup>41,42,44,45</sup> and absence of floor/ceiling effects<sup>36,39</sup> of LSA. A particularly important feature of our findings is that they occurred in the context of a median baseline LSA score of 20 which is lower than any reported in the literature, and far below the range ( $\leq 52$ – $56$ ) which has been proposed<sup>28,33</sup> as the “cutoff score” indicating mobility problems sufficient to hinder activities of daily living. In this context, our finding of statistically and clinically significant changes in LSA score over a relatively brief period of treatment is particularly noteworthy.

This study provides evidence of the construct validity and responsiveness of the LSA in routine community physical therapist practice among patients with very restricted functional mobility. We found that LSA scores are influenced by more than gait and balance problems; they may also reflect concepts such as confidence in mobilizing outdoors,<sup>18</sup> social participation,<sup>51</sup> and access to support resources. Hence, the LSA complements and brings added value to outcome measures commonly used by community physical therapists, such as the POMA1, by quantifying a person's functional mobility around the home and in negotiating outdoor environmental demands. This is essential if an individual is to take part in social activities which, ultimately, impacts upon quality of life.<sup>28,30</sup> Although the LSA is brief and straightforward to administer, and its questions easily understood, its scoring procedures as they stand are likely to limit its use in routine practice. The requirement to apply an algorithm written in SPSS syntax to raw Life-Space Level scores to generate a total score is prohibitive; few clinical services are likely to have access to SPSS software. However, the logical operations expressed by the algorithm are relatively simple and it is our belief that 3 enhancements to the scoring instructions (see our detailed suggestions in the eAppendix, available at <https://academic.oup.com/ptj>) would render the algorithm redundant and greatly increase the utility of the measure in routine practice. The evidence presented should encourage physical therapists, their assistants, and other health professionals and organizations providing rehabilitation/support programs for mobility in the community to consider adopting the LSA as one of their standard outcome measures.

Further research is required to evaluate the reliability, minimal detectable change, and minimal important clinical difference of the LSA among clinical populations with a variety of health conditions who receive physical therapist rehabilitation for gait and balance problems. This would further strengthen the case for adopting the LSA as an outcome

measure in routine practice and controlled evaluations of community physical therapist interventions. Other professions (eg, podiatry, occupational therapy) and rehabilitation services which aim to help people to regain or maintain functional mobility could also use the LSA to evaluate their interventions effectively. Finally, we are in agreement with the recommendation of Wijlhuizen et al<sup>52</sup> that, since older people are known to compensate for their fear of outdoor falls by changing their level of physical activity, outcome measures in falls research should include a measure of outdoor mobility; the evidence indicates that LSA is a good candidate for this.

## **Author Contributions and Acknowledgments**

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The authors are grateful to the funders, patients, caregivers, physical therapists, and service managers who made this study possible. Special thanks go to the telephone researchers: Sue Begg, Lesley Goodman, and Emma Dignan.

## **Ethics Approval**

South-East Scotland Research Ethics Service confirmed that NHS ethical review under the terms of the Governance Arrangements for NHS Research Ethics Committees (A Harmonised Edition) was not required because the data to be obtained were part of usual patient care. NHS Lothian's Quality Improvement Team assured compliance with data protection and other information governance aspects. This research was conducted in accordance with the Declaration of Helsinki.

## **Funding**

This study was funded by the Edinburgh and Lothians Health Foundation (grant ref. no. 10-576); recipients were A. McCrone, A. Smith, J. Hooper, and A. Peters). R.A. Parker was



supported by the National Health Service (NHS) Lothian via the Edinburgh Clinical Trials Unit. Support for the open access fee was provided by Edinburgh Clinical Trials Unit.

## Disclosure

The authors completed the ICJME Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest. Anonymized data are available on request.

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**Table 1.**

Demographic, Clinical Presentation, and Treatment Characteristics of Participants Stratified by Cohort and Overall

Characteristic	Overall	Cohort <sup>a</sup>			<i>P</i> <sup>b</sup>
		OP	DNH	DH	
No. of participants	276	90	90	96	
Sex, no. (%)					.81
Women	203 (73.6)	67 (74.4)	64 (71.1)	72 (75.0)	
Men	73 (26.4)	23 (25.6)	26 (28.9)	24 (25.0)	
Age (y)					.02
Median	80.5	79	83.5	79.5	
Range	25–99	25–95	56–96	27–99	
Scottish Index of Multiple Deprivation 2012 ranking <sup>c</sup>					.80
Median	4348	4230	4628	4295	
Range	45–6492	241–6492	45–6492	184–6492	
Main presenting problem, <sup>d</sup> no. (%) of participants					<.001
Musculoskeletal	150 (54.3)	62 (68.9)	69 (76.7)	19 (19.8)	
Orthopedic	83 (30.1)	1 (1.1)	13 (14.4)	69 (71.9)	
Neurological	38 (13.8)	27 (30.0)	8 (8.9)	3 (3.1)	
General surgical	5 (1.8)	0	0	5 (5.2)	
No. of physical therapist contacts					.09
Median	5	6	5	5	
Range	1–14	2–10	1–12	1–14	
Length of treatment (d)					.66
Median	53	49	56	52.5	



Range	7–210	14–169	7–201	8–210	
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<sup>a</sup>DH = domiciliary, recent hospital discharge; DNH = domiciliary, nonhospitalized; OP = outpatient.

<sup>b</sup>Chi-square test *P* value for binary data and Kruskal-Wallis test *P* value for continuous data.

<sup>c</sup>Ranking of small geographical areas of Scotland from 1 (most deprived) to 6505 (least deprived).

<sup>d</sup>General surgical = recent abdominal surgery; musculoskeletal = conditions and injuries involving muscles, joints, or soft tissues of lower limbs but no recent fracture or joint replacement; neurological = stroke, multiple sclerosis, Parkinson disease, or myopathy; orthopedic = recent lower limb, pelvic, or lumbar vertebral fractures or surgical replacement of lower limb joints.

**Table 2.**

Demographic and Treatment Characteristics of Participants Stratified by Main Presenting Problem and Overall

Characteristic	Overall	Main Presenting Problem <sup>a</sup>			
		Musculoskeletal	Orthopedic	Neurological	General Surgical
No. of participants	276	150	83	38	5
Sex					
Women	203 (73.6)	112 (74.7)	65 (78.3)	24 (63.2)	2 (40)
Men	73 (26.4)	38 (25.3)	18 (21.7)	14 (36.8)	3 (60)
Age (y)					
Median	80.5	84	79	66	73
Range	25–99	54–96	50–93	25–99	66–79
Scottish Index of Multiple Deprivation 2012 ranking <sup>c</sup>					
Median	4348	4359	4298	4652	3760
Range	45–6492	45–6492	261–6492	241–6448	1324–6343
No. of physical therapist contacts					
Median	5	6	5	5	4
Range	1–14	1–14	1–13	2–11	2–7
Length of treatment (d)					
Median	53	53.5	51	53	49
Range	7–210	7–210	8–197	14–173	14–73

<sup>a</sup>General surgical = recent abdominal surgery; musculoskeletal = conditions and injuries involving muscles, joints, or soft tissues of lower limbs but no recent fracture or joint replacement; neurological = stroke, multiple sclerosis, Parkinson disease, or myopathy;

orthopedic = recent lower limb, pelvic, or lumbar vertebral fractures or surgical replacement of lower limb joints.

<sup>b</sup>Chi-square test *P* value for binary data and Kruskal-Wallis test *P* value for continuous data.

<sup>c</sup>Ranking of small geographical areas of Scotland from 1 (most deprived) to 6505 (least deprived).

**Table 3.**

LSA Score at Initial Assessment and Change in LSA Score Over Treatment by Study

Cohort<sup>a</sup>

Parameter	Overall	Cohort <sup>b</sup>			<i>P</i>
		OP	DNH	DH	
LSA score at assessment					
No.	276	90	90	96	
Median	20	30.5	18	12	<.001 <sup>c</sup>
Range	4–92	6–92	4–63	4–71	
Change in LSA score over treatment					
No.	232	74	77	81	
Mean	10.5	5.2	8.8	17.0	<.001 <sup>d</sup>
SD	17.5	15.3	16.0	18.9	

<sup>a</sup>LSA = Life-Space Assessment.<sup>b</sup>DH = domiciliary, recent hospital discharge; DNH = domiciliary, nonhospitalized; OP = outpatient.<sup>c</sup>Kruskal-Wallis test.<sup>d</sup>Analysis of variance.

**Table 4.**

Correlations Between LSA Score and POMA1 Score at Initial Assessment and LSA Change Score and POMA1 Change Score Over Treatment<sup>a</sup>

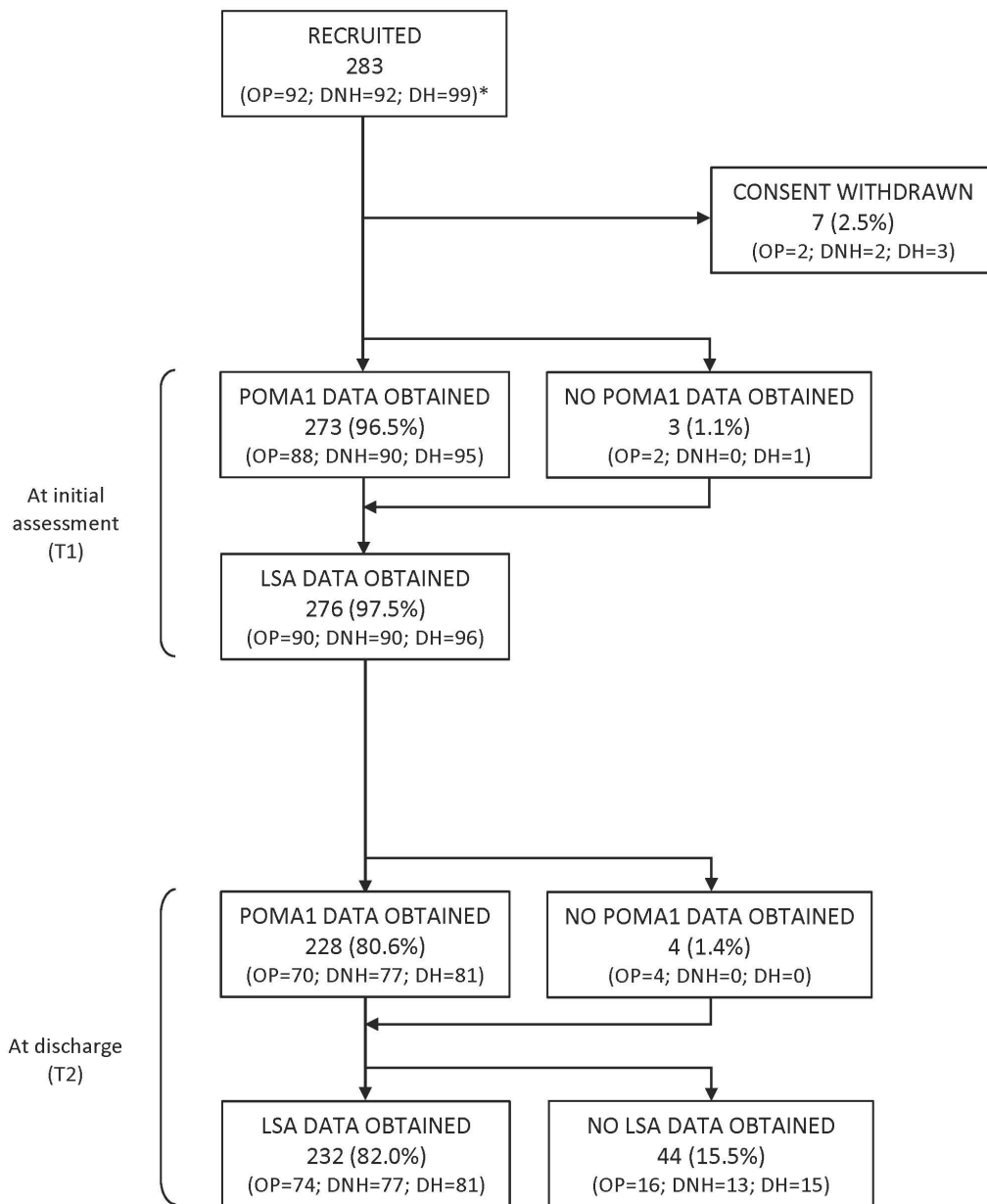
Parameter	Overall	Cohort <sup>b</sup>		
		OP	DNH	DH
LSA score and POMA1 score at assessment				
No.	273	88	90	95
Kendall tau-b	0.37	0.41	0.21	0.33
<i>P</i>	<.001	<.001	.01	<.001
LSA change score and POMA1 change score over treatment				
No.	228	70	77	81
Kendall tau-b	0.27	0.14	0.15	0.32
<i>P</i>	<.001	.11	.07	<.001

<sup>a</sup>LSA = Life-Space Assessment; POMA1 = Performance-Oriented Mobility Assessment.

<sup>b</sup>DH = domiciliary, recent hospital discharge; DNH = domiciliary, nonhospitalized; OP = outpatient.

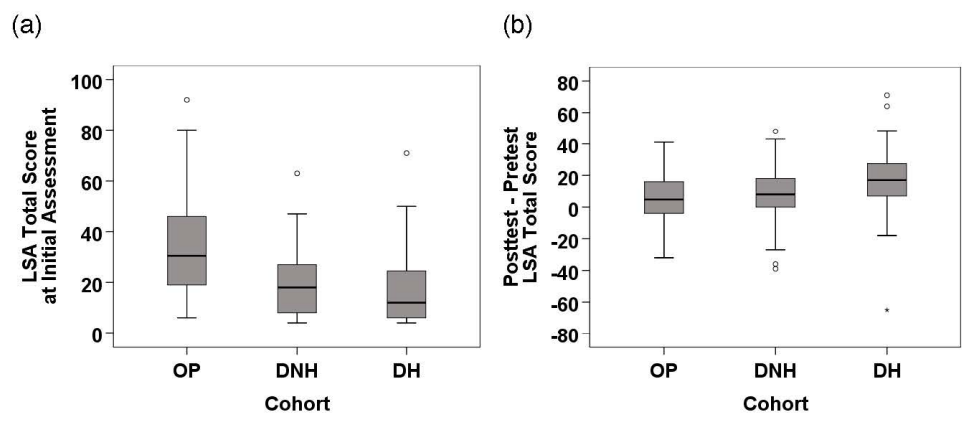
**Figure 1.**

Participant flow diagram. \*Cohorts: DH = domiciliary, recent hospital discharge; DNH = domiciliary, nonhospitalized; LSA = Life-Space Assessment; OP = outpatient; POMA1 = Performance-Oriented Mobility Assessment.



**Figure 2.**

Box plots of Life-Space Assessment (LSA) score at assessment (a) and LSA score change over treatment (b) by cohort. DH = domiciliary, recent hospital discharge; DNH = domiciliary, nonhospitalized; OP = outpatient.



**Appendix.**  
Life-Space Assessment<sup>a</sup>

UAB Study of Aging Life-Space Assessment<sup>b</sup>

Name:	Date:
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**These questions refer to your activities just within the past month.**

LIFE-SPACE LEVEL	FREQUENCY						INDEPENDENCE	SCORE
<b>During the past four weeks, have you been to . . .</b>	<b>How often did you get there?</b>						<b>Did you use aids or equipment? Did you need help from another person?</b>	Level X Frequency X Independence
<i>Life-Space Level 1. . .</i> <b>Other rooms of your home besides the room where you sleep?</b>	Ye s  1	No  0	Less than 1/w eek  1	1-3 times /wee k  2	4-6 times /wee k  3	Dail y  4	1 = personal assistance 1.5 = equipment only 2 = no equipment or personal assistance	
<i>Score</i>	_____ × _____ × _____ =							<i>Level 1 Score</i>
<i>Life-Space Level 2. . .</i> <b>An area outside your home such as your porch, deck or patio, hallway (of an apartment building), or garage, in your own yard or driveway?</b>	Ye s  2	No  0	Less than 1/w eek  1	1-3 times /wee k  2	4-6 times /wee k  3	Dail y  4	1 = personal assistance 1.5 = equipment only 2 = no equipment or personal assistance	

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<b>Score</b>	_____ × _____ × _____ =						<u>Level 2 Score</u>
<i>Life-Space Level 3. . .</i> <b>Places in your neighborhood, other than your own yard or apartment building?</b>	Yes 3	No 0	Less than 1/week 1	1-3 times/week 2	4-6 times/week 3	Daily 4	1 = personal assistance 1.5 = equipment only 2 = no equipment or personal assistance
<b>Score</b>	_____ × _____ × _____ =						<u>Level 3 Score</u>
<i>Life-Space Level 4. . .</i> <b>Places outside your neighborhood, but within your town?</b>	Yes 4	No 0	Less than 1/week 1	1-3 times/week 2	4-6 times/week 3	Daily 4	1 = personal assistance 1.5 = equipment only 2 = no equipment or personal assistance
<b>Score</b>	_____ × _____ × _____ =						<u>Level 4 Score</u>
<i>Life-Space Level 5. . .</i> <b>Places outside your town?</b>	Yes 5	No 0	Less than 1/week 1	1-3 times/week 2	4-6 times/week 3	Daily 4	1 = personal assistance 1.5 = equipment only 2 = no equipment or personal assistance
<b>Score</b>	_____ × _____ × _____ =						<u>Level 5 Score</u>
<b>TOTAL SCORE (ADD)</b>							<u>Sum of Levels</u>

<sup>a</sup>Reprinted with permission from Peel C, Sawyer Baker P, Roth DL, Brown CJ, Brodner EV, Allman RM. Assessing mobility in older adults: the UAB study of Aging Life-Space Assessment. *Phys Ther.* 2005;85:1008-1019.

<sup>b</sup>UAB = University of Alabama at Birmingham.