A Novel Longshi Scale Measured Activity of Daily Living Disability in Elderly Patients Affected by Neurological Diseases: a Multi-center Cohort Study in China

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Abstract

Background: The activity of daily life (ADL) ability is often impaired in the elderly patients with neurological diseases. Barthel index (BI) is a global disability scale which can assess the performance of ADL for old people. The Longshi scale is a novel pictorial-based scale for evaluating a patient's disability, but few studies assess the elderly patients. Hence, the aim of this study was to determine whether Longshi scale can distinguish the ADL level of the elderly people and investigate the relationship between the Longshi scale and BI in measuring ADL among the elderly disabled.

Methods: This was a multi-center cross-sectional study of elderly disabled patients (more than 65 years old). The ADL levels of all patients were evaluated by both Longshi scale and BI. Patients were divided into three groups (Bedridden group, Domestic group, Community group) based on the Longshi scale, while there were four groups (slight dependence, moderate dependence, severe dependence, total dependence) according to different BI scores. The relationship between the scores of Longshi scale and BI at different level were analysed.

Results: A total of 2438 consecutive patients were recruited into the study from 9 centers during a period of 6 months (from 1 Oct 2019 to 1 April 2020). There was a significant difference of the total BI scores between the three groups of Longshi scale ($p < 0.001$). Moreover, the Longshi scale scores showed significant differences between the four BI groups in the bedridden group, domestic group and community group of Longshi scale ($p < 0.001$), respectively. Furthermore, the Spearman correlation coefficients between the LS scores of three groups (bedridden, domestic and community group) and BI scores were 0.869, 0.848 and 0.828 ($P < 0.001$, respectively).

Conclusions: Longshi scale can efficiently distinguish the degree of ability of daily living activities among the elderly disabled and has positive correlations with the BI.

Background

According to statistics, at the end of 2019, the total population of mainland China was 1400 million, of which more than 250 million people were over 60 years old, accounting for about 18.1% of the population[1]. However, the elderly people often have declined structural and physiological function, which may damage the ability to perform activity of daily living (ADL)[2]. More seriously, the elderly patients who loss of ADL ability often have poor quality of life and increased medical economic burthen on family and healthcare system[3–6]. Therefore, it is important to evaluate the ADL disability in both clinical practice and social security system for elderly people[7–9].

Since Katz [10] and others proposed the Activities of Daily Living as a concept to evaluate the health and functional status of the elderly, this view has gradually been adopted. Several instruments have been used to evaluate the ADL of the elderly. Barthel index (BI) is a globally instruments to measure the ADLs, and has been recommended by the Royal College of Physicians for routine use in the assessment of older people[11, 12]. The index is an ordinal scale comprising 10 activities of daily living. The original BI was scored in steps of five points to give a maximum total score of 100. Functional Independence Measure is also validated for the elderly[13]. It is composed of 18 items, with a total score ranging from 18 to 126. But the assessment requires

professional training and is time-consuming. Functional Independence and Difficulty Scale is a Japanese ADL instrument with 14 items, but it's validated in Japanese population[14].

The Longshi scale (LS) was developed as a novel pictorial-based measure to assess disability with neuromuscular and musculoskeletal conditions[15]. The subjects were first evaluated whether patient belonged to bedridden group, domestic group or community group (Fig. 1). Then the patient was further evaluated through a specific form for the three groups (Fig. 2). Each form consists of 3 items. Each item was assessed using three pictures, corresponding to a three-point likert-type scale with 1 for maximum to fully dependent, 2 for partially independent, and 3 for maximum to fully independent. However, the Longshi scale has not been documented for older people, especially the elderly disabled with medical conditions.

The aim of this research was to verify whether Longshi scale can distinguish the level of ADL in the elderly disabled and to compare the relationship between Longshi scale and Barthel index in measuring disability among elderly patients affected by neurological disease.

Methods

Design, participants and ethics

All the elderly patients were assessed with both Longshi scale and Barthel index by 23 rehabilitation therapists from nine hospitals of Yunnan Province, Chengdu, Shanghai and Shenzhen et al. All participants completed the written informed consents and reserved the right to withdraw at any time. The present study acquired the ethical approval from the Ethics Committee of Shenzhen Second People's Hospital.

The inclusion criteria were subjects who were age ≥ 65 years, diagnosed with neurological diseases including stroke (cerebral infarction and hemorrhage), brain trauma, brain tumor, spinal injury and other disorders leading to functional disabilities. The exclusion criteria were patients unable to understand the images displayed by the Longshi Scale and reject to sign the informed consents.

The procedures of Longshi Scale evaluation were shown in Fig. 2. Participants were first assessed and classified into bedridden, domestic, or community group based on the flow chart (Fig. 2). The subjects of the above three groups were further evaluated through a specific form (Fig. 2).

The overall research process was showed in Fig. 3. There were 2438 consecutive patients diagnosed with functional disabilities were recruited into the study. The ADL level was assessed by 23 raters with proper training before the study. Firstly, Longshi scale was used for ADL assessment. The Longshi Scale contained 3 groups as previously described. Each group consist of 3 items on a three-point Likert-type scale that add up to a total score (minimum independence equal to 3 and maximum independence equal to 9)[15]. Each patient accepted an ADL assessment of Longshi scale, and then was divided into an abovementioned group (bedridden, domestic, and community group) (Fig. 3). Secondly, Barthel index was used for ADL assessment in bedridden/domestic/community groups respectively. The Barthel Index[16] measures the individual's performance of 10 ADL functions. The values assigned to each item in the BI are based on the amount of physical assistance required to perform the task. The BI increments are in steps of 5 points (Table 1). The total scores range from 0 to 100. Most items have a maximum of 10 points, scoring 0 for inability to perform the

task, 5 if any assistance is required, and 10 for total independence. The 2 items that have a maximum of 5 points are scored 0 for both inability and need any assistance, while 5 points for complete independence. On the other hand, the 2 items that have a maximum of 15 points are scored 0 for inability, 5 or 10 points for assistance and 15 points for full independence. The interview method was applied to perform the assessment of Longshi scale and Barthel Index in the current study.

Table 1
Bather Index scores.

Items	Unable to perform task	Needs assistance	Fully independent
Feeding	0	5	10
Bathing self	0	0	5
Personal hygiene	0	0	5
Dressing	0	5	10
Bowel control	0	5	10
Bladder control	0	5	10
Toilet	0	5	10
Chair/bed transfers	0	5–10	15
Ambulation	0	5–10	15
Wheelchair※	0	0	5
Stair climbing	0	5	10
Range	0		100
※Score only if unable to walk.			
A total BI score of 0–20 suggests total dependence, 21–60 severe dependence, 61–90 moderate dependence and 91–100 slight dependence. A score of 100 indicates that the patient is independent of assistance from others in this study.			

Data Collection

The demographic and clinical characteristics of participants were collected from the medical records. The assessment scores data of Longshi Scale and Barthel Index were gathered by a chief rater. When the evaluation completed, the study coordinators reviewed all materials collected. Missing information of the record was excluded.

Data analysis

All clinical and demographic variables of patients were performed with descriptive analyses. Mean (standard deviation [SD]) were provided for continuous variables, while frequencies (proportions) for categorical variables. Comparisons of BI scores between the three groups of LS were made using one-way ANOVA. The differences of Longshi Scale scores based on the groups of Barthel index were also analysed with one-way ANOVA. Furthermore, Spearman correlation analyses were used to evaluate the relationships between the LS scores and the BI scores. All data were analyzed in the Statistical Package for the Social Sciences (SPSS), version 21.0. Statistical significance was set at 0.05, and all tests were two tailed.

Results

Table 2 showed the baseline characteristics of the 2438 patients over 65 years old enrolled in the study from 2019/10/01 to 2020/04/01. The number of subjects in the 3 categories (bedridden, domestic, and community group) was 959, 644 and 835, respectively. More details of the three groups were shown in Table 2.

Table 2
Demographic and clinical characteristics of patients stratified by Longshi Scale.

Variables	Bedridden group(n = 959)	Domestic group(n = 644)	Community group(n = 835)	Total(n = 2438)
Female, n(%)	475(49.5)	299(46.4)	421(50.4)	1195(49.0)
Age (Mean $\pm$ SD)	78.40 $\pm$ 8.10	75.55 $\pm$ 7.09	71.78 $\pm$ 5.75	75.38 $\pm$ 7.64
Profession				
civil servant, n(%)	91(9.5)	57(8.9)	38(4.6)	186(7.6)
Worker, n(%)	354(36.9)	141(21.9)	150(18.0)	645(26.5)
Farmer, n(%)	232(24.2)	308(47.8)	546(65.4)	1086(44.5)
Others, n(%)	282(29.4)	138(21.4)	101(12.1)	521(21.3)
Marital status				
Single, n(%)	3(0.3)	7(1.1)	3(0.4)	13(0.5)
Married, n(%)	792(82.6)	565(87.7)	795(95.2)	2152(88.3)
Divorced, n(%)	8(0.8)	3(0.5)	5(0.6)	16(0.7)
Widowed, n(%)	156(16.3)	69(10.7)	32(3.8)	257(10.5)
Educational level				
Primary School or Below, n(%)	331(34.5)	346(53.7)	588(70.4)	1265(51.9)
Middle school, n(%)	245(25.5)	117(18.2)	122(14.6)	484(19.9)
High school	248(25.9)	100(15.5)	71(8.5)	419(17.2)
College or above, n(%)	99(10.3)	62(9.6)	42(5.0)	203(8.4)
Others, n(%)	36(3.8)	19(3.0)	12(1.4)	67(2.7)
Family income				
< 50,000 yuan, n(%)	265(27.6)	313(48.6)	528(63.2)	1106(45.4)
50000–100000 yuan, n(%)	332(34.6)	171(26.6)	188(22.5)	691(28.3)
100000–150000 yuan, n(%)	237(24.7)	111(17.2)	77(9.2)	425(17.4)
150000–200000 yuan, n(%)	70(7.3)	32(5.0)	26(3.1)	128(5.3)
> 200000 yuan, n (%)	55(5.7)	17(2.6)	16(1.9)	88(3.6)
Diagnosis				
Cerebral hemorrhage, n(%)	139(14.5)	41(6.4)	10(1.2)	190(7.8)
Cerebral infarction, n(%)	556(58.0)	309(48.0)	176(21.1)	1041(42.7)

Variables	Bedridden group(n = 959)	Domestic group(n = 644)	Community group(n = 835)	Total(n = 2438)
Spinal and osteoarticular diseases, n(%)	102(10.6)	183(28.4)	488(58.4)	773(31.7)
Others, n(%)	162(16.9)	111(17.2)	161(19.3)	434(17.8)
Hypertension, n(%)	660(68.8)	356(55.3)	660(79.0)	1274(52.3)
Diabetes, n(%)	260(27.1)	116(18.0)	100(12.0)	476(19.5)
Hyperlipidemia, n(%)	61(6.4)	30(4.7)	40(4.8)	131(5.4)
Heart disease, n(%)	277(28.9)	106(16.5)	85(10.2)	468(19.2)

As shown in Fig. 4, there was a significant difference between the Barthel Index scores based on the groups of Longshi Scale ($P < 0.001$, Table 3). Patients of community group had the highest mean BI total scores (95.01, SD = 8.16), while those of bedridden group had the lowest (19.99, SD = 19.32).

Table 3
The differences of Barthel index scores based on groups of Longshi Scale.

Groups of longshi Scale	Barthel index scores (mean $\pm$ SD)	F-value	P-value
Bedridden	19.99 $\pm$ 19.32	5032.94	< 0.001
Domestic	71.86 $\pm$ 18.81		
Community	95.01 $\pm$ 8.16		

In the Table 4, the Longshi scale scores showed significant differences between the BI groups (slight dependence, moderate dependence, severe dependence, and total dependence) in the bedridden group ($P < 0.001$), with lower scores in the BI total dependence groups (Fig. 5a). In domestic group, the highest mean scores of the Longshi scale were seen in the slight dependence group of BI (Fig. 5b). Significant differences of the Longshi scores were observed in domestic group ($P < 0.001$, Table 4). The scores of Longshi scale in community group were increased from severe dependence group to slight dependence group (Fig. 5c). There was a significant difference among them in the community group ($P < 0.001$).

Table 4
The differences of Longshi Scale scores based on the groups of Barthel index.

Groups of Longshi Scale scores	Groups of Barthel index				F-value	P-value
	slight dependence(n = 681)	moderate dependence(n = 604)	severe dependence(n = 601)	total dependence(n = 552)		
Bedridden, n(%)	2(0.3)	19(3.1)	391(65.1)	547(99.1)		
Scores (mean ± SD)	9.00 ± 0.00	7.00 ± 1.70	7.06 ± 1.20	4.06 ± 1.24	465.90	< 0.001
Domestic, n(%)	89(13.1)	352(58.3)	198(32.9)	5(0.9)		
Scores (mean ± SD)	7.88 ± 1.01	6.26 ± 1.44	3.89 ± 0.88	3.00 ± 0.00	267.84	< 0.001
Community, n(%)	590(86.6)	233(38.6)	12(2.0)	0(0)		
Scores (mean ± SD)	8.69 ± 0.82	6.48 ± 1.20	4.67 ± 1.50	-	522.26	< 0.001

The Spearman correlation coefficients between the LS scores of three groups (bedridden, domestic and community group) and BI scores were 0.869, 0.848 and 0.828. The Longshi scale scores of three groups were all positively correlated with the BI scores, respectively (P < 0.001, Table 5).

Table 5
The correlations between Longshi Scale scores and Barthel Index scores.

Groups of Longshi Scale	Longshi Scale scores (mean ± SD)	Barthel Index scores (mean ± SD)	correlation coefficient	P-value
Bedridden	5.35 ± 1.93	19.99 ± 19.32	0.869	< 0.001
Domestic	5.73 ± 1.84	71.86 ± 18.81	0.848	< 0.001
Community	8.02 ± 1.43	95.01 ± 8.16	0.828	< 0.001

Discussion

The results suggest that the Longshi Scale was a novel pictorial scale of ADL in efficiently distinguishing the degree of daily living activities ability of the elderly disabled. Data also demonstrated that this Longshi Scale had a positive correlation with Barthel Index in assessing the functional disability among the older patients.

In current study, we analyzed the BI scores based on the groups of LS. Patients of community group had the highest mean BI total scores (95.01, SD = 8.16), while those of bedridden group had the lowest (19.99, SD = 19.32). There was a significant difference of the BI scores between the three groups of LS ($P < 0.001$, Table 3). As shown in Table 3, participants classified to the bedridden group were associated with lower BI scores, indicating more severe functional loss, whereas patients in the community group had higher BI scores, representing minor functional loss. The finding revealed that the performance of ADL in the three groups of LS was significantly different. The ADL of three LS groups gradually improved as the BI scores increased. Our finding is consistent with previous researches [17, 18] that the ability of ADL in elderly patients is positively related to their scope of activity. It indicated that the categorization and scoring system of Longshi Scale make it easier to assess and understand the elderly patient's function status.

Meanwhile, patients were further divided into 4 groups based on the normalized BI scores: slight dependence group (91–100), moderate dependence group (61–90), severe dependence group (21–60), total dependence group (0–20). In present study, the LS scores of three separated groups showed significant differences between the 4 BI subgroups (slight dependence, moderate dependence, severe dependence, and total dependence), respectively ($P < 0.001$). The scores of three LS groups had gradually increased from total dependence group to slight dependence group. It showed that each LS group with the picture-based items can reflect the differences of ADL among older patients, which might be superior to those word-based scales especially for elderly patients [19–21]. Therefore, the results indicated the LS score can distinguish the ADL level of the elderly disabled in three functional groups (bedridden, domestic, and community group) respectively.

The Spearman correlation coefficients between the LS scores of three groups (bedridden, domestic and community group) and BI scores were 0.869, 0.848 and 0.828 ($P < 0.001$, respectively). The results revealed that there were strong positive correlations between the Longshi Scale and Barthel Index in all three groups, which indicated Longshi Scale can effectively reflect the ADL ability in elderly patients and has good validity among elderly disabled. The strength may facilitate the application of Longshi scale in future research.

Though hospitalized elderly patients may be suffering from a severe acute or chronic condition or infectious disease [22, 23], it is noteworthy that the assessment of Longshi scale for the community-dwelling elders who may have an undiagnosed chronic illness or disability is of great importance [24, 25]. Indeed, elders from either group may be at great risk of having a low level of self-care agency, which can have a profound effect on their quality of life [26, 27]. The LS measure might be useful for evaluating their level of self-care agency that may indicate a need for intervention [28]. The Longshi-scale has potential applicability at various phases of the nursing process. It can be used to assess the Chinese elder's ability to perform self-care activities to promote their health, whether health conditions exist or not.

Previous studies showed that the Longshi Scale was a simple, reliable and scientific ADL tool, which can be used by different groups of people such as medical and non-medical professionals as well as patients [15, 29]. Moreover, to deal with an aging society, it is necessary to establish a long-term care service system, medical security system to formulate relevant policies and meet the basic life demand of the elderly [30]. Hence, this pictorial-based Longshi scale would be of great significance especially for the elderly disabled with complications. Through the quick and effective assessment of ADL, the elderly can enjoy appropriate and

effective care, and further save the cost of care, reduce the pressure on elderly care services[31, 32]. Therefore, it would be benefit to improve the rehabilitation treatment, guide continuity of care and ensure adequate social support and disability benefits for the elderly patients[27].

There are several limitations of this study. This was a cross-sectional cohort study without examining the longitudinal change of the LS scores of the elderly disabled. Therefore, the sensitivity to change of the LS was not examined. The assessment of the LS item scores of the elderly disable patients was assumed to be accurate and reliable, though interrater reliability testing had not been performed in the present study. Despite of the above limitations, this is the first study to examine the ability of Longshi scores to distinguish the level of the disability among the elderly disabled after careful data examination in defining the favorable outcome of elderly disabled. It is a multicenter study including different ethnic groups, locations and broader training level of evaluators.

Conclusions

In conclusion, our findings indicated that the pictorial-based Longshi scale can efficiently distinguish the level of ADL in elderly patients. This scale shows great potential to promote the design of rehabilitation programs, continuity of care, and the application of disability benefits for the elderly patients. In the future, more longitudinal studied of Longshi scale should be conducted to evaluate the ADL changes of elderly patients.

Abbreviations

ADL: Activity of daily living, LS: Longshi scale, BI: Barthel Index, SD: standard deviation, SPSS: Statistical Package for the Social Sciences

Declarations

Ethics approval and consent to participate

The study acquired the ethical approval from the Ethics Committee of Shenzhen Second People's Hospital. Written informed consent was obtained from all participants.

Consent to publish

All authors consent to publish the paper.

Availability of data and materials

The datasets used during the current study are available from the author Dr. Jingpu Zhao on reasonable request.

Competing interests

The authors declare no competing interests.

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Authors' Contributions

JZ and YW contributed to the conception and design of the study, accomplished the surveys and edited the manuscript. JZ, LW and YG contributed to the statistical analyses and drafted the tables and Figs. MH and XL contributed to acquisition, analysis and interpretation of data. FZ, JL and DL reviewed and revised the manuscript. All authors read and approved the final manuscript.

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Figures

龙氏日常生活能力评定量表 Longshi scale for assessing the activities of daily living

姓名: (Name) 性别: (Sex) 年龄: (Age) 联系方式: (Contact Information) 诊断: (Diagnosis)

人群 Group	评定内容 (Evaluation Contents)	得分 Score	
床上人 Bedridden Group	大小便控制 (Bladder and bowel Management) 1分	2分	3分
	进食 (Feeding) 1分	2分	3分
	娱乐 (Entertainment) 1分	2分	3分
家庭人 Domestic Group	如厕 (Toileting) 1分	2分	3分
	个人清洁 (Grooming and bathing) 1分	2分	3分
	家务 (Housework) 1分	2分	3分
社会人 Community Group	小区锻炼 (Community mobility) 1分	2分	3分
	购物 (Shopping) 1分	2分	3分
	活动参与 (Social Participation) 1分	2分	3分
评分结果 Results	床上Bedridden ☐ 家庭Domestic ☐ 社区Community ☐	总分Total Score <input type="text"/>	
Evaluator: <input type="text"/>		Date: <input type="text"/>	

Figure 1

Longshi scale for assessing the activities of daily living.

龙氏日常生活能力评定量表 Longshi scale for assessing the activities of daily living

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Figure 1

Longshi scale for assessing the activities of daily living.

Figure 2

Flow chart of assessment using Longshi scale.

Figure 2

Flow chart of assessment using Longshi scale.

Figure 3

Overall approach for statistical analysis between Longshi scale scores and BI scores at different level.

Figure 3

Overall approach for statistical analysis between Longshi scale scores and BI scores at different level.

Figure 4

The differences of Barthel index scores based on groups of Longshi Scale.

Figure 4

The differences of Barthel index scores based on groups of Longshi Scale.

Figure 5

The differences of Barthel index scores based on groups of Longshi Scale.

Figure 5

Differences of Longshi Scale scores in Bedridden group(5a), domestic group (5b) and community group(5c) based on groups of BI. BI-1: slight dependence, BI-2: moderate dependence, BI-3: severe dependence, BI-4: total dependence.

Figure 6

Differences of Longshi Scale scores in Bedridden group(5a), domestic group (5b) and community group(5c) based on groups of BI. BI-1: slight dependence, BI-2: moderate dependence, BI-3: severe dependence, BI-4: total dependence.

Figure 6

Differences of Longshi Scale scores in Bedridden group(5a), domestic group (5b) and community group(5c) based on groups of BI. BI-1: slight dependence, BI-2: moderate dependence, BI-3: severe dependence, BI-4: total dependence.