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Katz index of activities of daily living in assessing functional status of older people: Reliability and validity of Sinhala version

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ABSTRACT

Purpose: This study evaluated the reliability and validity of the Sinhala version of Katz index of activities of daily living (ADL) in assessing the functional status of older people aged >65 years.
Materials and methods: The Katz index was translated to Sinhala, cross-culturally adapted and administered in two stages. In stage 01, 200 patients aged ≥65 years, selected randomly from out-patient medical clinics, were asked to fill the Sinhala version of Katz index along with the Sinhala version of the 10-item Barthel index (BI). The Katz index was re-administered after two weeks among a subgroup of 45 patients selected randomly. In stage 02, Katz index was administered among randomly selected 200 community dwelling older people, aged ≥65 years. In addition, performance-based physical functions [gait speed (GS) and short physical performance battery (SPPB)] were also measured.
Results: The analysis of stage 01 data showed internal consistency measured with Cronbach's alpha of 0.82 and test-retest reliability evaluated with intra-class correlation (ICC) (95% CI) of 0.94 (0.89–0.96) ($p < 0.001$). Exploratory Factor Analysis with the Principal Component Analysis revealed the presence of two factors with Eigen value exceeding 01, explaining 75.9% of cumulative variance. Further, the Sinhala version of Katz index total score showed a strong correlation with the BI total score ($r = 0.91$, $p < 0.001$) indicating strong concurrent validity. The stage 02 data revealed that older people with poor perception of general health status had lower mean (SD) Katz index score (3.58 ± 1.82) compared to those with good perception of health (5.56 ± 0.79) ($p < 0.001$). Similarly older people with prevalent diseases had comparatively lower scores of Katz index, compared to those without, indicating the known group validity ($p < 0.05$). Further, moderate correlations between the Katz index and performance based physical functions were observed showing the agreement (with GS – r; −0.26, $p < 0.001$, with SPPB – r; 0.31, $p < 0.001$).
Conclusions: We conclude that the Sinhala version of Katz index has satisfactory psychometric properties and it is a reliable and valid tool to assess the functional status of Sinhala conversant older people in Sri Lanka.

1. Introduction

Old age is characterized by the emergence of a multitude of complex health states that do not necessarily fall into discrete disease categories. These include frailty, urinary and bowel incontinence, recurrent falls, delirium and pressure ulcers [1]. They have multifactorial etiology and lead to the impairment of functional status and quality of life [2]. In corollary, the recent impairment of functional status or quality of life can be the first indication of the onset of these conditions. Therefore, the determination of functional status is an integral component of comprehensive geriatric assessment.

Functional status, particularly in older adults, is a key determinant of overall health and it reflects the ability of an individual to perform physical and social tasks necessary for self-care and daily activities [3]. Functional status of an individual is determined by three levels of activities; basic activities of daily living (BADLs), instrumental activities of daily living (IADLs) and advanced activities of daily living (AADLs) [4].

The Katz ADL index developed by Katz et al. in 1960s is widely used to assess BADL of older people in clinical settings and for research purposes [3]. The Katz ADL index measures the self-care tasks which include bathing, dressing, toileting, transferring to and from a chair, maintaining continence and feeding. Answers are given in a dichotomous manner - yes or no for

Abbrevations: ADL, Activities of daily living; BI, Barthel index; GS, Gait speed; SPPB, Short physical performance battery; ICC, Intra-class correlation; BADL, Basic activities of daily living; IADL, Instrumental activities of daily living; AADL, Advanced activities of daily living; THK, Teaching Hospital, Karapitiya; SPSS, Statistical Package of Social Sciences; FA, Factor Analysis; PCA, Principal Component Analysis; KMO, Kaiser-Meyer-Olkin.

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each task. The scores indicate the levels of functional impairments; total score of 6 - full function, 3 to 5 - moderate functional impairment, and 2 or less - severe functional impairment [3].

Despite the recommendations and wide use [5–8], the Katz index has not been validated among the local population in Sri Lanka depriving clinicians and researchers the access to a simple and valid tool in assessing patients. The index has demonstrated high internal consistency (Cronbach's alphas: 0.84–0.94) among Dutch, Turkish and Moroccans living in the Netherlands [9] while other studies have shown cross-cultural validity of the scale in different ethnic groups [10,11–13].

Sri Lankan older population currently represents 12.4% of the country's total population and this proportion is predicted to reach 24.8% by the year 2041 [14]. The percentage of older people in Sri Lanka will be the highest in South East Asia and the third highest in entire Asia, after Japan and Singapore [15]. Despite having a sizable population of older people, geriatric care services in Sri Lanka are not well established. Older people have to share inward and outpatient care services with young adults and no adequate attention is paid to the assessment of their functional capacity and physical dependence during routine clinical evaluation. High patients turn over, overcrowding of health care facilities and the lack of geriatric training are the main barriers in providing adequate care for these patients.

Furthermore, the lack of tools and questionnaires which are culturally adapted and validated in the local population is also a limitation. In Sri Lanka, although the Barthel index (BI) [16] has been validated previously [17], one questionnaire is not sufficient to capture the wide spectrum of physical functions of older people. The current study was, therefore, done to assess the reliability and validity of the Katz ADL index Sinhala version to provide an additional tool to assess physical functions for clinicians and researchers in the field of care of older people in Sri Lanka.

2. Materials and methods

2.1. Study design

This validation study was done between January and December 2021 as a cross-sectional study. It includes cross-cultural adaptation and evaluation of psychometric properties. Evaluation of psychometric properties was done in two stages. The adapted Katz index was administered among 200 older people selected from routine medical clinics in the stage 01 and among 200 community-dwelling older people in the stage 02.

2.2. Cross-cultural adaptation of Katz index

For the cross-cultural adaptation of the Sinhala version of Katz index, standard guidelines described by Beaton et al. [18] were followed. The original English version was translated (forward translation) to Sinhala language by two independent translators; a health professional and a lay person, both fluent in Sinhala and English languages. One translator was informed of the purpose of translation while the other was not informed. The two versions were consolidated into one to maximize the clarity of items. The synthesized translation was back translated (backward translation) to the English language by two separate independent persons, fluent in both Sinhala and English languages, to assess the comparability with the original version and to make sure that there were no gross inconsistencies or conceptual errors. A group of experts including a geriatrician, two physicians, two nursing academics, and forward and backward translators independently reviewed all the versions and decided on the pre-final Sinhala version. They ensured semantic equivalence, idiomatic equivalence, experiential equivalence and conceptual equivalence with the original version and finally the content validity was ensured while producing a pre-final version.

The pre-final version was further assessed for clarity, understandability, naturalness of items and time taken to complete the questionnaire in a focus group discussion with six older people who were admitted to the medical wards of Teaching Hospital, Karapitiya (THK) and the final version was decided. This version was piloted among 20 older people admitted to the medical wards of the same hospital.

2.3. Administration of Sinhala version of Katz index

In stage 01, 200 regular attendees from out-patient clinics (medical and neurology) of THK, Galle were selected by systematic random sampling method. THK is the premier state-run tertiary care center in the Southern Province of the country. The minimum sample size (90) was decided by multiplying the number of variables in the Katz index (6 items) by 15 [19]. This study was conducted as a part of another main project. In phase 1 of this project, we collected data from 200 older people and all of them were included in this analysis.

All participants answered the Sinhala version of Katz index and the previously validated Sinhala version of BI [17] on the same day. A subgroup of randomly selected 45 subjects filled the Sinhala version of the Katz index two weeks after the first administration under the same conditions.

The BI includes 10 personal activities of mobility and self-care; feeding, personal toileting, bathing, dressing and undressing, getting on and off a toilet, controlling bladder, controlling bowel, moving from wheelchair to bed and returning, walking on level surface (or propelling a wheelchair if unable to walk) and ascending and descending stairs. It evaluates the level of assistance required by an individual on these mobility and self-care of ADL in a three-item ordinal rating scale as, 0 = unable (dependent on help based), 5 = needs help (perform the task with some assistance), 10 = independent (perform the task independently). The levels of dependency are then calculated based on the scores obtained as 0–20 – total dependency, 21–60 – severe dependency, 61–90 - moderate dependency, and 91–100 – slight dependency.

In stage 02, the validated questionnaire was administered among randomly selected 200 community dwelling older people in Southern Sri Lanka to evaluate the level of functional capacity among them. Apart from the validated Katz index, BI, objective measurements of gait speed (GS) and short physical performance battery (SPPB) were also assessed. GS was measured while the subjects walked for an eight-meter distance and the time taken to walk the middle four meters was obtained (meter/s). The initial and final 2 m were excluded from the calculation to eliminate the effects of acceleration and deceleration [20]. This test was repeated twice for each subject and the average of two trials was used. The subjects were asked to stand with the feet together in side by side, semi tandem and tandem positions, time taken to walk 8 ft (2.44 m) and time taken to rise from a chair and return to the seated position five times were assessed in SPPB and relevant scores were given. In this scale, the total score ranges from 0 (worst performance) to 12 (best performance) [21].

2.4. Statistical analysis

Statistical Package for Social Sciences (SPSS) 25.0 version was used for the data analysis and statistical significance was considered as p value <0.05. The basic characteristics of subjects who participated in the evaluation of psychometric properties were presented as frequencies (percentages) or mean (SD). The functional capacity of the older people was evaluated using the guidelines of analyzing the Katz index and BI. Psychometric properties (reliability and validity) were evaluated using the following reliability and validity criteria using the data gathered in stage 01 and 02.

2.4.1. Data from stage 01

The test-retest reliability was examined by intra-class correlation coefficient (ICC) comparing the overall scores of Katz index of two consecutive administrations [22]. Internal consistency was assessed with Cronbach's alpha for overall and an alpha value equal or more than 0.7 was regarded acceptable [22]. Construct Validity was evaluated with both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). EFA was performed with the Principal Component Analysis (PCA). It was done keeping the Varimax with Keiser normalization as rotation method to determine whether the latent item structure mirrored the three domains specified in the instrument construction [22]. Correlation matrix and Variance Inflation Factors (VIF) of items was observed for multi-collinearity and further, the

Kaiser-Meyer-Olkin (KMO) and Bartlett's test of Sphericity statistics were also identified. The number of extracted components was determined by the Scree plot, percentage of variance explained by each component and number of Eigen values over 01 (Kaiser-Guttman rule) [22]. Items were considered representative of a component if their individual item loading was ≥0.40 [22]. CFA was evaluated using AMOS 23 software. The root means square error of approximation (RMSEA) and comparative fit index (CFI) were examined. The cut-off values for acceptable model fit used for this study were: RMSEA $^{>}$ 0.06 for a good fit; CFI $^{>}$ 0.90 for an acceptable fit [23]. Path diagram of the model was drawn.

Convergent validity was evaluated by observing the Pearson correlation between each item score and the overall score of Katz index while concurrent validity was evaluated by the Pearson correlation between the overall scores of Katz index and BI [22]. Further, agreement between the Katz index and BI was evaluated by cross tabulating of functional impairment and dependency categories by the Cohen's Kappa value. Further, effect size (Cohen's d) for the total score was calculated [24].

2.4.2. Data from stage 02

The level of functional capacity was evaluated and the Katz index score was compared between people with and without prevalent disease and those with good and poor perception on health to identify the known group validity using the independent sample *t*-test. Apart from that, the agreement between the self-reported Katz index score and the performance-based physical functions measures with GS and SPPB were evaluated with Pearson's correlation coefficient to test the concurrent validity further.

2.5. Ethical clearance

The ethical clearance for the study was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Ruhuna, Sri Lanka [Ref No: 2020.P.122 (22.10.2020)] and written informed consent was obtained from the consented older people prior to administering the questionnaires.

3. Results

3.1. Data from stage 01

Mean (SD) age of the participants was 74.7 (6.5) years. The majority of them were females (63.7%), living with the family (84%), of low-income category (87.4%), recipients of only primary education (57%) and cared by children and grandchildren (57%).

Mean (SD) of Katz index and BI total scores were 4.41(1.89) and 80.86 (25.15), respectively. Based on the Katz index total score, the majority had full function (41%, $n = 82$) while 39% ($n = 78$) had moderate functional impairment and 20% ($n = 40$) had severe functional impairment. According to the BI total score the 46.5% ($n = 93$) were slightly dependent, 33.5% ($n = 67$) were moderately dependent, 13% ($n = 26$) were severely dependent while only 7% ($n = 14$) had total dependency.

3.1.1. Reliability of Katz index

The internal consistency measured with Cronbach's alpha (overall) was 0.82 while the item-total correlations ranged from 0.31 to 0.85 (Table 1). The test re-test reliability evaluated with ICC (95% CI) was 0.82 (0.77–0.85) ($p < 0.001$).

3.1.2. Construct validity of Katz index

Initial analysis suggested multicollinearity <0.5 among the variables while VIF was <3 in all variables. Bartlett's test of Sphericity was significant (KMO measure of sampling adequacy = 0.74, Approx. Chi Square value = 882.24, df = 15, $p < 0.001$). The EFA with PCA revealed the presence of two factors with Eigen value exceeding 1 (Fig. 1), explaining 73.9% of cumulative variance (each factor responsible for 48. 6% and 25.3%). The factor loading was high and ranged from 0.61 to 0.95). Bathing, dressing, toileting and maintaining continence loaded into one factor while transferring and feeding loaded into a separate factor (Table 2).

Table 1
Internal consistency of items (stage 01).

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Bathing	3.63	2.405	0.778	0.943	0.751
Dressing	3.62	2.388	0.813	0.951	0.745
Toileting	3.77	2.409	0.629	0.485	0.783
Transferring	3.76	2.837	0.319	0.223	0.852
Continence	3.73	2.469	0.607	0.512	0.788
Feeding	3.54	2.943	0.452	0.223	0.818

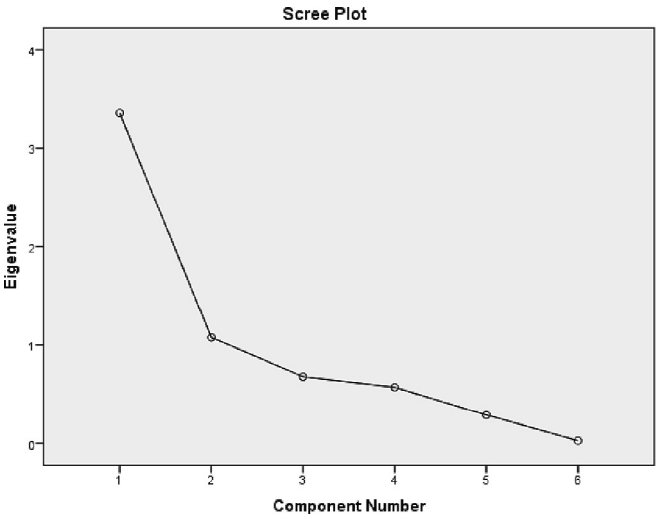

Fig. 1. Scree plot of factor extraction (stage 01).

CFA suggested chi-square goodness-of fit *p* value as 0.45, which indicates that there is no difference between the hypothesized model and the data. The CFI value and RMSEA values were 0.97 and 0.02 respectively indicating the model has a good fit for the data gathered. The drawn path diagram is shown in Fig. 2. *Convergent validity of Katz index.*

The item scores of the Katz index showed strong correlations (r ranged between 0.58 and 0.88, $p < 0.001$) with total Katz index score showing satisfactory convergence between items and the total score.

3.1.3. Concurrent validity of Katz index

Katz index score showed strong correlation with the BI score ($r = 0.96$, $p < 0.001$). Further, agreement between functional status and dependency obtained from Katz index and BI showed a good agreement (Cohen's kappa = 0.70, p < 0.001, SE = 0.04) (Table 3). Effect size was high (Cohen's d = 2.33) indicating higher significance of findings.

3.2. Data from stage 02

Age of the community dwelling older people included in Stage 02 ranged from 65 to 81 years. The mean (SD) Katz index and BI scores were

Table 2
Rotated component matrix of FA (stage 01).

Item	Factor	
	1	2
1. Bathing	0.95	
2. Dressing	0.95	
3. Toileting	0.62	
4. Transferring		0.89
5. Continence	0.79	
6. Feeding		0.68

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

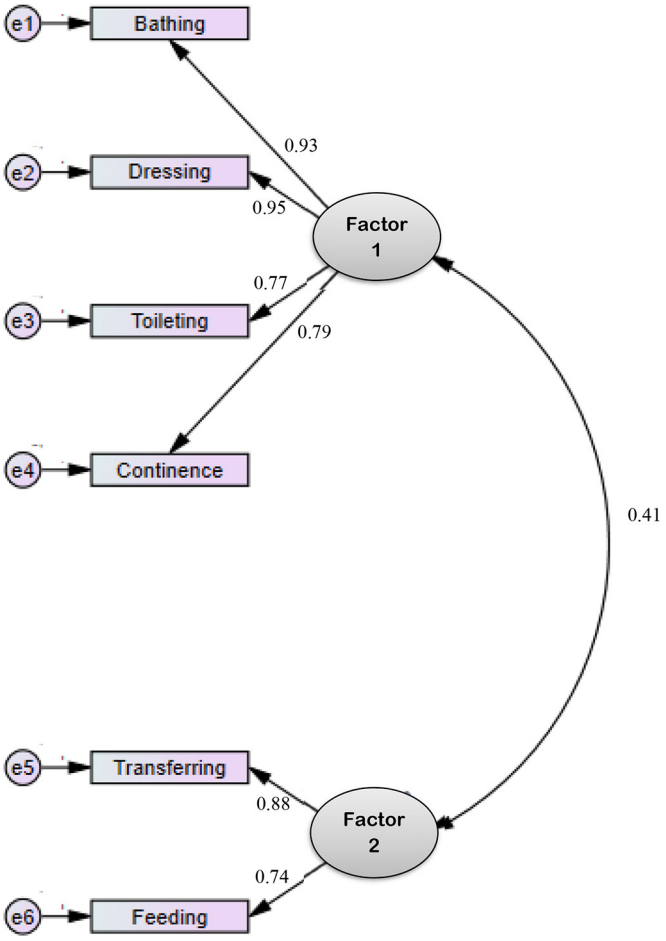

Fig. 2. Path diagram of the model (stage 01).

4.63(1.70) and 77.38(17.29) respectively. The level of functional impairment and physical dependency measured with Katz index and BI are shown in Table 4.

3.2.1. Known group validity of Katz index

Older people with poor perception on general health status had lower mean (SD) Katz index score (3.58 ± 1.82) compared to those with good perception (5.56 ± 0.79) ($p < 0.001$). Further, those with chronic diseases had comparatively lower scores of Katz index compared to those without, indicating the known group validity ($p < 0.05$) (Table 5).

3.2.2. Agreement between Katz index and performance-based physical functions

Moderate correlations between the scores of Katz index and performance based physical functions were also observed showing self-reported and objectively measured physical functions (with GS – r; −0.26, $p < 0.001$, with SPPB – r; 0.31, p < 0.001).

Table 3
Agreement between Katz index (functional impairment) and BI (dependency) (stage 01).

		BI		
		Slightly Dependent	Moderately Dependent	Severely – Totally Dependent
Katz index	Full function	75	07	0
	Moderate Functional Impairment	18	60	0
	Severe Functional Impairment	0	0	40

Cohen's kappa = 0.70, p < 0.001, SE = 0.04.
BI = Barthel index.

Table 4
Level of functional capacity and physical dependence among community dwelling older people (stage 02, $n = 200$).

Katz index	
Level of functional capacity	Frequency (%)
Full function	96 (48%)
Moderate functional impairment	80 (40%)
Severe functional impairment	24 (12%)
Barthel index	
Level of physical dependence	Frequency (%)
Slightly dependent	38 (19%)
Moderately dependent	139 (69.5%)
Severely dependent	23 (11.5%)

4. Discussion

The current study shows that the Sinhala version of the Katz index cross-culturally adapted is a reliable and valid tool and can be used to evaluate the BADL of Sinhala speaking older people in Sri Lanka.

The index was cross-culturally adapted following the standard guidelines widely accepted. During the process, few terms in the index were culturally adapted to suit the local setting. For instance, in the Sri Lankan context, bathing involves a shower or a bowl to pour water over the head rather than a bath tub. This requires them to be either standing or seated. Further, the use of toilet paper is rare and often water is used to clean up after the use of toilet. Furthermore, questions had to be modified to suit the use of fingers rather than fork and spoon while eating. These modifications were well accepted by the study subjects during the process of validation.

In this study, the Sinhala version of Katz ADL demonstrated a high Cronbach's alpha coefficient, test-retest reliability, item-total correlations and convergence between the total score and items. Further, a high agreement between the Katz index and previously validated BI was also seen. During the FA, all six items were retained indicating the relevance of all items in the index. However, the two-factor structure seen in the current study is a major deviation from the original factor structure which showed a single factor structure.

The findings of the current study are concordant with previous validation studies of the Katz index. While the Turkish version of the Katz index has shown Cronbach's α of 0.838 [5], the Netherland version administered to Dutch, Turkish, and Moroccan immigrants in the Netherland was associated with Cronbach's alpha between 0.84 and 0.94 [9]. Spector et al. demonstrated internal consistency ranging from 0.73 to 0.78 for the Katz index in Georgia [25] while Alvarez et al. observed an alpha value of 0.86 in Spain [26].

Even though the two-weeks period is considered a long interval to assess the scale's stability among older people who are prone to sudden changes [26], the index showed high test-retest correlations at two weeks. Similar to the current validation, previous studies also have observed a high test-retest reliability during validation of the Katz index.

Table 5
Comparison of Katz index score in diseased and healthy groups of community dwelling older people (stage 02, n = 200).

Disease condition	Older people with disease Mean (SD)	Older people without disease Mean (SD)	P value
Diabetes mellitus ($n = 97$)	4.16 (1.92)	5.07 (1.33)	<0.001
Musculoskeletal deformity ($n = 10$)	3.00 (0.21)	4.68 (1.71)	0.01
Osteoarthritis ($n = 20$)	3.65 (1.62)	4.74 (1.54)	0.007
Rheumatoid arthritis ($n = 11$)	3.82 (1.16)	4.68 (1.72)	0.03
Malignancy ($n = 20$)	4.52 (1.75)	5.60 (0.59)	0.007
Hypertension ($n = 86$)	4.33 (1.99)	4.86 (1.42)	0.02

These include ICC of 0.999 seen in the Turkish version [5] and 0.94 observed by Alvarez et al. [26].

Similar to the current study, previous studies have shown satisfactory concurrent validity of the Katz index. Strong associations between Katz ADL, BI and physical function (PF) domain of (SF-36 PF) have been demonstrated ($r = 0.988$, $p < 0.001$ and $r = 0.674$, $p < 0.001$) in the Turkish version [5]. Reijneveld et al. also showed a strong association between Katz ADL and SF-36 PF subscale [9]. Mystakidou et al. reported the validity of Katz ADL by demonstrating strong correlations between the Greek version of Katz ADL and Lawton IADLs scale ($r = 0.756$ for males, $r = 0.572$ for females) [10]. Since, the BI is a specific measure of the ADLs compared to the SF-36 which is more general, the agreement between the BI and Katz index can be considered a better measure of concurrent validity.

Further, in the current study, we observed the agreement between Katz index score and performance-based activities indicating the concurrent validity of the questionnaire. Since the performance-based measures can be considered reference standard for functional status, this data confirms the capacity of Katz index for the assessment of functional status in older people. Further, older people with chronic diseases and those who had poor perception about their general health, showed Katz index lower scores indicating the known group validity of the questionnaire.

Measuring basic ADL in older people requires a tool which is brief and practical. This is especially relevant in busy clinical setups with less human resources. To the best of our knowledge, apart from BI, no other scale has been validated in the local population to measure basic ADL. Further, in Sri Lanka, the Katz index has been used in a study; however, evidence of cultural adaptation and assessment of validity is uncertain [27]. We used a sufficient sample size in this analysis and their physical functions varied widely. Furthermore, they were long term clinic attendees with multiple comorbidities. They were unlikely to be a selected group since the study center has an open admission policy and all services are state sponsored. Therefore, we feel that the findings of the current study are generalizable to the rest of the country.

We, however, did not evaluate the inter-rater agreement of the Katz index. The inter-rater agreement of the index between nurses and doctors would be useful as nurses can be involved in the assessment of older adults in busy clinical set ups. Further, the study included only Sinhala conversant patients in outpatient clinics and this is a limitation of the study. We feel that the validation needs to be extended to other languages as well.

5. Conclusions

The culturally adapted Sinhala version of the Katz index is an easy to perform, reliable and valid tool for the measurement of ADLs in older people who are conversant in Sinhala language. It would provide quick and easy assessment of the level of functional functions and this information is essential for clinical decision making, monitoring the progress and predicting outcomes of older people.

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Author contribution

All authors involved in conception of the study and design of the work, NR and RK involved in data collection. NR analyzed the data and initially drafted the manuscript, TA, WZ and DP involved in interpretation of analyzed data and reviewing of the manuscript. SL contributed for the interpretation of analyzed data and critically reviewing the manuscript for important intellectual content. All authors read and approved the final version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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