


Comparison of Three Instruments for Activity Disability in Acute Ischemic Stroke Survivors

Qian Wu , Aijie Tang, Shuzhen Niu, Aiping Jin, Xiaoqing Liu, Li Zeng, Jinxia Jiang, Jennifer Kue, Yan Shi, Xiaoping Zhu

ABSTRACT: Background: Disabilities in physical activity and functional independence affect the early rehabilitation of stroke survivors. Moreover, a good instrument for assessing activity disability allows accurate assessment of physical disability and assists in prognosis determination. **Objective:** To compare three assessment tools for physical activity in acute-phase stroke survivors. **Methods:** We conducted this prospective observational study at an affiliated hospital of a Medical University in Shanghai, China, from June 2018 to November 2019. We administered three instruments to all patients during post-stroke days 5–7, including the Modified Barthel Index (MBI), Instrumental Activities of Daily Living (IADL), and modified Rankin scale (mRs). We analyzed correlations among the aforementioned scales and the National Institutes of Health Stroke Scale (NIHSS) using Spearman's rank-order correlations test. Univariate analyses were performed using the Mann–Whitney U test. We used a binary logistic regression model to assess the association between the NIHSS (30 days) and patient-related variables. Finally, we used receiver operating characteristic (ROC) curves to assess the predictive value of the multivariate regression models. **Results:** There was a high correlation among the three instruments; furthermore, the MBI had a higher correlation with the NIHSS (days 5–7). The NIHSS (day 30) was correlated with thrombolysis. ROC analysis revealed that the mRs-measured disability level had the highest predictive value of short-term stroke severity (30 days). **Conclusion:** The MBI was the best scale for measuring disability in physical activity, whereas the mRs showed better accuracy in short-term prediction of stroke severity.

RÉSUMÉ : Comparaison entre trois outils d'évaluation de l'invalidité dans le cas de patients ayant survécu à un AVC ischémique aigu. *Contexte :* Des limitations fonctionnelles en matière d'activité physique et d'autonomie vont affecter les premières étapes de la réadaptation des survivants à un AVC. Par ailleurs, on sait qu'un bon outil d'évaluation de ces limitations permettra de les évaluer adéquatement et d'établir un pronostic. *Objectif :* Comparer trois outils d'évaluation des limitations fonctionnelles liées à l'activité physique dans le cas de survivants à un AVC. *Méthodes :* De juin 2018 à novembre 2019, nous avons effectué une étude prospective d'observation au sein d'un établissement hospitalier affilié à une école de médecine de Shanghai. Entre les cinquièmes et septièmes jours consécutifs à un AVC, tous nos patients ont été évalués au moyen des trois outils suivants : l'indice modifié de Barthel (IMB), l'échelle de Lawton ciblant les activités instrumentales de la vie quotidienne et la *Modified Rankin Scale* (MRS). Au moyen du test de Spearman, nous avons ensuite analysé les corrélations se dessinant entre ces trois outils et les résultats obtenus avec un autre outil, la *National Institutes of Health Stroke Scale* (NIHSS). Nos analyses univariées ont été par ailleurs effectuées à l'aide du test de Wilcoxon-Mann-Whitney. Nous avons également recouru à un modèle de régression logistique binaire afin d'évaluer l'association existant entre le NIHSS (30 jours) et des variables liées aux patients. Finalement, nous avons fait appel à la fonction d'efficacité du récepteur (ou courbe ROC) pour évaluer la valeur prédictive de nos modèles de régression multivariés. *Résultats :* Une forte corrélation entre nos trois outils a émergé. De plus, il est apparu que c'est le IMB qui a montré la plus forte corrélation avec la NIHSS (jours 5, 6 et 7). La NIHSS (jour 30) a été également corrélée avec un traitement thrombolytique. Nos analyses au moyen de la fonction d'efficacité du récepteur ont révélé que le niveau de limitations fonctionnelles mesuré par la MRS avait la valeur prédictive la plus élevée pour le degré de sévérité des AVC à court terme (jour 30). *Conclusion :* L'IMB est donc apparu comme le meilleur outil pour évaluer les limitations fonctionnelles en matière d'activité physique tandis que la MRS a montré la meilleure précision quand il s'agit de prédire à court terme le niveau de sévérité des AVC.

Keywords: Stroke, Activity, Disability, Modified Rankin scale, Modified Barthel index, Instrumental ADL, NIHSS

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INTRODUCTION

In recent years, there has been an increase in the prevalence of stroke in China. A nationwide population-based survey

reported that stroke is becoming a major cause of adult disability and premature death in China.¹ Specifically, there has been a steady increase in ischemic stroke (IS) cases, which accounted

From the Shanghai Tenth People's Hospital Affiliated to Tongji University, Shanghai, People's Republic of China (QW, AJ, XL, LZ, JJ, YS, XZ); College of Medicine, Tongji University, Shanghai, People's Republic of China (QW, AT, SN, LZ, JJ, YS); and College of Nursing, The Ohio State University, Columbus, OH, USA (JK)

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Correspondence to: Xiaoping Zhu, RN, Shanghai Tenth People's Hospital Affiliated to Tongji University, Shanghai, People's Republic of China; Yan Shi, RN, PhD, Shanghai Tenth People's Hospital Affiliated to Tongji University, Shanghai, People's Republic of China. Email: 392470352@qq.com Phone: 18917683111

for 87.5% of all stroke cases from 2013 to 2015.² Early disability severity is an important predictor of functional outcome and the effectiveness of stroke treatment.³ Moreover, functional independence of stroke survivors ultimately affects their early rehabilitation, the ability to fully integrate into social life, and the resource cost.^{4,5}

Previous studies have suggested that patients admitted to an acute stroke unit are inactive and physically limited during the first 2 weeks after stroke.⁶ Early evaluation of disability allows to prompt intervention and therapy, which provide a basis for early recovery planning and lead to better outcomes ultimately. Moreover, assessing the activities of daily living could assist nurses and caregivers to deliver proper care, health services, and living assistance. Ovbiagele et al.⁷ reported that the assessment of disability or dependence in activities of daily living could strongly predict long-term disability in patients with stroke, especially those who had ischemic stroke onset within 1 week. Given the availability of data in the hospital and the lack of long-term evaluation due to loss to follow-up, 1 week is considered as the best and most practical time point for measuring the direct effect of thrombolysis.⁸

Several instruments are available for assessing physical disability and dependency in patients with stroke. Among these instruments, the Modified Barthel Index (MBI),⁹ modified Rankin scale (mRs),¹⁰ and instrumental activities of daily living (IADL)¹¹ are the most widely and frequently used in clinical practice and trials. Each instrument has its advantages and disadvantages. For example, the MBI assesses patients' basic activities; however, it lacks information on the IADL. Compared with the MBI, the mRs is considered as a global but more subjective scale. The IADL is related to cognitive changes, because it not only measures the ability of patients to live independently and take care of themselves, but also assesses cognitive, intellectual, and social skills by evaluating their ability to use the phone, manage finance, and take transportation.¹² It is not usually or conveniently used among acute stroke survivors for completing the test content, which is difficult. Most previous studies assessed disability in stroke survivors during the rehabilitation and recovery period.¹³ For example, a previous qualitative review recommended the MBI and mRs as prognostic assessment tools for long-term outcomes after stroke.¹⁴ Cioncoloni et al.¹⁵ reported that mRs had better sensitivity in determining functional recovery at 6 months after stroke onset. However, few studies used those three instruments simultaneously on the assessment of physical activity in acute stroke survivors. Moreover, it remains unclear that which tool is more sensitive and more suitable to be used as a reference tool for acute stroke survivors.

In this study, we compared MBI, IADL, and mRs in stroke survivors in an acute care unit before post-stroke day 30. In the first stage, we administered four instruments for all patients during post-stroke days 5–7, including mRs, MBI, IADL, and NIHSS assessments. In the second stage, we evaluated the NIHSS scores on the 30th day after post-stroke. We aimed to describe the distribution of the scores of the three instruments and factors affecting the recovery of prognosis on the 30th day after stroke by using NIHSS. Moreover, we aimed to compare the three instruments and determine the best and most sensitive measures for determining physical disability.

PATIENTS AND METHODS

Patients

We conducted this prospective observational study at Shanghai Tenth People's Hospital Affiliated to Tongji University from June 2018 to November 2019. The inclusion criteria were a diagnosis of acute ischemic stroke and an age of >18 years. We excluded patients with dementia; no significant functional improvement after 48 hours of treatment; psychiatric history; and severe complications, including heart, renal, and hepatic failure, as well as patients that were isolated due to infectious diseases.

Measures

Sociodemographic Questionnaire

This questionnaire items included age, education, marital status, body mass index (BMI), hospitalization cost, length of hospital stay, career, and habits (sedentary lifestyle, smoking, and drinking habits).

Clinical Characteristics

We assessed the following clinical characteristics: infarct site, stroke severity, thrombolysis process, sleep situation as assessed by the Pittsburgh sleep quality index (PSQI), history of chronic disease (hypertension, coronary heart disease, atrial fibrillation, diabetes, and hyperlipidemia), and history of TIA. We obtained patients' clinical characteristics from the medical records. Based on the neuroimaging and clinical characteristics, experienced stroke neurologists made a definitive diagnosis of ischemic stroke. Moreover, neurologists and radiologists confirmed the stroke type and localization using head magnetic resonance imaging and/or computed tomography.

Physical Disability Assessment

In this study, we used the mRs, MBI, and IADL to assess physical disability.

The Modified Barthel Index (MBI). The MBI is a 10-item scale used to investigate the patient's capacity in activities of daily living (feeding, bowel control, bladder control, personal hygiene, transfer, dressing, ambulation, bathing, and stair climbing).¹⁵ The 10 subscale scores add up to a maximum possible score of 100 (independent) and minimum possible score of 0 (completely dependent). Moreover, a score of 0–40, 41–60, and 61–95 points indicates severe, moderate, and mild functional impairment. The Chinese version of the MBI has been reported to have good validity and reliability among patients with stroke.¹⁶

Modified Rankin Scale (mRs). The mRs is a 6-point scale: a 0 score indicates no symptoms at all; a 1 score indicates no significant disability despite symptoms and able to perform all usual duties; a 2 score indicates slight disability, and inability to perform all previous activities, but able to look after their own affairs without assistance; a 3 score indicates moderate disability, requiring some help but able to walk without assistance; a 4 score indicates moderately severe disability, and unable to

walk and attend to their own bodily needs without assistance; and a 5 score indicates severe disability, bedridden, incontinent, and requiring constant nursing care and attention.¹⁷ This scale has poor sensitivity to change; however, it has relatively good psychometric properties, especially with respect to inter-rater reliability.¹⁸

Instrumental Activities of Daily Living (IADL). The IADL scale is an 8-item care worker-rated instrument that assesses the ability to use a telephone, shop, prepare food, housekeep, do laundry, use transportation modes, responsibly take medications, and handle finances. The total score ranges from 0 (the lowest function) to 8 (the highest function). In the IADL, disability is defined as presenting impairment in one or two of the eight IADL scale items.¹⁹ The IADL scores are correlated with tasks that require sufficient capacity to make good decisions and those that require significant interaction with the environment.²⁰

The National Institute of Health Stroke Scale (NIHSS). The NIHSS is a 15-item neurologic examination stroke scale that assesses consciousness, ocular movement, vision, coordination, speech and language, sensory function, upper and lower limb strength, facial muscle function, and visual hemi-neglect.²¹ It reflects both the degree of neurological damage and the mobility of the patient. A higher score indicates greater stroke severity. The cutoff of NIHSS categories is 0–5 for mild stroke, 6–14 for moderate stroke, 15–24 for severe stroke, and >24 indicates a very severe stroke.²² NIHSS >5 includes all non-mild stroke categories. It is a well-validated assessment tool that is commonly used in acute-clinical stroke practice up to 3 months after stroke; moreover, it has shown good agreement with other outcome measures.²³ Notably, the baseline scores have strong predictive validity that patient with a baseline score of <5 is considered to satisfy the discharge criteria. In this study, we considered an NIHSS score of <5 as a good outcome.²²

Sleep Assessment

The Pittsburgh Sleep Quality Index (PSQI). The PSQI was proposed by Buysse et al.²⁴ in 1989 and consists of 24 items. All items are divided into seven dimensions: subjective sleep quality, time to sleep, sleep time, sleep efficiency, sleep disorders, hypnotic drugs, and daytime function. Higher PSQI scores indicate more severe insomnia. Because it is easy to use and has good reliability and validity, it has become a commonly used scale for clinical assessment in psychiatry.²⁵

PROCEDURE

Three nurses were trained to use the three instruments, simultaneously; their consistency was assessed on 20 patients prior to study onset. We collected information on the sociodemographic and clinical characteristics from the medical records. The trained nurses conducted assessments for physical disability and the sleep situation. When a patient could not complete an interview, we used a proxy, for example, the nurse-in-charge or caregiver. We assessed the NIHSS score²⁶ at 5–7 post-stroke days and at 30 post-stroke days. This open descriptive study received approval from the Shanghai Tenth People's Hospital Ethics Committee (SHSY-IEC-KY-4.0/17-47/01).

STATISTICAL ANALYSIS

We analyzed all data using the Statistical Package for Social Sciences version 21.0 software package (IBM Inc., Armonk, NY). For descriptive statistics, we used frequency and proportion for categorical variables and mean \pm standard deviation (SD) and number (percentage) for continuous variables.

We assessed the relationship among the MBI, IADL, and mRs scores in the acute stroke survivors. We used boxplots to present the distribution of MBI and IADL scores within each mRs grade. We used cross tabulation in Pearson's chi-squared test to determine the overlap of samples at each level of the three scales and Spearman's rank-order correlations test to analyze the correlations among the MBI, mRs, IADL, and the NIHSS (5–7 days) scores.

We used the Mann–Whitney U test for univariate analysis. We used a binary logistic regression model to assess the association between the NIHSS (30 days) scores and patient-related variables, including demographic and clinical characteristics. The NIHSS scores were dichotomized and coded as ≤ 5 (good outcome) and > 5 (bad outcome). The categorical variables were MBI (cutoff values: 40 and 60), IADL (cutoff values: 0 and 1), mRs (cutoff value: 2), and the NIHSS scores. We performed a multivariate analysis using variables with a p-value of < 0.05 in the univariate analysis. Receiver operating characteristic (ROC) curves were used to assess the predictive value of the multivariate regression models. ROC analysis was conducted to examine the best assessment tool to predict the presence of NIHSS > 5 on 5–7 days after stroke onset. We used the area under the curve (AUC) to assess the fit of the models. The results were interpreted as follows: 0.7–0.9 as moderate accuracy and 0.5–0.7 as low accuracy. We considered variables with a p-value of < 0.05 as significant for all analyses.

RESULTS

Patient Characteristics

We enrolled 136 acute stroke survivors. Table 1 summarizes the demographic and clinical characteristics.

Distribution of the MBI and IADL Scores Related to the mRs Grades

We determined the frequency distribution of the MBI and IADL scores within each mRs grade. There was a significant difference ($P < 0.001$) in the distribution of the MBI and IADL median scores within the mRs grades (Kruskal–Wallis: 109.549 and 54.547 for MBI and IADL, respectively) (Figure 1).

Table 2 presents the number of patients overlapping at each level of the three scales. We observed that when the mRs score was < 2 , the MBI score was > 60 . With an increase in the mRs score, there was an increase in MBI scores that were < 60 . When the mRs score was equal to 5, all the MBI scores were < 60 . The distribution of the IADL scores within the mRs grades overlapped when the mRs score was < 3 points and > 4 points. Given the meticulous classification of the IADL and its different emphasis compared with the mRs, the intersection of the intermediate scores is more complicated compared with that of MBI.

Correlation among the Three Scales

Spearman's correlation analysis revealed correlations among the three scales ($P < 0.001$); specifically, the IADL, mRs, and

Table 1: Demographic and clinical characteristics of the participants

Demographic Data	n(%)	Clinical Data	n(%)
Gender		The infarct region	
Male	94(69.1)	Vertebrobasilar region	57(41.9)
Female	42(30.9)	Bilateral cerebral hemisphere	9(6.6)
Age		Right cerebral hemisphere	25(18.4)
≤40	4(2.9)	Left cerebral hemisphere	25(18.4)
40–50	3(2.2)	Else	20(14.7)
50–60	34(25.0)	The use of thrombolysis	
>60	95(69.9)	Yes	21(15.4)
BMI		No	115(84.6)
≤18.5	2 (17.6)	Sedentary	
18.5–24	56(70.6)	Yes	135(99.3)
>24	78(8.8)	No	1(0.7)
Marriage		Smoking	
Unmarried	15(11.0)	Yes	63(46.3)
Married	121(89.0)	No	73(53.7)
Career		Drinking	
Incumbent	11(8.1)	Yes	37(27.2)
Retirement	125(91.9)	No	99(72.8)
Education		Hypertension	
Elementary and below	10(7.3)	Yes	82(60.3)
Junior high school	64(47.1)	No	54(39.7)
High school	31(22.8)	Diabetes	
Specialist and above	31(22.8)	Yes	31(22.8)
Hospital costs (yuan)		No	105(77.2)
540–5840	6(4.4)	Coronary heart disease	
5840–11,140	86(63.2)	Yes	15(11.0)
11,140–16,440	36(26.5)	No	121(19.0)
16,440–21,740	4(2.9)	Atrial fibrillation	
21,740–52,803	4(2.9)	Yes	9(6.6)
Stay at hospital		No	127(93.4)
≤7 days	38(27.9)	Hyperlipidemia	
>7 days	98(73.1)	Yes	8(5.9)
Time from onset to admission		No	128(94.1)
≤24 hours	82(60.3)	The history of Transient ischemic attack	
1–7 days	32(23.5)	Yes	132(97.1)
>7 days	22(16.2)	No	4(2.9)
		PSQI scores	
		≤7	98(72.1)
		>7	38(27.9)
		mRs	
		≤2 scores	38(27.9)
		>2 scores	98(72.1)

Table 1. (Continued)

Demographic Data	n(%)	Clinical Data	n(%)
		NIHSS(30 days)	
		≤5	74(54.4)
		>5	62(45.6)
		MBI	
		0–40 scores	16(11.8)
		41–60 scores	45(33.1)
		61–100 scores	75(55.1)
		IADL	
		0 scores	15(11.0)
		1–7 scores	121(89.0)

PSQI = Pittsburgh sleep quality index; IADL = instrumental activities of daily living; mRs = modified rankin scale; MBI = modified barthel index; BMI = body mass index; NIHSS = national institute of health stroke scale.

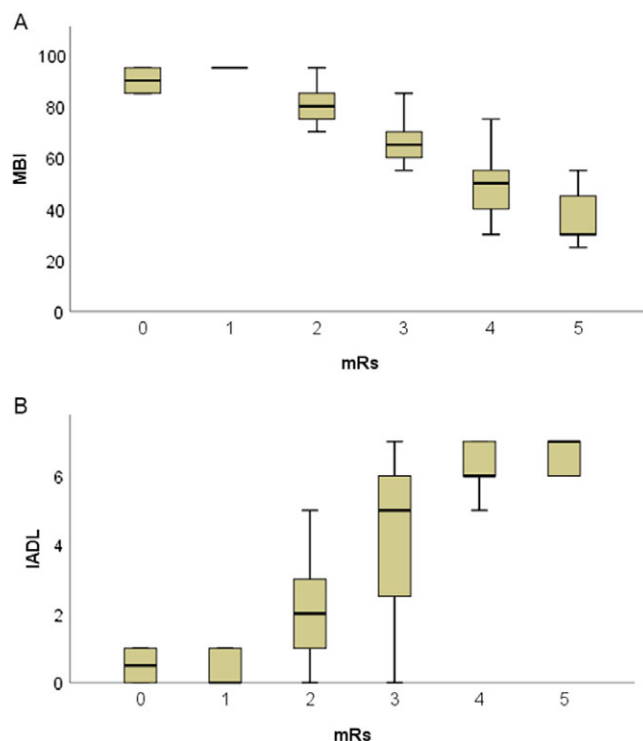


Figure 1: (A) Distribution of the MBI scores within the mRs grades. The frequency distribution of the MBI scores within each mRs grade at 5–7 days is shown. The figure presents boxplots of the MBI score within each mRS grade at 5–7 days post-stroke. There is no overlap in the median frequency distribution at 5–7 days. There are significant differences between grade 5 and the remaining grades. (B) Distribution of the IADL scores within the mRs grades. The frequency distribution of the IADL scores within each mRs level at 5–7 days is shown. The figure shows the boxplots of the IADL score within each mRS grade at 5–7 days post-stroke. There is no overlap in the median frequency distribution at 5–7 days. There are significant differences between grade 5 and the remaining grades.

MBI were negatively correlated ($r < 0$), while the IADL and mRs were positively correlated ($r > 0$). Moreover, there was a high correlation between the mRs and MBI ($r = -0.870$) and a

Table 2: Overlapping of samples at each level of the three scales

Instrument scores	MBI				Total	IADL score							Total	
	0	1	2			0	1	2	3	4	5	6		7
	0	0	0	0	0	1	1	0	0	0	0	0	0	2
mRs score	1	5	0	0	5	3	2	0	0	0	0	0	0	5
	2	32	0	0	32	5	6	8	6	3	4	0	0	32
	3	32	12	0	44	3	4	4	2	6	9	13	3	44
	4	4	31	12	47	3	2	2	1	2	2	17	18	47
	5	0	2	4	6	0	0	0	0	0	0	2	4	6
Total		75	45	16	136	15	15	14	9	11	15	32	25	136

MBI = modified barthel index.

Note: 0 = 61–99 scores; 1 = 41–60 scores; 2 = 0–40 scores in the MBI.

Table 3: The correlation between the three scales

	mRs scores		MBI scores		IADL scores	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>P</i>
IADL scores	0.559	<0.001	–0.587	<0.001		
MBI scores	–0.870	<0.001				

IADL = instrumental activities of daily living; mRs = modified rankin scale; MBI = modified barthel index.

Table 4: The correlation between the three scales and the NIHSS (admission)

	mRs scores		MBI scores		IADL scores	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>P</i>
NIHSS scores	0.769	<0.001	–0.823	<0.001	0.569	<0.001

IADL = instrumental activities of daily living; mRs = modified rankin scale; MBI = modified barthel index.

moderate correlation of the IADL and mRs with MBI ($r = 0.559$ and -0.587 , respectively) (Table 3).

Correlation between Each of the Three Scales and the NIHSS (5–7 Days)

Spearman correlation analysis revealed correlations between each of the three scales and the NIHSS (days 5–7) ($P < 0.001$). Specifically, there was a negative correlation of the NIHSS (days 5–7) with the MBI ($r < 0$) and a positive correlation of the NIHSS (admission) with the IADL and mRs ($r > 0$). There was a high correlation of the MBI and mRs with NIHSS (days 5–7) ($r = -0.823$ and 0.769 , respectively) and a moderate correlation of the IADL with NIHSS (days 5–7) ($r = 0.569$) (Table 4).

Univariate and Multivariate Analysis of the NIHSS Scores (Day 30)

Table 5 presents the results of univariate and multivariate analyses of the NIHSS scores (day 30). Thrombolysis ($P < 0.001$) and time from onset to admission ($P = 0.016$) showed statistically

significant associations with the NIHSS score (day 30). Binary logistic regression analysis revealed the significant association between thrombolysis and the NIHSS score (day 30) after adjusting for the variable time from onset to admission. Concomitantly, thrombolysis was an independent protective factor of NIHSS (day 30) (OR = 0.057, 95% CI = 0.042–0.585, $P = 0.006$).

Receiver Operator Curves of the Predictive Ability of the MBI, IADL, and mRs Compared to that of the NIHSS (Day 30)

ROC curves showed the predictive power of the multivariable model for the three scales (Figure 2). Figure 2 demonstrates that the MBI score (cutoff value: 60), IADL score (cutoff value: 1), and mRs scores (cutoff value: 2) had the best sensitivity, which indicates that these scales had the best prognosis for acute stroke. The area under the ROC curve for the model for the mRs score (cutoff value: 2), MBI scores (cutoff value: 60), and IADL score (cutoff value: 1) was 0.831 (95% CI: 0.761–0.901), 0.749 (95% CI: 0.664–0.835), and 0.698 (95% CI: 0.608–0.789).

Table 5: Univariate and multivariate analysis of factors associated with the NIHSS (day 30)

Factors	n (%)	Univariate analysis*		Multivariate analysis		Factors	n (%)	Univariate analysis	
		NIHSS (5 cutoff) Statistics P		NIHSS(5 cutoff) OR P 95% CI				NIHSS (5 cutoff) Statistics P	
Gender						Career			
Male	94 (69.1)	0.437	0.491			Incumbent	11(8.1)	<0.001	0.993
Female	42 (30.9)					Retirement	125(91.9)		
Age						Coronary heart disease			
≤40	4 (2.9)	2.052	0.152			Yes	15(11.0)	0.405	0.525
40–50	3 (2.2)					No	121(19.0)		
50–60	34 (25.0)					Sedentary			
>60	95 (69.9)					Yes	135(99.3)	0.838	0.360
BMI						No	1(0.7)		
≤18.5	2 (17.6)	0.010	0.940			Smoking			
18.5–24	56(70.6)					Yes	63(46.3)	0.009	0.923
>24	78(8.8)					No	73(53.7)		
The history of TIA						Drinking			
Yes	4 (2.9)	0.699	0.403			Yes	37(27.2)	0.003	0.959
No	132 (97.1)					No	99(72.8)		
Atrial fibrillation						Hypertension			
Yes	9(6.6)	1.783	0.191			Yes	82(60.3)	0.047	0.829
No	127(93.4)					No	54(39.7)		
Hyperlipidemia						Diabetes			
Yes	8 (5.9)	0.223	0.637			Yes	31(22.8)	1.641	0.200
No	128 (94.1)					No	105(77.2)		
The use of thrombolysis						Region of infarct			
Yes	21(15.4)	12.195	<0.001†	0.057‡	0.006	Vertebrobasilar region	57(41.9)	0.265	0.492
					(0.042–0.585)				
No	115(84.6)					Bilateral cerebral hemisphere	9(6.6)		
Time from onset to admission						Right cerebral hemisphere	25(18.4)		
≤24 hours	82(60.3)	6.103	0.016†	1.495	0.112	Left cerebral hemisphere	25(18.4)		
					(0.910–2.454)				
1–7 days	32(23.5)					Else	20(14.7)		
>7 days	22(16.2)					Marriage			
Education						Unmarried	15(11.0)	0.345	0.538
Elementary and below	10(7.3)	0.005	0.646			Married	121(89.0)		
Junior high school	64(47.1)					PSQI score			
High school	31(22.8)					≤7	98(72.1)	3.196	0.074
Specialist and above	31(22.8)					>7	38(27.9)		

BMI = body mass index; TIA = transient ischemic attack; PSQI = Pittsburgh sleep quality index.

*Mann–Whitney U test.

†Statistically significant (P < 0.05).

‡Odds ratio indicated that patients with functional recovery (NIHSS < 5) were 0.057 times more likely to be functionally impaired (NIHSS > 5) at 30 days compared to patients who did not undergo thrombolysis.

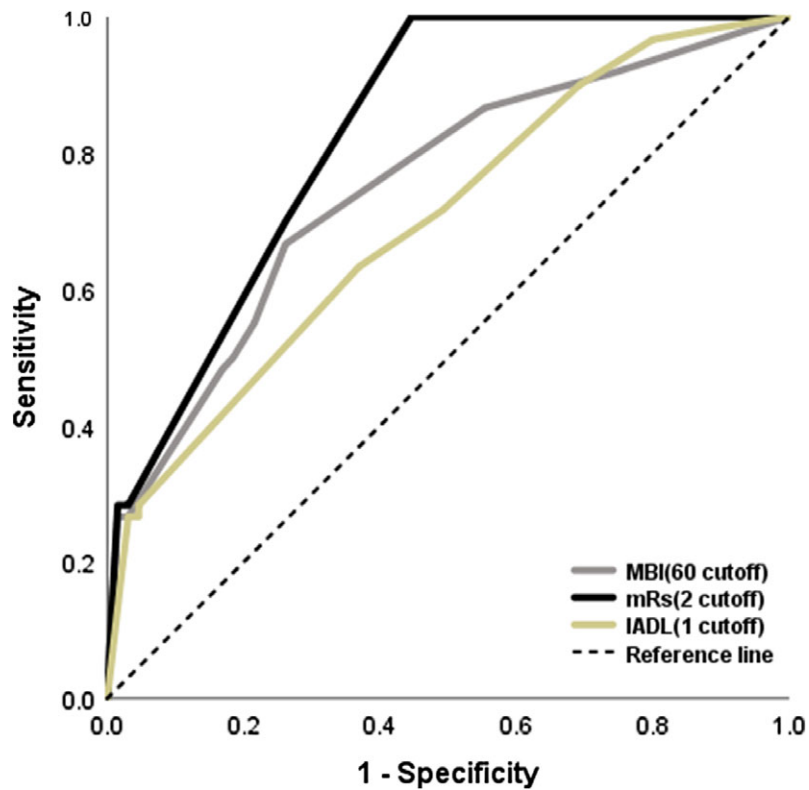


Figure 2: The area under the ROC curve shows an improved predictive value (0.698–0.831) for total prognosis after inclusion of the MBI score (cutoff value: 60), IADL score (cutoff value: 1), and mRs score (cutoff value: 2).

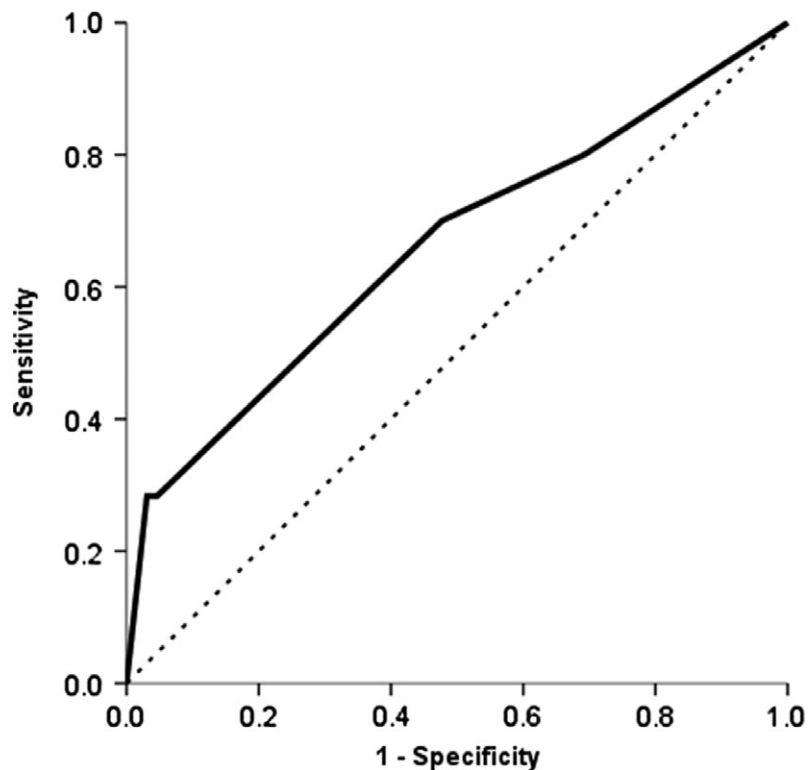


Figure 3: The area under the ROC curve of the multivariable model for the NIHSS (day 30) is 0.659 (95% CI: 0.563–0.755) with the inclusion of thrombolysis and time from onset to admission as independent variables.

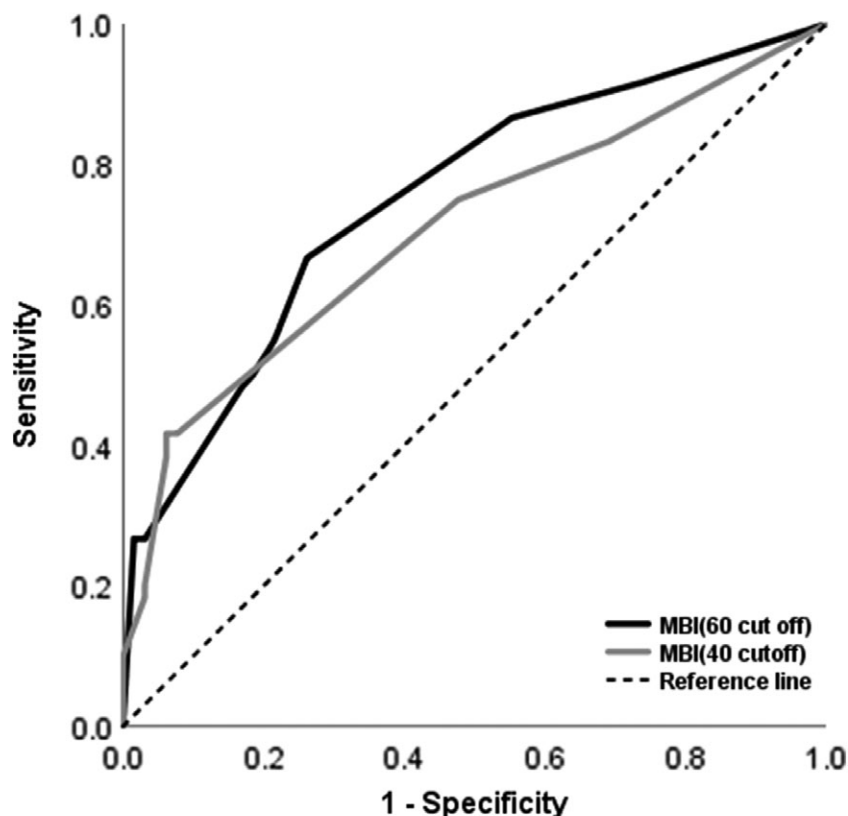


Figure 4: The area under the ROC curve of the multivariable model for the MBI (cutoff value: 40) is 0.706 (95% CI: 0.613–0.798) with the inclusion of thrombolysis, time from onset to admission, and the MBI score (cut off value: 40) as independent variables. The area under the ROC curve of the multivariable model for the MBI (cutoff value: 60) is 0.749 (95% CI: 0.664–0.835) with the inclusion of thrombolysis, time from onset to admission, and MBI (cutoff value: 60) as independent variables.

Figure 3 shows the predictive power of the NIHSS (day 30) in the multivariable model. The area under the ROC curve for the model for the NIHSS (day 30) was 0.659 (95% CI: 0.563–0.755). The regression analysis model that included thrombolysis and time from onset to admission as the independent variables showed low sensitivity for explaining stroke prognosis.

Figure 4 presents the predictive power of the multivariable model for the MBI (cutoff value: 60 and cutoff value: 40, respectively). The area under the ROC curve for the model for the MBI (cutoff value: 40) and MBI (cutoff value: 60) was 0.706 (95% CI: 0.613–0.798) and 0.749 (95% CI: 0.664–0.835), respectively. Both regression analysis models with the inclusion of thrombolysis and time from onset to admission as independent variables showed moderate sensitivity for explaining acute stroke prognosis.

Figure 5 presents the predictive power of the multivariable model for the IADL (using cutoff values of 0 or 1). The area under the ROC curve for two different models of the IADL (cutoff value: 0) and IADL (cutoff value: 1) was 0.665 (95% CI: 0.570–0.760) and 0.698 (95% CI: 0.608–0.789). Both regression analysis models, with the inclusion of thrombolysis and time from onset to admission as independent variables, showed low sensitivity for explaining acute stroke prognosis.

DISCUSSION

We aimed to compare three assessment tools of physical disability at two time points in the acute post-stroke stage (within 30 days after stroke) among first-stroke survivors. We observed a high correlation among the three assessment tools ($P < 0.05$). Although they all measured physical disability, they placed emphasis on different activity aspects. The MBI and mRS measure the degree of assistance required from other people to perform basic activities of daily living, while the IADL places emphasis on assistance required from devices. This could have contributed to the significant differences ($P < 0.001$) in the distribution of the MBI and IADL scores within the mRS grades (Figures 1 and 2). Our study is consistent with a previous work,¹⁵ which shows that the MBI score distribution within mRS grades overlapped at 10 days. Kwon et al. assessed the frequency distribution of MBI scores within mRS grades and showed that the highest MBI scores (95–100, indicating excellent to complete recovery) corresponded to mRS grades 0, 1, 2, and 4.²⁷ The MBI is used to assess activity function; however, its efficiency is compromised when administered too early (within 5 days post-stroke).²⁸

The American Heart Association/American Stroke Association recommends early assessment of patients with acute

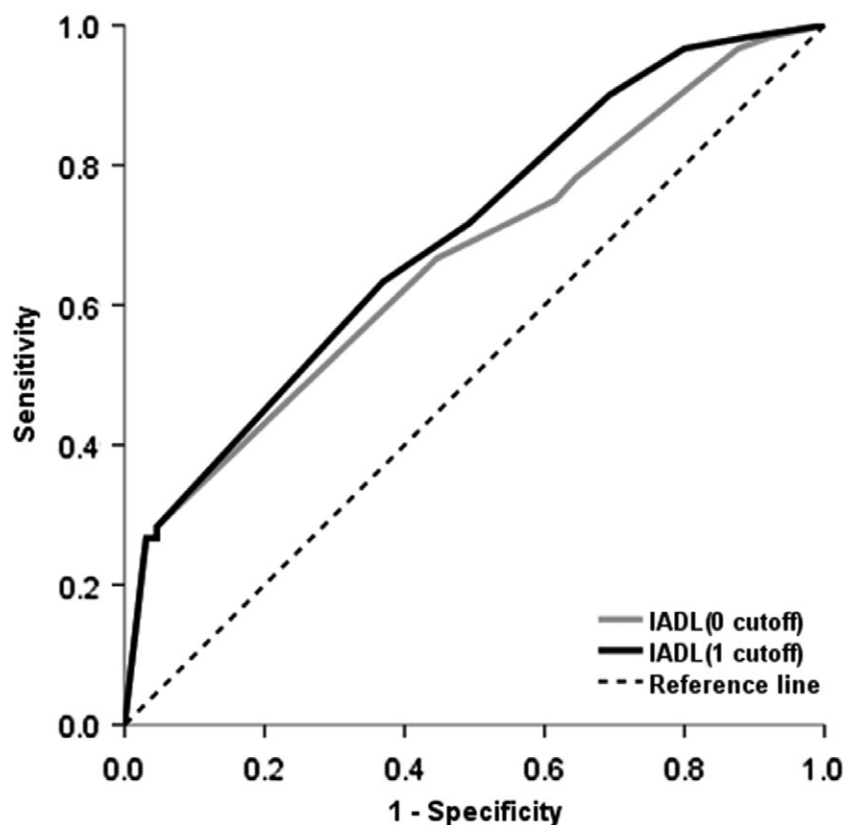


Figure 5: The area under the ROC curve of the multivariable model for the IADL (cutoff value: 0) is 0.665 (95% CI: 0.570–0.760) with the inclusion of thrombolysis, time from onset to admission, and the IADL (cutoff value: 0) as independent variables. The area under the ROC curve of the multivariable model for the IADL (cutoff value: 1) is 0.698 (95% CI: 0.608–0.789) with the inclusion of thrombolysis, time from onset to admission, and IADL (cutoff value: 1) as independent variables.

ischemic stroke,²⁹ which could be facilitated by accurate assessment tools, which help to screen patients with the ability to perform activities and evaluate the effectiveness of rehabilitation treatment. The NIHSS is an important scale that reflects stroke-induced global neurological and motor impairment. Compared with the other two scales, we found that the MBI had the highest correlation ($r = -0.823$, $P < 0.001$) with the NIHSS. A previous study reported that the MBI is more reliable for disability assessment than the mRs.²³ The inter-rater reliability and internal consistency of the MBI can be assessed, while the internal consistency of the mRs cannot be evaluated, because it is one-dimensional. Compared to the mRs, the MBI is considered less subjective since it allows for objective and specific evaluation, while the mRs obscurely describes the activity levels. As a disability measure, the mRs subsumes some items in the IADL and MBI (e.g., walking, dressing, bathing) and emphasizes compromised motor function. However, the mRs is more sensitive than the MBI in the measurement of stroke disability.³⁰

It is recognized that activity ability could predict long-term outcomes and independence in the subsequent recovery period in patients with stroke. Univariate and multivariate analyses showed that thrombolysis (95% CI: 0.042–0.585; $P = 0.006$) was independently associated with the NIHSS (day 30). A previous study

reported an association of thrombolysis with post-stroke outcome.³¹ Moreover, we compared the sensitivity and specificity of the three assessment tools in predicting stroke severity at the end of the acute stage. The multivariate analysis model with the mRs (cutoff value: 2) had the highest AUC (Figure 3), indicating that it could better predict functional recovery after acute stroke. Consistent with our findings, Dewilde et al.⁴ reported that prognostic outcomes were associated with increasing levels of the mRs: in the first few months after a stroke, higher mRs scores were associated with higher disability levels and a higher cost of rehabilitation in the first month after the stroke. Moreover, the predictive validity of the mRs is indicated by the association between short-term and long-term post-stroke care needs.³² With respect to the IADL and MBI, different cutoff values showed different ROC curves and AUCs. Specifically, the AUCs of the MBI (cutoff value: 60) and the MBI (cutoff value: 40) were 0.794 (95% CI: 0.664–0.835) and 0.706 (95% CI: 0.613–0.798), respectively. On the other hand, the AUCs of the IADL (cutoff value: 0) and the IADL (cutoff value: 1) were 0.665 (95% CI: 0.570–0.760) and 0.698 (95% CI: 0.608–0.789), respectively. Therefore, when using the MBI or IADL to predict the short-term stroke severity, moderate scores of the MBI (cutoff value: 60) and IADL (cutoff value: 1) could be employed as predictive factors.

LIMITATIONS

Our study has several limitations. First, we enrolled first ischemic stroke survivors during the acute stage (30 days after stroke). The main short-term outcome was the NIHSS score at day 30; however, other studies could employ mortality and assess readmission rates with larger samples. Additionally, in this study, we only assessed physical disability at a single time point rather than multiple time points throughout the 30 days. Finally, we did not assess and account for the relevant biochemical markers.

CONCLUSIONS AND POLICY IMPLICATIONS IN PRACTICE

In summary, compared with the other two instruments, we found that the BI was the best scale for reflecting disability in physical activity in acute stroke survivors; moreover, it was highly correlated with the NIHSS. This indicates that the MBI could assist nurses and caregivers to accurately assess physical disability and functional independence, which providing information for the degree of assistant and early as well as making a personal early rehabilitation plan in the acute stage. Furthermore, we found that the mRs showed better accuracy in the prediction of short-term stroke severity, which is consistent with previous findings regarding its utility for long-term outcomes. The level of mRs could guide doctors and nurses to make a proper decision for the follow-up plan. The findings are relevant to stroke care and might be meaningful for the rational utilization of medical resources.

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CONFLICT OF INTEREST

None.

STATEMENT OF AUTHORSHIP

QW, YS, and XPZ were responsible for the study's concept and design. AIT and SZN did the statistical analysis and data collection. QW wrote the paper. SZN, APJ, XQL, and LZ contributed to the analysis and interpretation of the data. JXJ and JK were responsible for subsequent drafts and revision.

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