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ความเชื่อมั่นและความเที่ยงตรงตามสภาพของแบบประเมินการทรงตัว Postural Assessment Scale for Stroke ในผู้ป่วยโรคหลอดเลือดสมองกึ่งเฉียบพลัน

Reliability and Concurrent Validity of Postural Assessment Scale for Stroke (PASS) in Subacute Stroke Patients

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บทคัดย่อ

ผู้ป่วยโรคหลอดเลือดสมองมีความท้าทายในการฟื้นฟูสมรรถภาพในการใช้ชีวิตประจำวัน การทรงตัวและการเดิน แบบประเมินการทรงตัว Postural Assessment Scale for Stroke (PASS) และ Berg Balance Scale (BBS) เป็นแบบประเมินการทรงตัวในผู้ป่วยโรคหลอดเลือดสมอง อย่างไรก็ตามข้อมูลด้านความเที่ยงตามสภาพระหว่างแบบประเมิน PASS กับ BBS ในผู้ป่วยโรคหลอดเลือดสมองกึ่งเฉียบพลันยังไม่มีมาก่อน การศึกษานี้มีวัตถุประสงค์เพื่อประเมินความเที่ยงตามสภาพ และความน่าเชื่อถือทั้งภายในและระหว่างผู้ประเมินของแบบประเมิน PASS ในผู้ป่วยโรคหลอดเลือดสมองกึ่งเฉียบพลัน เป็นการศึกษาแบบภาคตัดขวางในผู้ป่วยโรคหลอดเลือดสมองกึ่งเฉียบพลัน จำนวน 16 ราย มีนักกายภาพบำบัด 2 คนประเมินอาสาสมัครทั้งหมดโดยใช้แบบประเมิน PASS และ BBS โดยการประเมินความเที่ยงตามสภาพให้คะแนนผ่านการประเมินโดยตรง ส่วนความน่าเชื่อถือภายในและระหว่างผู้ประเมินให้คะแนนจากคลิปวิดีโอ มีการคำนวณค่าสัมประสิทธิ์สหสัมพันธ์(ICC) ค่าความคลาดเคลื่อนมาตรฐานของการวัด(SEM) และค่าน้อยที่สุดที่เห็นการเปลี่ยนแปลงทางคลินิก(MDC) โดยกำหนดระดับช่วงความเชื่อมั่นที่ 95% ผลการศึกษาพบว่าความน่าเชื่อถือภายในผู้ประเมินอยู่ที่ระดับดีเยี่ยมทั้งหมด(ICC = 0.904-0.999) ความน่าเชื่อถือระหว่างผู้ประเมินอยู่ในระดับดีถึงดีเยี่ยม (ICC = 0.885-0.960) ค่า SEM เท่ากับ 0.19 คะแนน ค่า MDC ของคะแนนรวม PASS เท่ากับ 0.54 หมวดการรักษาท่าทางเท่ากับ 2.19 คะแนน หมวดการเปลี่ยนท่าทางเท่ากับ 1.63 คะแนน ค่าความเที่ยงตามสภาพอยู่ในระดับดีเยี่ยมที่ค่าสัมประสิทธิ์สหสัมพันธ์สเปียร์แมนเท่ากับ 0.981 สรุปผลวิจัยแสดงให้เห็นถึงประสิทธิภาพของแบบประเมิน PASS มีเหมาะสมในการนำมาใช้ทางคลินิก มีความน่าเชื่อถือและความเที่ยง

ตามสภาพในระดับสูงในผู้ป่วยโรคหลอดเลือดสมองกึ่งเฉียบพลัน สามารถระบุข้อบกพร่องด้านการทรงตัวได้ดี ช่วยปรับวิธีการรักษาให้เหมาะสม นำไปสู่ผลลัพธ์การรักษาที่ดี

คำสำคัญ: การทรงตัว ความสามารถในการเดิน การฟื้นฟูสมรรถภาพ

ABSTRACT

Background and Purpose: Stroke survivors often experience challenges in regaining functional abilities, including balance and walking impairments. The Postural Assessment Scale for Stroke Patients (PASS) and the Berg Balance Scale (BBS) are fundamental assessment tools for evaluating balance in stroke patients. However, the concurrent validity of PASS with BBS in subacute stroke remains underexplored. This study aimed to evaluate the concurrent validity, inter-rater, and intra-rater reliability of PASS in subacute stroke patients, providing insights to refine rehabilitation strategies and improve patient outcomes.

Methods: This cross-sectional study recruited 16 subacute stroke patients, aged between 42 and 72 years (mean = 57.56; SD = 0.56). Two physiotherapists assessed all participants using PASS and BBS. Concurrent validity was assessed through face-to-face evaluations, while intra-rater and inter-rater reliability were evaluated using video recordings and intraclass correlation coefficients (ICC2,1) and (ICC3,1). The standard error of measurement (SEM) and minimal detectable changes at the 95% confidence level were also determined.

Results: The study revealed outstanding intra-rater reliability for PASS total scores and subsystems (ICC = 0.904-0.999) and good to excellent inter-rater reliability (ICC = 0.885-0.960). The SEM for PASS total scores was 0.19 points, with minimal detectable changes at 95% confidence level of 0.54 points for total scores, 2.19 points for maintaining posture, and 1.63 points for changing posture. A Spearman correlation coefficient of 0.981 between PASS and BBS scores indicated excellent concurrent validity.

Conclusion: The findings emphasize the effectiveness of PASS as a practical tool for detecting balance issues in subacute stroke patients, enhancing clinical practice. Its reliability and validity make it a valuable asset for promptly identifying deficits and designing tailored interventions, ultimately leading to better patient care and outcomes in subacute stroke rehabilitation.

Keywords: Balance, Walking ability, Rehabilitation

บทนำ (Introduction)

Stroke is a leading cause of long-term disability worldwide, with significant implications for individuals' functional abilities and quality of life(Feigin et al., 2016). Among the many challenges faced by stroke survivors, impairments in balance and walking ability represent a crucial aspect affecting independence and participation in daily activities(Langhorne, Bernhardt, & Kwakkel, 2011). Furthermore, previous research revealed that balance and trunk control are strong predictors of post-stroke walking ability outcomes(Preston et al., 2021). Therefore, assessing balance is an essential requirement in the process of rehabilitating stroke patients.

Assessing balance is a crucial goal in the process of rehabilitating stroke patients(Tyson & Connell, 2009). The Berg Balance Scale (BBS) and the Postural Assessment Scale for Stroke Patients (PASS) are the primary assessment tools used to evaluate balance in individuals who have had a stroke(Barak & Duncan, 2006; Benaim et al., 1999). The Academy of Neurologic Physical Therapy (ANPT) recommended the use of the PASS as a means of evaluating balance outcomes(Rose, 2021). We highly recommend using this strategy for both inpatient and outpatient stroke treatment, as well as acute stroke rehabilitation(Rose, 2021). The PASS scale assesses balance by examining the patient's posture in supine, seated, and upright positions. The assessment consists of 12 items, each with a value ranging from 0 to 3. A score of 0 indicates the lowest degree of functioning, while a score of 3 indicates the most. The maximum possible total score is 36(Benaim et al., 1999; Chien et al., 2007).

PASS, which evaluates the ability to move in bed, is more appropriate than the BBS for assessing patients in the first stages of rehabilitation(Dos Santos et al., 2023; Tyson & DeSouza, 2004). PASS had excellent intra-rater reliability for the total score ($r = 0.98$, $p < 0.001$) in people who had just had an acute stroke (Benaim et al., 1999). Similarly, it has been found excellent inter-rater reliability for the total score (ICC = 0.97, 95% confidence interval (CI) 0.95-0.98) in people who had just had a stroke (Mao et al., 2002). A strong correlation ($p = 0.92$-0.95) has been demonstrated between the scores of both tests (PASS and BBS) during the acute stage of stroke, 180 days following the onset. This indicated a high level of concurrent validity(Mao et al., 2002). The PASS scale demonstrated good construct validity with the FAC, WGS, FIM, and BI at 6 and 12 months. This suggested that the PASS scale is a good way to measure balance in stroke patients, especially during the stroke phases at 6 and 12

months(Estrada-Barranco et al., 2021). The previous studies focused on the subacute stroke period, which was scarce. Researchers had not previously studied the intra-interrater reliability of PASS and the concurrent validity of PASS and BBS in subacute stroke patients.

Our study was interested in investigating the concurrent validity and reliability of the PASS balance assessment tools. Assessing the validity and reliability of these tools is important, as it holds the key to improving patient outcomes and optimizing rehabilitation strategies. Despite the increasing use of PASS in clinical settings, research on its psychometric properties remains lacking, particularly in the context of subacute stroke. The study's findings hold significant potential to benefit physicians and physical therapists by providing them with valuable information for integrating the PASS assessment tool into rehabilitation protocols. Additionally, the study's insights could enhance the monitoring of patients' progress with increased certainty, ultimately leading to more informed decision-making in clinical practice.

วัตถุประสงค์การวิจัย(Purposes)

1. To verify the inter-rater and intra-rater reliability of PASS scores in subacute stroke patients.
2. To investigate the concurrent validity of PASS with BBS in subacute stroke patients.

สมมติฐานการวิจัย(Hypothesis)

The hypothesis posited a positive correlation between PASS and BBS results, indicating the concurrent validity of the tests. Furthermore, there was an expectation of excellent reliability for PASS scores across multiple raters and within the same rater.

กรอบแนวคิดการวิจัย(Conceptual framework)

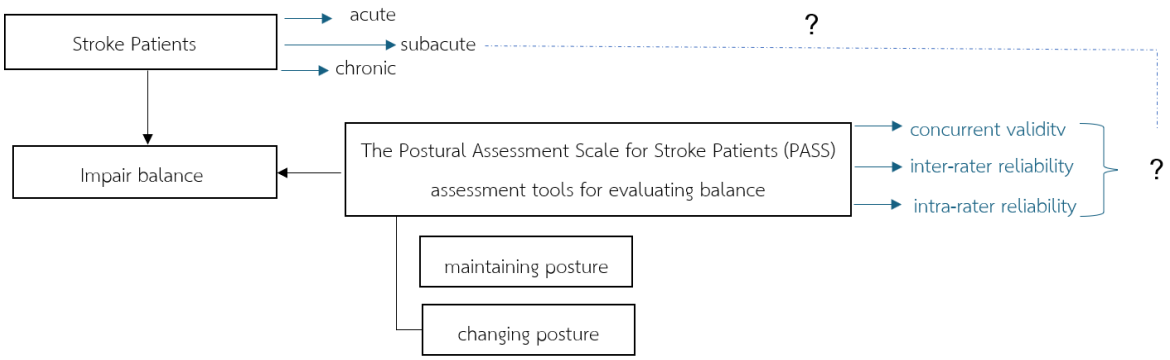


Figure 1 Conceptual framework

วิธีดำเนินการวิจัย (Research Methodology)

ประชากรและกลุ่มตัวอย่าง(Population and Sample size)

This study used a cross-sectional design and determined the sample size before beginning the investigation. The calculated total sample size was 14, with a minimum acceptable reliability (ICC) ($\rho 0$) of 0.60 and an anticipated reliability (ICC) ($\rho 1$) of 0.9, a significance level (α) of 0.05, and a power (1-β) of 80%. After considering a dropout rate of 10%, the final sample size was found to be 16 participants (Arifin, 2024). At the beginning of our study, all stroke patients were invited to participate in the study. We determined eligibility by evaluating the following criteria: (1) Participants must be between the ages of 18 and 80, regardless of gender. (2) A definitive diagnosis of stroke made by a neurologist, substantiated by MRI or CT results. (3) Duration of time passed from the onset of the stroke, between 31 and 180 days; (4) Stable medical conditions are defined as having constant vital signs. (5) ability to understand and execute instructions that include two steps. We excluded the following categories of individuals from our study: (1) Individuals with orthopedic or neurological problems that might negatively affect gait or balance, such as severe osteoarthritis, recurrent stroke, cardiac conditions, vestibular disorders like vertigo, or Parkinson's disease, will not be included. (2) Previous lower limb surgical operations, such as knee or hip arthroplasty, that might hinder movement. (3) Reports of leg soreness with a pain score of 8 out of 10 or significant exhaustion on the scheduled evaluation day.

เครื่องมือที่ใช้ในการรวบรวมข้อมูล(Outcome Assessments)

There were two balance assessments, the PASS and BBS. The PASS evaluates a person's ability to maintain or change body positions, ranging from lying to upright. The set consists of 12 items, each assigned a score ranging from 0 (indicating inability to execute) to 3 (indicating optimal performance). The total score might vary between 0 and 36, with higher values suggesting superior postural control (Anderson, 2016; Benaim et al., 1999). PASS consisted of two subsystems: (1) maintaining a posture of 5 items; and (2) changing a posture of 7 items (Anderson, 2016). The researcher will provide detailed instructions for each item, demonstrate the activity if necessary, and then watch the participant's execution. During this investigation, the researcher will protect the participants' safety by providing assistance or hands-on support as needed. The BBS is a set of 14 items designed to evaluate an individual's static and dynamic balance skills. The scale of scores for each task ranges from 0 to 4, with the highest possible score of 56 representing perfect balance (Miyata et al., 2022). The tasks will vary in difficulty, ranging from basic movements such as sitting without help to more challenging ones like balancing on one foot (Blum & Korner-Bitensky, 2008; Miyata et al., 2022). The researcher will provide clear spoken instructions for each activity. Precautions, such as using a belt and ensuring the testing area is clear of obstructions, will be put in place to ensure safety.

วิธีรวบรวมข้อมูล(Data Collection)

We collected all of the initial screening data of all individuals, including age, gender, type of stroke, comorbidities, onset, and eligibility criteria. All of the researchers who evaluated the tests were experienced neurological physical therapists with a minimum of 5 years of professional experience. The researcher 1 assessed concurrent validity by scoring the participants after they completed the PASS and BBS exams in a face-to-face setting. Regarding inter-rater reliability (ICC2,1), both researchers decided on a PASS assessment after separately watching the video. (after a 7-day evaluation period). The researcher 1 assessed the intra-rater reliability (ICC3 ,1) by watching the video and scoring it as a PASS. This evaluation was conducted after 7- and 14-days evaluation period (Figure 2).

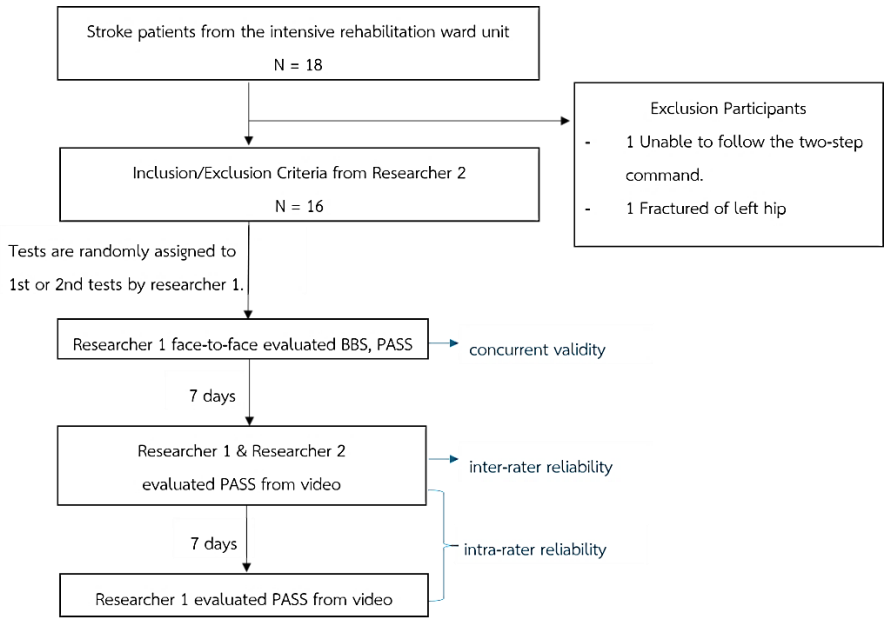


Figure 2 Flow of participants and Statistical analysis

สถิติที่ใช้ในการวิเคราะห์ข้อมูล(Statistical Analysis)

Participant characteristics were analyzed using descriptive statistics, including measures of position and variability for quantitative variables and relative percentages for categorical variables. Statistical analyses were conducted using SPSS Statistics version 28, with a significance level set at $P < 0.05$. We analyzed the intra-rater reliability of PASS using their ICC $(3,1)$, and we determined the inter-rater reliability of PASS using their ICC $(2,1)$(Koo & Li, 2016).The interpretation of ICC values indicated that values below 0.5 indicate poor reliability, values between 0.5 and 0.75 indicate moderate reliability, values between 0.75 and 0.9 indicate good reliability, and values over 0.90 indicate excellent reliability(Koo & Li, 2016).We assessed absolute reliability by utilizing the standard error of measurement (SEM) to determine the minimal detectable change at a 95% confidence interval (MDC 95). SEM was calculated according to the following formulae: $SEM = SD \times \sqrt{(1 - ICC)}$, and $MDC\ 95 = SEM \times 1.96 \times \sqrt{2}$, where SD represents the standard deviation of the scores obtained from all individuals and ICC refers to the intra-rater reliability(Viveiro et al., 2019).

The concurrent validity assessment assessed the correlation between scores obtained from PASS and BBS. We determined concurrent validity using the Spearman rank correlation coefficient (r). The Spearman rank correlation coefficient ranges between -1 and

+1. An r value of +1 indicates a perfect positive linear relationship, while an r value of -1 indicates a perfect negative linear relationship (Akoglu, 2018). The Spearman rank correlation coefficient (r) was interpreted according to around 0.1 to 0.2 = poor relationship, 0.3 to 0.5 = fair degree of relationship, 0.6 to 0.7 = moderate/good relationship, and 0.8 to 0.9 = very strong/excellent correlation. An r value of 0 suggests no linear relationship (Akoglu, 2018).

สรุปผลการวิจัย (Results)

At the start of our study, we initially encountered 18 stroke patients at the Sirindhorn National Medical Rehabilitation Institute. However, two individuals were excluded due to their inability to follow a two-step command and a left hip fracture (Figure 2). Of the remaining 16 participants in our sample, 12 (75%) were male, while 4 (25%) were female. The average age of the subjects was 57.56 years, with a standard deviation of 0.56 (Table 1). And Table 1 delineates additional clinical characteristics, including the time since stroke onset.

Table 1 Demographic and clinical characteristics of people with subacute strokes in the study. Characteristics Total (n=16)

Characteristics	Total (n=16)
Age (years)	57.56±0.56
Gender (male), n (%)	12(75%)
Time since stroke onset (days)	100.38±46.09
Type of stroke (ischemic), n (%)	12(75%)
Affected side (left), n (%)	8(50%)

The intra-rater reliability results for PASS, including its subsystems, revealed excellent reliability, with all total PASS scores and subsystems related to maintaining and changing posture demonstrating intraclass correlation coefficients (ICCs) exceeding 0.90 (Table 2). Inter-rater reliability also demonstrated excellent reliability (ICC > 0.90) for PASS scores overall, with subsystems related to maintaining and changing posture indicating good reliability (ICC > 0.75-0.90) (Table 2). Additionally, Table 3 presents the standard error of the mean (SEM) and the minimum detectable change at the 95% confidence level (MDC 95) for PASS scores.

Table 2 Intra-rater and inter-rater reliability of the BBS and PASS

Balance Tests	Intra-rater Reliability (n = 16)		Inter-rater Reliability (n = 16)	
	ICC $_{(3,1)}$	95% CI	ICC $_{(2,1)}$	95% CI
PASS (total score)	0.999	0.998-1.0	0.969	0.892-0.990
Subsystems of PASS				
Maintaining a Posture	0.904	0.748-0.965	0.885	0.707-0.958
Changing a Posture	0.974	0.927-0.991	0.894	0.408-0.971

All intraclass correlation coefficients (ICCs) were significant, with a p-value of <0.01.

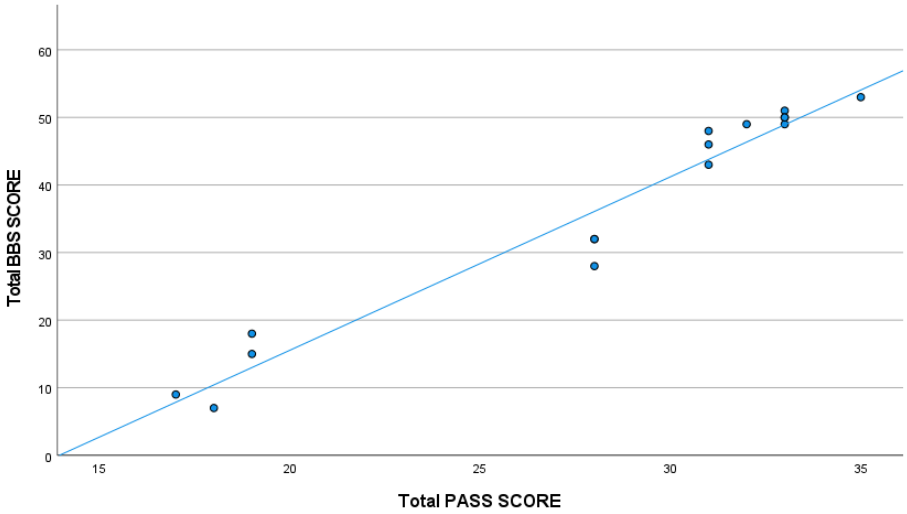
CI: confidence interval

Table 3 SEM and MDC 95 for the PASS

Balance Tests	SEM(Points)	MDC_{95} (Points)
PASS (total score)	0.19	0.54
Subsystems of PASS		
Maintaining a Posture	0.79	2.19
Changing a Posture	0.59	1.63

Concurrent validity assesses the correlation between scores obtained from PASS and BBS. The study demonstrated an excellent positive correlation ($r = 0.981$, $p < 0.01$) between the total scores of PASS and BBS, indicating concurrent validity of the PASS total score in subacute stroke patients (Figure 3).

Figure 3 The scatter diagram shows a



correlation between the scores of PASS and BBS.

(r) Spearman; r = 0.981, p < 0.01.

(*) The correlation is significant at the 0.01 level (2-tailed).

อภิปรายผลการวิจัย(Discussion)

Our study highlights the importance of identifying balance issues to reduce fall risks, enhance walking ability, and improve the quality of life for stroke patients. Our evaluation of the PASS revealed outstanding levels of intra- and inter-rater reliability. Additionally, the PASS exhibited robust concurrent validity when compared with the widely-used BBS.

These results strongly support the effectiveness and utility of the PASS as a valuable tool for assessing balance in stroke patients. This has significant implications for guiding rehabilitation interventions and optimizing patient outcomes. Importantly, our study is the first to investigate the measurement properties of the PASS specifically in subacute stroke patients, filling a notable gap in the existing literature. This pioneering aspect of our research highlights the unique importance of understanding balance assessment during this critical phase of stroke recovery. Furthermore, our findings suggest that subacute stroke patients can effectively utilize either the PASS or the BBS to assess their balance.

While previous studies have reported similar results in other phases of stroke recovery, such as good reliability and validity of the PASS in chronic stroke patients (Benaim

et al., 1999), and slightly superior psychometric properties of the PASS compared to the BBS and Functional Independence Measure for Balance during the acute stage and up to 180 days post-stroke (Mao et al., 2002), our study extends this understanding specifically to the subacute phase. Overall, these findings suggest that the PASS maintains reliability across different stages of stroke recovery, further supporting its utility as a comprehensive assessment tool for balance in stroke rehabilitation, particularly in the subacute phase.

In our study, it is noteworthy to highlight the exceptionally low Standard Error of Measurement (SEM) value of 0.19 points reported for the PASS. This value signifies a remarkably small degree of variability or error in the measurement, underscoring the high precision and reliability of the PASS scores obtained in our study. Comparatively, this SEM value stands out as significantly smaller than those reported in other studies. For instance, studies have reported SEM values of 1.14 points for PASS in chronic stroke patients (Liaw et al., 2008) and 2.4 points for PASS in acute stroke patients (Chien et al., 2007). Our study's SEM value of 0.19 points indicates a notably higher level of accuracy and consistency in the assessment of balance using the PASS.

The remarkable difference in the SEM value, notably smaller in our study (0.19 points) compared to previous studies, may be attributed to several factors unique to our methodology and expertise of the evaluators. Firstly, our study utilized video recording during reliability testing, which could have contributed to minimizing measurement error. Video recording allows for precise observation and review of patient movements, ensuring consistency in scoring and reducing the likelihood of subjective interpretation variations among evaluators. This meticulous approach likely enhanced the reliability of the PASS assessment in our study. Secondly, the evaluators in our study were physical therapists specialized in neurological conditions with extensive experience exceeding five years. Their expertise and familiarity with stroke rehabilitation likely contributed to a higher level of skill and accuracy in administering the PASS, resulting in reduced measurement error. The ability of experienced physical therapists to discern subtle changes in posture and balance could have further enhanced the reliability of the assessment. This exceedingly small SEM value strengthens the confidence in the reliability and precision of the PASS as an assessment tool for balance in stroke patients. It suggests that the PASS yields highly consistent and dependable results,

further supporting its effectiveness in clinical practice and rehabilitation interventions for stroke survivors.

The MDC95 serves as a crucial indicator of the smallest clinically significant change in a measurement beyond random error. When comparing our findings with those reported in acute stroke patients, we find notable similarities in the sensitivity and precision of the PASS across different stages of stroke recovery. In the study, consistent MDC95 values of 1.8 points were reported for the PASS test in acute stroke patients (Hsueh et al., 2013). This suggests that a change of at least 1.8 points in PASS scores is required to confidently discern meaningful improvements in balance among acute stroke patients. In our study, we similarly found the MDC95 for PASS to be quite comparable, with a value of 0.54 points in the total score. Specifically, it was 2.19 points for maintaining a posture and 1.63 points for changing a posture. These findings indicate that relatively small changes in PASS scores are necessary to detect improvements in balance among stroke patients in the subacute phase.

In clinical settings, the PASS presents several practical advantages over alternative assessment tools. One of its key benefits is its user-friendly nature, requiring a relatively short assessment time of 10–15 minutes. In comparison, the BBS, another commonly used assessment tool for balance, typically takes 20–30 minutes to administer. Despite both tests yielding reliable results, the simplicity and efficiency of PASS make it especially suitable for hospital or rehabilitation settings where quick balance assessments are invaluable. The streamlined process of PASS allows healthcare professionals to efficiently evaluate a patient's balance abilities without significant time investment, enabling them to promptly identify any deficits and tailor rehabilitation interventions accordingly.

The present study further confirmed the validity of PASS compared to the BBS, demonstrating its utility in assessing balance issues among subacute stroke patients. However, our investigation focused solely on concurrent validity within this specific population. Future research should explore the validity of PASS in assessing balance among individuals with chronic stroke, particularly those with low functional performance, such as those requiring dependent or supervised walking. When utilizing PASS in different settings, we recommend adhering to the training methods outlined in this study to ensure the reliability of raters and

test results. This will help maintain consistency and accuracy in balance assessments across various clinical contexts.

However, the study had limitations. It focused solely on subacute stroke patients, limiting generalizability to other stroke phases or patient populations. Future research could explore the validity of PASS in chronic stroke patients or those with varying levels of functional impairment. Additionally, while the study demonstrated concurrent validity with the BBS, further investigation into the criterion validity of PASS against gold standard measures of balance would strengthen its validity evidence.

In summary, these findings underscore the suitability of PASS as a feasible testing instrument for identifying balance issues in patients with subacute stroke, making it a valuable addition to clinical practice. Its simplicity and efficiency, evidenced by its short assessment time and user-friendly nature, render PASS a practical choice for balance assessment in stroke rehabilitation settings. The robust reliability and concurrent validity demonstrated by PASS further support its utility as a reliable and valid tool for evaluating balance in subacute stroke patients, facilitating prompt identification of deficits and tailored rehabilitation interventions. Overall, the study highlights the clinical utility of PASS in efficiently assessing balance in subacute stroke patients, ultimately contributing to improved patient care and outcomes.

ข้อเสนอแนะ(Recommendations)

This study validates PASS as a quick, simple, and effective tool for assessing balance issues in subacute stroke patients, recommending its integration into clinical practice. Demonstrating reliability and validity, PASS enables timely identification of deficits and personalized interventions, enhancing rehabilitation outcomes and patient care.

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