Original Article

A Retrospective Analysis of Stroke Rehabilitation Outcomes in the Intermediate Care (IMC) Service Plan Comparing Home-based and Outpatient-Based Services Using Propensity Score Matching

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ABSTRACT

Objectives: To compare rehabilitation outcomes up to 24 weeks post-stroke, therapy exposure, and complication rates between home-based and outpatient-based IMC stroke rehabilitation programs, before and after propensity score matching in a hospital.

Study design: Retrospective observational cohort design with Propensity Score Matching

Setting: Department of Rehabilitation Medicine, Songkhla Hospital, a tertiary care hospital in southern Thailand

Participants: Intermediate care stroke patients who received rehabilitation services through either the home-based or outpatient-based model between October 2022 and September 2025.

Methods: This retrospective study analyzed stroke patients enrolled in the IMC program. Baseline characteristics, Barthel Index (BI) scores, dependency levels, complications, and therapy session counts were collected at baseline, 2 weeks, 12 weeks, and 24 weeks. Propensity score matching was conducted using initial BI, National Institutes of Health Stroke Scale (NIHSS), age, sex, and other key covariates to ensure baseline clinical balance.

Results: Before matching, the home-based group was older and predominantly female, while the outpatient-based group tended to present with more-severe strokes and lower initial BI scores. The outpatient-based group also received substantially more therapy (median PT: 10 vs. 3; OT: 8 vs. 1; both $p < 0.001$). After matching, therapy exposure remained higher in the outpatient-based group (PT: 1.6 [SD = 1.9] vs. 8.5 [SD = 6.6], SMD = –1.63; OT: 8.5 [SD = 6.2] vs. 9.2 [SD = 6.2], SMD = –1.43). Short- and intermediate-term BI gains were similar between the groups, with identical median gains during several intervals. Long-term BI gain (baseline–24 weeks) was greater in the outpatient-based group. The home-based group met non-inferiority criteria for BI gain at 24 weeks ($p = 0.035$), but not at 12 weeks. Trends toward higher pneumonia and pressure ulcer rates were observed in the home-based group, whereas recurrent stroke tended to be more common in the outpatient-based group, though neither reached statistical significance. At 6 months, 62.7% of the home-based and 63.7% of the outpatient-based group had achieved a level of mild or no disability.

Conclusions: Home-based and outpatient-based IMC rehabilitation yielded broadly comparable outcomes despite a substantially lower therapy dosage in the home-based group. Increasing therapy intensity and integrating advanced rehabilitation technologies could potentially further improve functional recovery within the IMC framework. The home-based group demonstrated statistically non-significant trends toward higher rates of preventable complications such as pneumonia and pressure ulcers.

Keywords: home-based, outpatient-based, functional outcome, intermediate care (IMC), propensity score

ASEAN J Rehabil Med. 2026; 36(3): 132-140.
doi: 10.67880/ajrm.2026.36.04

Introduction

Stroke remains a leading cause of mortality and disability worldwide, including Thailand, with significant implications for functional independence and quality of life.[1-4] The subacute or intermediate care phase, defined as the first six months post-stroke, is recognized as a golden period for neuroplasticity and functional recovery. Neuroimaging studies have demonstrated enhanced cortical reorganization during this period,[5] and early rehabilitation interventions have been associated with improved activities of daily living (ADL) and reduced long-term dependency.[6,7]

In Thailand, the Ministry of Public Health has implemented an Intermediate care (IMC) service plan to address the growing burden of stroke-related disability and to provide a seamless service network to fill the gap left by insufficient transitional care between acute care to long-term care (LTC). This service system is composed of multidisciplinary teams that collaborate and link healthcare facilities at all levels. Depending on their needs and readiness, patients and families will be offered various rehabilitation services, including inpatient (minimum 15 hours per week), outpatient, and outreach services, with a mean of 1 to 3 sessions per week (minimum 30 sessions in 6 months).[8]

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Received: February 17, 2026 Revised: April 8, 2026 Accepted: May 1, 2026

Telerehabilitation (TR) technologies are increasingly being used in stroke rehabilitation. These technologies have the potential to increase therapy intensity, motivate users through engaging, interactive environments, and improve access to rehabilitation services in both clinical and home settings. Usability assessment is essential to ensure effective, engaging, and accessible interventions.[9]

Songkhla Hospital has implemented an IMC service tailored to stroke survivors since 2019, delivered through 2 intermediate beds, outpatient services, and outreach rehabilitation, including home-based and community-based rehabilitation. Due to infrastructure limitations, these services are limited to outpatient-based and home-based models, with no intensive inpatient rehabilitation available. This study aimed to evaluate the outcomes of these two service delivery models, focusing on functional outcomes as measured by the Barthel Index (BI), to identify current limitations and opportunities for improving stroke rehabilitation care in Songkhla Hospital.

The objectives of this study are twofold: (1) to compare patient characteristics (age, gender, comorbidities, stroke severity and type) and initial functional status between home-based and outpatient-based groups, and (2) to assess differences in functional outcomes (BI changes over time) between the two groups using standard t-tests and propensity score matching to account for potential biases. We hypothesized that home-based rehabilitation would be non-inferior to outpatient-based rehabilitation in BI gains, with a margin of 1.85 points.

Methods

Study design

This report is a retrospective observational cohort design using Propensity Score Matching. Chart review to analyze IMC rehabilitation stroke patients at Songkhla Hospital from October 2022 to September 2025. The Songkhla Hospital Institutional Review Board granted ethical approval (approval number SKH IRB 2026-Md-In3-1004, October 22, 2025). This study has been reported according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for observational studies.

Participants

Eligible cases included IMC stroke patients who had received rehabilitation services through either the outpatient-based or home-based model. Exclusion criteria were: (1) deceased patients (death occurring within 2 weeks after hospital discharge), n = 68, (2) incomplete medical records (BI scores at 2 weeks and 3 months), n = 38, and (3) patients achieving a BI score of 20 (indicating full functional independence) at 2 weeks post-stroke, n = 148. A total of 204 patients were included, with 102 in the home-based group and 102 in the outpatient-based group (Figure 1).

Data collection

Data were extracted from medical records, including:

- Demographics: age, gender.
- Premorbid health status: presence of dyslipidemia (DLP), hypertension (HT), diabetes mellitus (DM), heart disease, atrial fibrillation (AF), and previous stroke.
- Stroke characteristics: Type (ischemic or hemorrhagic), side (left or right), National Institutes of Health Stroke Scale (NIHSS) score at admission to acute care, and length of stay (LOS) in acute care.
- Rehabilitation outcomes: BI scores at admission (initial), 2 weeks, 3 months, and 6 months post-stroke plus BI gains between these time points.
- Care delivery: number of physical therapy (PT) and occupational therapy (OT) sessions.
- Home-based program: PT and/or OT delivered therapy, 45 minutes per session, 1 to 2 sessions per month.
- Outpatient-based program: PT and OT delivered therapy, 45 minutes per session, 1 to 2 sessions per week.
- Complications and impairments: Presence of complications (e.g., joint stiffness, pneumonia, recurrent stroke, urinary tract infection), speech impairments (aphasia, dysarthria), swallowing difficulties, and spasticity (Modified Ashworth Scale).

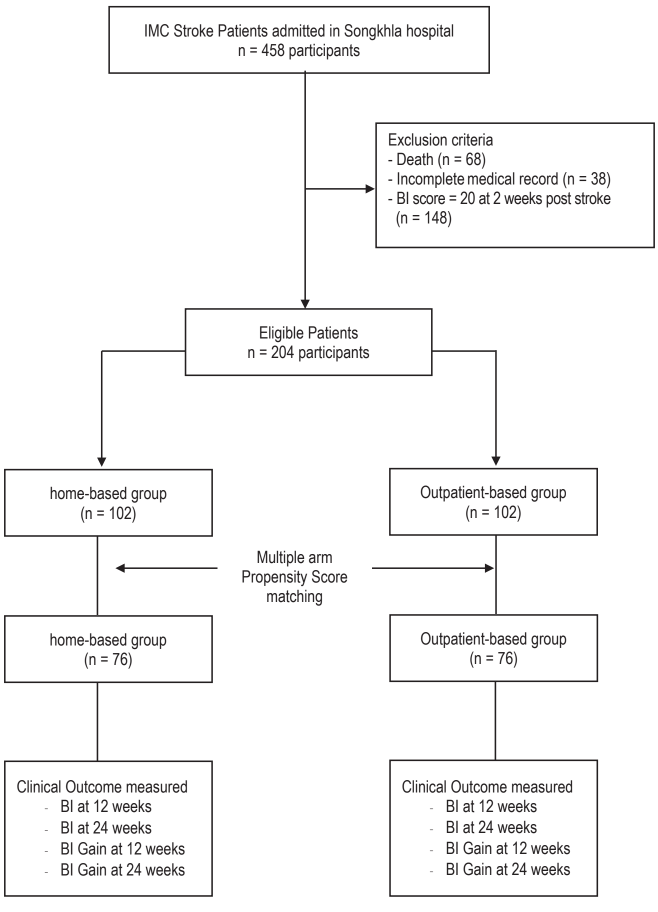

Figure 1. Flow of participants through the study
IMC, Intermediate care; BI, Barthel Index

- Dependency status: categorized at 2, 12 and 24 weeks post-stroke based on BI scores (no disability: 20; mild disability: 15 to 19; moderate disability: 10 to 14; severe disability: 5 to 9; very severe disability: 0 to 4).

Sample size

The sample size was calculated using the non-inferiority margin of 1.85, which represents the Minimal Clinically Important Difference (MCID) for the BI in stroke patients[10] with a standard deviation of 4.94 in clinical endpoint BI at 6 months after stroke, p-value = 0.05, power 0.80, and ratio sample size 1:1 (matching). The required sample size was 178 participants (89 per group).

Statistical analysis

Descriptive statistics were used to summarize patient characteristics and outcomes. Continuous variables (e.g., age, BI scores, number of therapy sessions) are reported as means (SD) or medians (interquartile ranges, IQR) for non-normally distributed data (confirmed by Shapiro-Wilk tests, $p < 0.001$ for most variables). Categorical variables (e.g., gender, complications) are reported as numbers and percentages. Group comparisons used:

- t-tests or Mann-Whitney tests for continuous variables, depending on normality.
- Chi-squared tests for categorical variables.
- Propensity score matching to adjust for potential confounding factors and to evaluate the unbiased effect of the service model on outcomes.
- Non-inferiority statistics to assess equivalence in dependency status at 3 and 6 months.

Statistical significance was set at $p < 0.05$. Analyses were conducted using appropriate statistical software.

Results

Patient characteristics

A total of 204 patients were included, with 112 (54.9%) males and 92 (45.1%) females. The home-based group (n = 102) had a higher proportion of females (52.0% vs. 38.2%, SMD = 0.27) and a higher mean age (68.1 (SD = 12.4) vs. 62.8 (SD = 12.9) years, SMD = 0.42) than the outpatient-based group (n = 102). No significant differences were found in comorbidities (DLP, HT, diabetes, heart disease, AF, previous stroke), stroke type (ischemic vs. hemorrhagic), stroke side, or LOS in acute care (Table 1).

Stroke severity and functional outcomes

There was a non-statistically significant trend suggesting that the outpatient-based group presented with higher median NIHSS scores (home-based: 6 [IQR: 4–11] vs. outpatient-based: 8 [IQR: 4–14], $p = 0.180$), a longer median LOS (home-based: 4 [IQR: 3–7] vs. outpatient-based: 5 [IQR: 3–7], $p = 0.327$), and lower median initial BI scores (home-based: 6 [IQR: 4–8] vs. outpatient-based: 5 [IQR: 2–7], $p = 0.036$) (Table 2). The outpatient-based group also demonstrated greater, longer-term BI gains from baseline to 24 weeks (home-based: 10 [IQR: 4–14] vs. outpatient-based: 12 [IQR: 7–14], $p = 0.202$), as well as from 2 weeks to 24 weeks (home-based: 4 [IQR: 2–8] vs. outpatient-based: 6 [IQR: 2–9], $p = 0.071$), although these differences did not reach statistical significance.

Interestingly, BI scores in the outpatient-based group tended to be lower than those in the home-based group at multiple time points: at 2 weeks (home-based: 12 [IQR: 6–15] vs. outpatient-based: 10 [IQR: 6–12], $p = 0.040$), at 12 weeks (home-based: 14 [IQR: 9–19] vs. outpatient-based: 12 [IQR: 9–17], $p = 0.055$), and at 24 weeks (home-based: 18 [IQR: 13–20] vs. outpatient-based: 17 [IQR: 12–20], $p = 0.655$). However, median BI gains over shorter time intervals—baseline to 2 weeks (home-based: 5 [IQR: 1–8] vs. outpatient-based: 5 [IQR: 2–7], $p = 0.936$) and 2 weeks to 12 weeks (home-based: 2 [IQR: 0–5] vs. outpatient-based: 2 [IQR: 0–5], $p = 0.950$)—were similar.

Care delivery and complications

The outpatient-based group received significantly more therapy sessions than the home-based group: median PT sessions were 10 (IQR: 7–17) vs. 3 (IQR: 2–4; $p < 0.001$), and median OT sessions were 8 (IQR: 3–14) vs. 1 (IQR: 0–2; $p < 0.001$). Complications were more frequent in the outpatient-based group (26.5% vs. 14.7%, $p = 0.038$), particularly joint stiffness (25.5% vs. 13.7%, $p = 0.034$). No statistically significant differences were observed in pneumonia (home-based: 6.9% vs. outpatient-based: 3.9%, $p = 0.352$), recurrent stroke (home-based: 6.9% vs. outpatient-based: 10.8%, $p = 0.324$), or urinary tract infections (home-based: 1.0% vs. outpatient-based: 2.0%, $p = 0.561$). Speech impairments, swallowing difficulties, and spasticity were also comparable between the groups (Table 3).

There were non-statistically significant trends indicating a higher occurrence of pressure ulcers in the home-based group (4.9% vs. 2.0%, $p = 0.249$) and recurrent stroke in the outpatient-based group (10.8% vs. 6.9%, $p = 0.324$), although neither of these trends reached statistical significance.

Dependency status

As shown in Table 4, both groups demonstrated a high proportion of very severe and severe disability at the initial time point (home-based: very severe 32.4%, severe 48.0%; outpatient-based: very severe 40.2%, severe 51.0%), with these proportions gradually decreasing over time in both cohorts. Interestingly, although the outpatient-based group showed a higher percentage of very severe and severe disability at baseline, at 3 months (home-based: very severe 6.9%, severe 18.6% vs. outpatient-based: very severe 3.9%, severe 23.5%) and 6 months (home-based: very severe 4.9%, severe 11.8% vs. outpatient-based: very severe 2.9%, severe 14.7%), the home-based group had a greater proportion of patients remaining in these more dependent categories;

Table 1. Patient demographics, clinical characteristics, and prognostic factors: a comparison between home-based and outpatient-based stroke rehabilitation programs

Characteristics	Original cohort			Propensity-matched cohort		
	Home-based	Outpatient-based	SMD	Home-based	Outpatient-based	SMD
n (%)	102 (50.0)	102 (50.0)		76 (50.0)	76 (50.0)	
Female[1]	53 (52.0)	39 (38.2)	0.27	43 (56.6)	44 (57.9)	0.02
Age[2]	68.1 (12.4)	62.8 (12.9)	0.42	65.8 (12.4)	65.2 (12.0)	0.04
Comorbidities[1]	91 (89.2)	86 (84.3)		66 (86.8)	66 (86.8)	0.00
Hypertension[1]	75 (73.5)	72 (70.6)	0.06	53 (69.7)	55 (72.4)	0.05
Diabetes[1]	32 (31.4)	26 (25.5)	0.13	22 (28.9)	23 (30.3)	0.02
Dyslipidemia[1]	47 (46.1)	39 (38.2)	0.15	32 (42.1)	32 (42.1)	0.00
Previous stroke[1]	31 (30.4)	24 (23.5)	0.15	20 (26.3)	20 (26.3)	0.00
Atrial fibrillation[1]	9 (8.8)	7 (6.9)	0.07	7 (9.2)	7 (9.2)	0.00
Heart disease[1]	14 (13.7)	10 (9.8)	0.12	9 (11.8)	10 (13.2)	0.03
Premorbidity[1]						
Independent free-hand	82 (80.4)	89 (87.3)		65 (85.5)	65 (85.5)	
Independent with gait aids	16 (15.7)	12 (11.8)		10 (13.2)	10 (13.2)	
Need assist or cannot walk	4 (3.9)	1 (1.0)	0.22	1 (1.3)	1 (1.3)	0.00
Type of stroke[1]						
Ischemia	74 (72.5)	74 (72.5)		53 (69.7)	58 (76.3)	
Hemorrhage	28 (27.5)	28 (27.5)	0.00	23 (30.3)	18 (23.7)	0.14
Side of stroke[1]						
Left	46 (45.1)	53 (52.0)		39 (51.3)	40 (52.6)	
Right	56 (54.9)	49 (48.0)	0.13	37 (48.7)	36 (47.4)	0.02
Dysphagia[1]	24 (23.5)	26 (25.5)	0.05	19 (25)	19 (25)	0.05
Aphasia[1]	9 (8.8)	15 (14.7)		8 (10.5)	8 (10.5)	
Dysarthria[1]	53 (52.0)	60 (58.8)	0.24	43 (56.6)	43 (56.6)	0.00
Cognitive impairment[1]	22 (21.6)	25 (24.5)	0.06	17 (22.4)	18 (23.7)	0.03
Spastic[1]						
MAS I	1 (1.0)	5 (4.9)		1 (1.3)	4 (5.3)	
MAS I +	1 (1.0)	1 (1.0)	0.23	1 (1.3)	1 (1.3)	0.22
NIHSS[2]	8.4 (6.2)	9.3 (6.2)	-0.09	8.5 (6.2)	9.2 (6.2)	-0.11
LOS[2]	6.6 (7.8)	7.3 (7.1)	-0.14	6.4 (6.2)	6.6 (6.6)	-0.02
BI Initial[2]	6.1 (4.1)	4.9 (3.5)	0.30	5.8.(3.8)	5.6 (3.5)	0.05
Treatment[1]				62 (81.6)	61 (80.3)	
Medication	79 (77.5)	78 (76.5)		8 (10.5)	8 (10.5)	
rtPA	10 (9.8)	13 (12.7)		2 (2.6)	2 (2.6)	
rtPA + thrombectomy	4 (3.9)	2 (2.0)		4 (5.3)	5 (6.6)	
Surgery	9 (8.8)	9 (8.8)	0.14	3.1 (1.7)	11.8 (7.3)	0.05
Number of PT session[2]	3.1 (1.5)	12.1 (6.8)	-1.82	1.6 (1.9)	8.5 (6.6)	-1.63
Number of OT session[2]	1.4 (1.7)	8.7 (6.3)	-1.57	8.5 (6.2)	9.2 (6.2)	-1.43

[1]Number (%), [2]mean (SD)

SMD, standardised mean difference; BI, Barthel Index; NIHSS, The National Institutes of Health Stroke Scale; LOS, Length of stay; rtPA, recombinant tissue plasminogen activator; OT, occupational therapy; PT, physical therapy; MAS, The Modified Ashworth Scale, BI initial, BI score at admission

however, these trends did not reach statistical significance.

The only time point at which a statistically significant difference in disability level between groups was observed was at 3 months post-stroke ($p = 0.047$).

Propensity score matching

To mitigate potential confounding by indications arising from baseline differences between the home-based and outpatient-based groups, a propensity score (PS) was estimated using multivariable logistic regression. Covariates included gender, age, HT, DM, DLP, AF, premorbid functional status, treatment type, recurrent stroke, joint stiffness, initial BI, swallowing impairment, speech impairment, cognitive impairment, and NIHSS score (Table 5). The predicted probability of receiving home-based rehabilitation defined the PS for each patient.

Multiple-arm propensity score matching without replacement was performed within propensity score strata (deciles), seeded iteratively to minimize the standardised mean differences (SMD). The optimal seed (370) yielded the smallest mean pairwise SMD of 0.0428, indicating excellent covariate balance (Figure 2). After matching, 76 patients remained in each group (n = 152 total).

Table 2. Stroke severity and outcome of rehabilitation at different time points: comparison between home-based and outpatient-based stroke rehabilitation programs

Variables Median (IQR)	Home-based (n = 102)	Outpatient-based (n = 102)	Test Statistic	*p-value
NIHSS (at acute admission)	6 (4–11)	8 (4–14)	Z = -1.34	0.180[a]
LOS	4 (3–7)	5 (3–7)	Z = -0.98	0.327[a]
BI Initial	6 (4–8)	5 (2–7)	Z = -2.09	0.036[a]
BI at 2 weeks	12 (6–15)	10 (6–12)	Z = -2.05	0.040[a]
BI at 12 weeks	14 (9–19)	12 (9–17)	Z = -1.92	0.055[a]
BI at 24 weeks	18 (13–20)	17 (12–20)	Z = -0.45	0.655[a]
BI Gain initial to 2 weeks	5 (1–8)	5 (2–7)	Z = -0.08	0.936[a]
BI Gain 2 weeks to 12 weeks	2 (0–5)	2 (0–5)	Z = -0.06	0.950[a]
BI Gain 2 weeks to 24 weeks	4 (2–8)	6 (2–9)	Z = -1.80	0.071[a]
BI Gain Initial to 12 weeks	8 (3–12)	7 (4–11)	Z = -0.14	0.887[a]
BI Gain Initial to 24 weeks	10 (4–14)	12 (7–14)	Z = -1.27	0.202[a]

[a]Mann-Whitney test, *$p < 0.05$ indicate statistical significance; SMD, standardised mean difference
NIHSS, The National Institutes of Health Stroke Scale; LOS, Length of stay; BI, Barthel Index

Table 3. Rehabilitation care delivery, specific impairments due to stroke, and complications: comparison between home-based and outpatient-based stroke rehabilitation programs

Variables	Home-based (n = 102)	Outpatient-based (n = 102)	*p-value
Complications			
Joint Stiffness (Upper extremities)[1]	14 (13.7)	26 (25.5)	0.034[b]
Pressure sore[1]	5 (4.9)	2 (2.0)	0.249[b]
Pneumonia[1]	7 (6.9)	4 (3.9)	0.352[b]
Recurrent Stroke[1]	7 (6.9)	11 (10.8)	0.324[b]
UTI [1]	1 (1.0)	2 (2.0)	0.561[b]
Complex stroke impairments			
Aphasia[1]	9 (8.8)	15 (14.7)	0.107[b]
Dysarthria[1]	53 (52.0)	60 (58.8)	
Dysphagia[1]	24 (23.5)	26 (25.5)	0.933[b]
Spasticity[1]			
MAS I	1 (1.0)	5 (4.9)	
MAS I +	1 (1.0)	1 (1.0)	0.253[b]
Access to Care			
Number of OT sessions[3]	1 (0–2)	8 (3–14)	< 0.001[a]
Number of PT sessions[3]	3 (2–4)	10 (7–17)	< 0.001[a]

[1]Number (%), [3]median (IQR), [a]Mann-Whitney test, [b]Chi-squared test; UTI, urinary tract infection; MAS, The Modified Ashworth Scale; OT, occupational therapy; PT, physical therapy

Table 4. Comparison of Barthel index severity classes between home-based and outpatient-based stroke rehabilitation programs at 0, 2, 12 and 24 weeks after stroke

Time point	Program Number (%)	Severity class					p-value
		Very severe disability (BI 0-4)	Severe disability (BI 5-9)	Moderate disability (BI 10-14)	Mild disability (BI 15-19)	No disability (BI 20)	
0 weeks	Home-based	33 (32.4)	49 (48)	16 (15.7)	4 (3.9)	0 (0.0)	0.143
	Outpatient	41 (40.2)	52 (51)	8 (7.8)	1 (1.0)	0 (0.0)	
2 weeks	Home-based	12 (11.8)	33 (32.4)	28 (27.5)	28 (27.5)	1 (1.0)	0.068
	Outpatient	11 (10.8)	40 (39.2)	38 (37.3)	13 (12.7)	0 (0.0)	
12 weeks	Home-based	7 (6.9)	19 (18.6)	26 (25.5)	32 (31.4)	8 (17.6)	0.047*
	Outpatient	4 (3.9)	24 (23.5)	42 (41.2)	23 (22.5)	9 (8.8)	
24 weeks	Home-based	5 (4.9)	12 (11.8)	21 (20.6)	25 (24.5)	39 (38.2)	0.852
	Outpatient	3 (2.9)	15 (14.7)	19 (18.6)	29 (28.4)	36 (35.3)	

*Statistically significant; BI, Barthel Index

Table 5. Derivation of propensity scores via multivariable logistic regression model

Equation parameters	Coefficient	Standard error	95% confidence interval	*p*-value
Female	-0.44	0.32	-1.07, 0.18	0.166
Age	-0.03	0.01	-0.06, -0.01	0.015
Hypertension	0.17	0.36	-0.53, 0.88	0.634
Diabetes mellitus	-0.28	0.37	-1.01, 0.44	0.440
Dyslipidemia	-0.29	0.34	-0.94, 0.37	0.396
Atrial fibrillation	-0.21	0.59	-1.37, 0.95	0.724
Recurrent stroke	0.80	0.58	-0.34, 1.94	0.168
Independent ambulation with gait aid	-0.39	0.48	-1.34, 0.55	0.416
Need assist or cannot walk	-0.82	1.23	-3.23, 1.59	0.506
Dysphagia-On NG	-0.56	0.57	-1.68, 0.56	0.329
Dysphagia-Oral feeding	-0.35	0.66	-1.64, 0.93	0.592
Aphasia	0.79	0.64	-0.46, 2.05	0.216
Dysarthria	0.42	0.35	-0.27, 1.12	0.234
Cognitive impairment	0.22	0.47	-0.70, 1.15	0.637
NIHSS	-0.01	0.04	-0.08, 0.06	0.737
Treatment with rtPA	-0.16	0.52	-1.17, 0.86	0.763
Treatment with surgery	-0.45	0.66	-1.75, 0.85	0.494
Joint stiffness	0.89	0.44	0.03, 1.76	0.042
BI initial	-0.07	0.05	-0.16, 0.02	0.128

On NG, nasogastric tube feeding; NIHSS, National Institutes of Health Stroke Scale; BI, Barthel Index

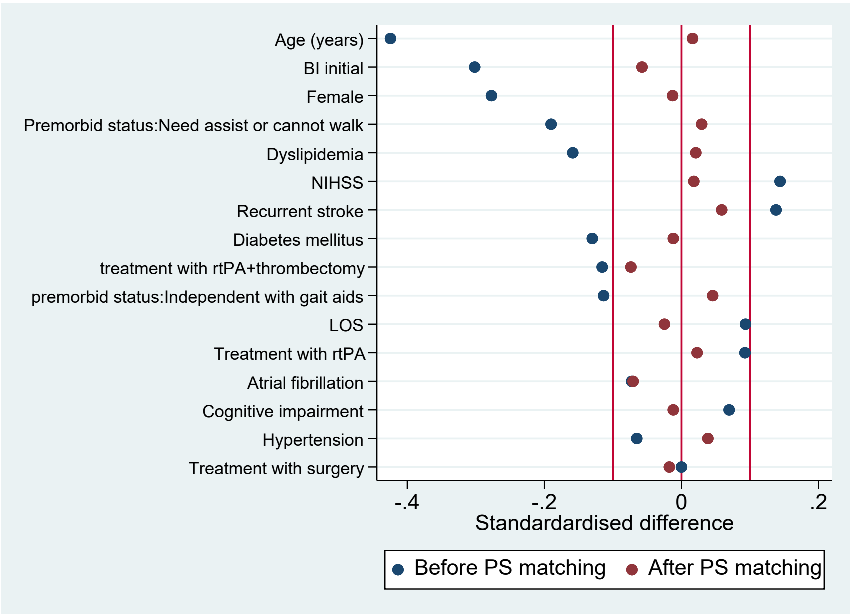

Figure 2. Standardised mean difference (SMD) before and after Propensity Score matching
BI, Barthel Index; NIHSS, The National Institutes of Health Stroke Scale; LOS, Length of stay; rtPA, recombinant tissue plasminogen activator; PS, Propensity Score

Regarding the characteristics of the propensity-matched cohort, all baseline variables achieved an SMD < 0.10 and non-significant *p*-values, confirming a successful balance between the groups. Notably, initial BI scores (home-based: 5.8 [SD = 3.8] vs. outpatient-based: 5.6 [SD = 3.5], $p = 0.739$) and NIHSS scores (home-based: 8.5 [SD = 6.2] vs. outpatient-based: 9.2 [SD = 6.2], $p = 0.497$) were equivalent (Table 1).

Table 6 displays the results of the two one-sided t-tests (TOST) for non-inferiority, using a pre-specified margin (Δ) of 1.85 BI points. In the matched cohort, home-based rehabili-

Table 6. Functional outcomes using non inferior test (two one side t-test, tostt)

Clinical endpoints Mean (SD)	Home-based (n = 76)	Outpatient-based (n = 76)	*p*-value
BI at 12 weeks	13.4 (5.4)	12.2 (5.1)	0.221
BI at 24 weeks	15.5 (5.3)	14.9 (5.5)	0.064
BI Gain initial to 12 weeks	7.6 (4.9)	6.6 (4.4)	0.129
BI Gain initial to 24 weeks	9.4 (5.1)	9.7 (5.2)	0.035*

*Statistically significant for non-inferiority; BI, Barthel Index tation demonstrated non-inferiority for BI gain from baseline to 24 weeks (p = 0.035), but not at 12 weeks (p = 0.129). Furthermore, absolute BI scores at 12 weeks and 24 weeks did not meet the non-inferiority criteria (p = 0.221 and p = 0.064, respectively).

Discussion

Patients who entered the home-based and outpatient-based stroke rehabilitation programs differed clinically and demographically. The home-based group was significantly older and comprised a higher proportion of female patients. Non-statistically significant trends were observed in several clinical outcomes. The BI was used as the principal outcome measure due to its high validity and reliability for functional assessment in stroke populations.[11] BI scores correlate strongly with other established outcomes measures such as the Modified Rankin Scale (mRS) and the SF-36 physical function domain, supporting its appropriateness for comparative analysis and long-term follow-up in community rehabilitation settings.[12,13]

After propensity score matching, significant differences in therapy exposure persisted between groups.

The outpatient-based group continued to receive substantially more PT sessions than the home-based group (1.6 (SD = 1.9) vs. 8.5 (SD = 6.6); SMD = –1.63) and more OT sessions (8.5 (SD = 6.2) vs. 9.2 (SD = 6.2); SMD = –1.43), indicating that marked disparities in rehabilitation dosage remained even after adjustment for baseline characteristics. After propensity score matching, none of the differences in clinical outcomes between the two groups reached statistical significance, except that the home-based group is non-inferior to the outpatient-based group (p = 0.035).

Reconciling these findings requires consideration of the underlying differences between the two cohorts. In real-world practice, home-based patients tend to be older and more often female, whereas outpatient-based patients more frequently present with indicators of more severe stroke, including higher NIHSS scores, lower initial BI, and a non-statistically significant trend toward higher recurrent stroke rates. At the same time, the outpatient-based group received substantially more therapist contact. These baseline and service-delivery differences help explain the observed pattern of outcomes.

Despite receiving far fewer therapy sessions, the home-based group achieved short- and intermediate-term BI gains comparable to the outpatient-based group, with many time intervals showing identical median improvements. The finding is not that the outpatient-based group is superior, but rather that the home-based group is statistically non-inferior to the outpatient-based group at 24 weeks. The p-value of 0.035 confirms that the difference is within the equivalence margin, not that one group is “better” than the other.

These findings are broadly consistent with reports from other regions of Thailand. Data from Korat Province showed that 79.0% of stroke survivors in 2017 and 82.0% in 2022 achieved either mild disability or no disability at follow-up (BI 15–20) under a similar IMC-style, low-dose outpatient rehabilitation model.[14] In comparison, our outcomes at 6 months were fairly close: 62.7% in the home-based cohort (24.5% mild + 38.2% no disability) and 63.7% in the outpatient-based cohort (28.4% mild + 35.3% no disability). The slight difference may be partly attributable to selection bias, as our analysis excluded patients who had died, those with missing data, and those who had already achieved full independence (BI = 20) at 2 weeks—factors that may shift the overall distribution toward more functionally impaired cases at follow-up.

The equivalent outcomes observed in our home-based and outpatient-based groups—despite substantial disparities in therapy dosage—may reflect a common ceiling of recovery determined primarily by stroke lesion severity and initial impairment (mean NIHSS ~8.5–9.2 in both groups after matching). However, it is also possible that more intensive, neuroscience-guided rehabilitation could elevate this ceiling by enhancing neuroplasticity and accelerating functional gains beyond what is achievable with low-dose therapy alone.

In contrast, intensive inpatient rehabilitation programs demonstrate substantially greater gain.[15-17] At Ramathibodi Hospital,[18] a structured 28.9-day inpatient rehabilitation program achieved a discharge BI of 17.4—similar to the BI level our patients reached only approximately 12 weeks post-stroke. This highlights the influence of rehabilitation intensity and structured multidisciplinary care on accelerating functional recovery.

Overall, these findings imply that both IMC models provide meaningful recovery, but neither fully realizes the potential gains achievable with higher-intensity, neuroscience-guided rehabilitation. The modest improvements observed across both groups align with expectations for low-dose, community-based rehabilitation and contrast with the more robust gains in high-intensity inpatient programs.

The outpatient-based group showed a higher percentage of recurrent stroke events, whereas the home-based group demonstrated higher rates of pneumonia and pressure ulcers, despite exhibiting a trend toward milder disability at baseline.

These patterns may reflect real-world clinical decision-making in which patients perceived as having more severe, medically complex conditions or being at higher risk for deterioration are preferentially directed toward outpatient-based care, while those with comparatively milder presentations are managed at home—unless socioeconomic, logistical, or caregiver-related constraints dictate otherwise.

The only complication that appeared more common in the outpatient-based group was joint stiffness. This difference may be attributable to increased frequency of in-person encounters with healthcare staff, leading to heightened detection of stiffness or spasticity during hands-on assessments, rather than representing a true increase in severity. This interpretation is supported by the absence of a corresponding trend toward higher Modified Ashworth Scale ratings, suggesting that the observed difference may reflect detection bias rather than a genuine difference in spasticity burden. Interestingly, the home-based group demonstrated non-significant trends toward higher rates of preventable complications such as pneumonia and pressure ulcers, despite initially presenting with milder disability. This may reflect reduced direct supervision, less frequent reassessment, and variation in caregiver skill in the home environment.

The reliability of these findings is strengthened by the hospital's integrated health information system, which automatically registers all acute stroke cases linked to national payment programs. This ensured near-complete case capture during the study period. However, the number of deceased patients and those with incomplete data could not be verified, as these cases were excluded during extraction. The final matched sample size (n = 152) was lower than the calculated sample size (n = 178), which may have reduced statistical power. This limitation may have introduced selection bias and should be considered as an overestimation when interpreting the overall representativeness of the results.

It is important to avoid drawing the incorrect conclusion that home-based rehabilitation is inherently as effective as outpatient-based therapy, or that home-based care should replace outpatient services entirely. The apparent similarity in outcomes between the two groups is likely influenced by the overall low rehabilitation dose delivered in both models, which allows the effects of natural neurological recovery to dominate the trajectory of functional improvement. When therapy intensity is low in both settings, the differences attributable to treatment dose become less visible, making the two models appear more similar than they may truly be under higher-intensity conditions. Therefore, the near-equivalent outcomes observed in this study should not be interpreted as evidence that home-based rehabilitation alone is sufficient, nor that outpatient-based therapy offers no additional benefit.

Future studies should explore strategies to enhance therapy dose, specificity, and accessibility within the IMC framework. Potential avenues include integrating advanced rehabilitation technologies (e.g., robotic-assisted gait training, telerehabilitation platforms, neuromodulation), revising reimbursement policies that limit therapy intensity, and considering broader financial reforms such as expanded insurance coverage or government-supported rehabilitation benefits.

Evaluations should include not only clinical outcomes but also health economic analyses, which may help demonstrate the long-term value of enhanced rehabilitation services through reduced disability, lower downstream medical costs, and improved quality-adjusted life years (QALYs).

Conclusions

Stroke survivors in this general hospital are accessing outpatient-based versus home-based rehabilitation. Home-based rehabilitation can achieve non-inferior outcomes despite a substantially lower therapy dosage. Therefore, the near-equivalent outcomes observed in this study should not be interpreted as evidence that home-based rehabilitation alone is sufficient, nor that outpatient-based therapy offers no additional benefit. Increasing therapy intensity and integrating advanced rehabilitation technologies may further improve functional recovery within the IMC framework. These results highlight opportunities for improving access to and the quality of rehabilitation care.

Conflict of interest declaration

The authors declare no conflicts of interest.

Generative AI declaration

The authors confirm that all core intellectual contributions to this manuscript, including conceptualization, data analysis planning and execution, drafting of the narrative flow, conclusion, and discussion, were performed entirely through human reasoning and effort. A large language model (Grok) was used solely for grammar checking and minor improvements to sentence structure in the final drafts, without generating any original content, ideas, or analyses.

Acknowledgments

The authors would like to thank Professor Dr. Jayanthon Patumanond and Associate Professor Dr. Sarayut Lucien Geater for their time and dedication in supervising the research and statistical analysis.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability

The data that support the findings of this study are available from the corresponding author, Phuangphet Siriloetthananon, upon reasonable request.

Author contributions

Phuangphet Siriloetthananon: conceptualization, methodology, data curation, formal analysis, writing-original draft, writing – review and editing,

Nataporn Nakkaew: data curation, visualization, writing, review and editing.

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Appendix

Table 7. Functional outcomes using non inferior test (two one side *t*-test, tostt), original cohort

Clinical endpoints	Home-based (n = 102)	Outpatient-based (n = 102)	*p*-value
BI at 12 weeks[2]	13.7 (5.5)	12.4 (4.9)	0.227
BI at 24 weeks[2]	15.5 (5.4)	15.3 (5.2)	0.013*
BI Gain initial to 12 weeks[2]	7.6 (5.0)	7.4 (4.5)	0.005*
BI Gain initial to 24 weeks[2]	9.4 (5.5)	10.3 (5.1)	0.120

[2]mean(SD), *statistically significant

Table 8. Outcome of rehabilitation at different point of time: comparison between home-based and outpatient-based stroke rehabilitation programs, propensity-matched cohort

Variable	Home-based (n = 76)	Outpatient-based (n = 76)	Test Statistic	*p*-value
BI Initial[3]	6 (4–8)	6 (4–7)	Z = 0.47	0.635[a]
BI at 2 weeks[3]	6 (4–11)	11 (6–12)	Z = 1.02	0.307[a]
BI at 12 weeks[3]	14 (9–18)	12 (8–17)	Z = 1.42	0.157[a]
BI at 24 weeks[3]	18 (13–20)	17 (12–20)	Z = 0.53	0.593[a]
BI Gain Initial to 12 weeks[3]	8 (4–11)	7 (2–10)	Z = 1.31	0.191[a]
BI Gain Initial to 24 weeks[3]	10 (6–14)	11 (6–13)	Z = 0.41	0.683[a]

[3]median(IQR) , [a]Mann-Whitney test