Original Article

# Factors Associated with Goal Attainment in Children with Cerebral Palsy: An Ambidirectional Cohort Study

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## ABSTRACT

*Objectives:* This study aimed to identify factors influencing goal attainment in children with cerebral palsy (CP) while evaluating the appropriateness of established therapeutic goals.

*Study design:* An ambidirectional cohort study

*Setting:* The Rehabilitation Department, Siriraj Hospital, Bangkok, Thailand

*Subjects:* Patients aged 0 to 15 years with a diagnosis of cerebral palsy were eligible if they had received at least two sessions of goal-directed therapy (GDT) and a post-therapy Goal Attainment Scale (GAS) evaluation between January 2016 and March 2022.

*Methods:* A total of 462 goals were evaluated using the GAS. Clinical variables, including age, sex, CP type, functional classification, goals, comorbidities, and therapy frequency, were analyzed for associations with goal attainment.

*Results:* Clinical data were collected from 111 pediatric CP patients (51.4% female) undergoing GDT at a university hospital rehabilitation unit. The participants had a mean age of 4.7 years (SD = 2.7), with spastic CP being the most prevalent type (77.7%). The goals for high-functioning participants frequently targeted ambulation and hand function, while the goals for low-functioning groups focused on sitting, hand function, and swallowing. Overall, therapeutic goals were found to be appropriate, with a GAS T score of 50.2. The Gross Motor Function Classification System (GMFCS) levels I and II emerged as the sole statistically significant independent predictor of goal attainment ($p$ = 0.04).

*Conclusion:* Children with CP who demonstrate greater gross motor function exhibit a greater likelihood of therapeutic goal attainment. The GMFCS should inform the selection of appropriate therapeutic goals. High-functioning children may benefit from active goals such as improving ambulation and hand function, while low-functioning groups progress best with passive goals centered on preventing complications and achieving early motor milestones.

*Keywords:* associated factor, cerebral palsy, goal attainment, goal-directed therapy, goal setting

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## Introduction

Cerebral palsy (CP), a nonprogressive neuromotor disorder stemming from disturbances in early brain development, ranks among the primary causes of childhood disability.[1,2] With a global prevalence of approximately 2.11 per 1,000 live births (1 per 1,000 in Thailand),[3,4] Children with CP often manifests as motor dysfunction, spasticity, and impaired hand function, leading to activity limitations. Further potential consequences include sensory, cognitive, communication, visual, and auditory deficits, as well as epilepsy.[1] These complications diminish the quality of life for children with CP and their families, prompting the need for diverse interventions.[1,5]

Systematic reviews support a "traffic light" classification (green, yellow, red) for CP management, endorsing goal-directed therapy (GDT) or functional training ("green light") as beneficial.[6] GDT is a collaborative approach involving the patient, family, and the rehabilitation team in setting specific, measurable, attainable, realistic, and timely (SMART) goals.[7] With its emphasis on caregiver-facilitated home programs and effective communication, GDT can improve motor function and demonstrates particular suitability for resource-limited settings such as Thailand.[8]

To optimize therapeutic outcomes, goals within GDT should be challenging yet achievable.[9] Setting precise, individualized goals requires trained and experienced therapists.[8] Typical goals in clinical practice target sitting, walking, hand function, and swallowing. However, not all clients will fully achieve their personalized goals due to various factors which can influence goal attainment. Evaluating the quality of established goals reveals their suitability and reflects the therapist's expertise, contributing to ongoing professional development.

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Extensive research has identified factors influencing treatment outcomes in children with CP. The Gross Motor Function Classification System (GMFCS) has been shown to strongly correlate with improvements in gross motor function. Additionally, CP type, cognitive impairment, communication function, manual ability, vision, age, and therapy frequency all impact functional outcomes, including activities of daily living (ADLs), handwriting, locomotion, and wheelchair use in children with CP.[10-16] These factors fall into three categories: patient, disease, and therapy. However, no clear consensus exists on factors associated explicitly with goal attainment in GDT for children with CP.

Therefore, this study aimed to (1) identify factors associated with therapeutic goal attainment in children with CP and (2) evaluate the appropriateness of established goals.

## Methods

### Study design

This study employed a cohort design with ambidirectional features. Written informed consent was obtained from parents or guardians during the prospective period (October 2021-March 2022). The Siriraj Institutional Review Board granted ethical approval for the study on August 5, 2021 (approval number Si-603/2021). This report followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

### Participants

The study leveraged data from a CP clinical tracer program implemented at a university hospital rehabilitation department in Bangkok, Thailand. Patients were eligible to participate if they had a diagnosis of CP, were aged 0 to 15 years, had received at least two GDT sessions, and had undergone a post-GDT evaluation with a GAS score between January 2016 and March 2022.

### Sample size calculation

The sample size was determined a priori using an exploratory approach based on the principle of events per variable (EPV). Therefore, 10 to 15 goal attainments were required per independent variable. At least eleven variables were included in the analysis: sex, age, type of CP, GMFCS, Manual Ability Classification System (MACS), Communication Function Classification System (CFCS), epilepsy, hearing impairment, visual impairment, intellectual impairment, and frequency of therapeutic sessions. In this study, the unit of analysis in the regression model was the Goal Attainment Scale (GAS) evaluation rather than the individual participant (Figure 1). Accordingly, a sample size of at least 130 to 194 GAS evaluations was required, assuming an anticipated GDT success rate of 85.0% based on the CP tracer.

### Goal setting

Attending physiatrists evaluated children with CP (aged 0 to 15 years) to determine appropriate therapeutic interventions. By employing the SMART approach, physiatrists, therapists, children, and families collaboratively established individualized, short-term (less than 12 months) therapeutic goals. Physiotherapists and occupational therapists assessed and documented goal attainment using the five-point Goal Attainment Scale (GAS) following two therapy sessions within one month. The GAS objectively measured each patient's functional progress relative to established goals.

Physical therapy (PT) goals typically targeted neck and trunk control, sitting, and ambulation, while occupational therapy (OT) focused on swallowing, hand function, cognition, and ADLs. Home programs were routinely assigned to primary caregivers, with adherence documented in a logbook. The frequency, duration, and intensity of therapy varied based on individual goals, physician appointments, therapist availability, and family convenience. Programs exceeding three physical and/or occupational therapy sessions per week were classified as intensive training.[17]

### Goal evaluation and follow-up

Upon completing a course of therapy, physiotherapists or occupational therapists evaluated participants' progress toward goals using the GAS. Outcomes were documented and reported to the attending physiatrist. During follow-up, physiatrists reassessed participants and revised treatment plans, establishing new goals and continuing the GDT cycle. Individual goal attainment scores were aggregated into an overall GAS T score.

Data from participants with complicating medical conditions (such as infection or seizure), those receiving fewer than two therapy sessions, or those unable to complete sessions for GAS evaluation were excluded.

### Data collection

At the beginning and completion of therapy, health professionals collected data relating to the GMFCS, MACS, CFCS, sex, goals, home program compliance (assessed via logbooks), and GAS. A physiotherapist or occupational therapist assessed the GMFCS, MACS, and CFCS data. Age, CP type, therapy session frequency, and relevant comorbidities were retrieved from medical records through a retrospective analysis to provide baseline clinical information. These data were supplemented with information collected during the prospective phase of the study. In the absence of information in the medical records, data were supplemented by phone interviews to reduce attrition bias.

### Outcome measurements

*Goal Attainment Scale*

The GAS provides a structured method for quantifying progress toward individually established goals. It has found extensive application in pediatric rehabilitation, particularly within the context of CP. The GAS utilizes a 5-point scale (-2 to +2) to map goal achievement, assigning numeric values

to performance levels.[18] The scale's midpoint (0) represents the expected outcome. Positive scores (+1, +2) indicate outcomes that exceed expectations, while negative scores (-1, -2) signify outcomes that fall below expectations, with -2 reflecting no change from the baseline.[18] A score greater than or equal to 0 denotes goal attainment. In the present study, the GAS was selected as the primary outcome measure to evaluate the effectiveness of the GDT.

Individuals may have multiple goals, each of which receives a GAS score. These individual scores can then be combined into a single overall GAS T score, representing overall progress across all goals. To calculate this overall score, the following equation was used:

$$\text{Overall GAS} = 50 + \frac{10\Sigma(W_i X_i)}{\sqrt{(0.7\Sigma W_i^2 + 0.3(\Sigma W_i^2))}}$$

Where Xi = the GAS score and Wi = the weighting of each goal

The GAS T score had a mean of 50 and a standard deviation of 10. A mean T score of 50 indicates that goals are appropriately challenging. A T score below 50 suggests that goals may be too difficult to achieve, while a T score exceeding 50 implies that goals may be too easily attainable.[18]

*Gross Motor Function Classification System (GMFCS)*

The GMFCS is a standardized, five-level ordinal system used to evaluate gross motor function in children with CP aged 1-12 years. The expanded and revised GMFCS (GMFCS-E&R) further extends this classification to include adolescents aged 12-18 years. The GMFCS focuses on self-initiated movement and the use of assistive mobility devices during typical activities. Individuals at GMFCS level I can perform age-appropriate gross motor activities, potentially with minor limitations in speed and movement quality. However, individuals at GMFCS level V demonstrate significant difficulties with head and trunk control and have limited voluntary movement. The GMFCS is well established and has strong reliability and stability.[19,20]

*Communication Function Classification System*

The Communication Function Classification System (CFCS) is a validated, five-level ordinal system for assessing everyday communication in individuals with CP. It evaluates both the sending and receiving of information. CFCS level I individuals can communicate effectively with both familiar and unfamiliar partners. However, individuals at the CFCS level V are seldom able to communicate effectively, even with familiar people. The CFCS exhibits good test-retest and interrater reliability among professionals, with slightly lower reliability observed in parent-professional assessments.[21]

*Manual Ability Classification System*

The Manual Ability Classification System (MACS) provides a five-level framework to evaluate hand function in children with CP during daily activities. MACS level I indicates ease and success in object handling. Conversely, MACS level V denotes severely limited hand function, even for simple tasks. The MACS has good validity and reliability.[22]

## Type of CP

The classification of CP was based on the predominant motor abnormalities. Four categories were used: spastic, dyskinetic, ataxic, and mixed.[2]

## Comorbidities

Intellectual, hearing, and visual impairments were classified based on documented diagnoses in medical records.

## Statistical analysis

Data analyses were performed using IBM SPSS Statistics, version 26 (IBM Corp, Armonk, NY, USA). Continuous data are reported as means and standard deviations, while categorical data are expressed as frequencies and percentages. Overall GAS T scores were calculated with equal weighting for each goal (Wi = 1), and the baseline Xi was set at -2.

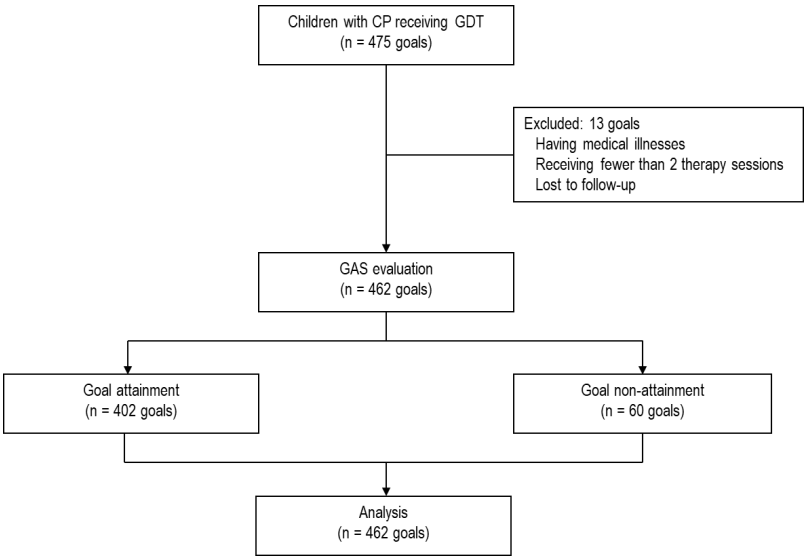


**Figure 1.** Flow diagram of study participants

Univariable and multivariable logistic regression analyses were employed to identify factors associated with goal attainment (a GAS score of 0 or greater). Univariable analysis included age, sex, CP type, GMFCS, MACS, CFCS, epilepsy, hearing impairment, visual impairment, intellectual impairment, and intensive training. GMFCS, MACS, and CFCS were categorized into levels I-II, level III, and levels IV-V. Variables with a $p \leq 0.2$ in the univariable analysis, along with clinically relevant factors (age, type of CP, and intellectual impairment), were included in the multivariable logistic regression model, with no evidence of multicollinearity. Variables not significantly associated with the outcome were excluded from the multivariable analysis. A significant level of < 0.05 was applied to all statistical tests. Missing data were addressed using complete case analysis.

## Results

This study included 111 participants (57 females, 54 males) with a total of 462 goals. Thirteen goals (2.7%) were excluded due to participants having medical illnesses, having received fewer than two therapy sessions, or being lost to follow-up (Figure 1). The mean participant age was 4.7 years (SD = 2.7), with spastic CP being the most prevalent diagnosis (77.7%).

Participants attended a median of 5 therapy sessions (range: 2-20) over a mean duration of 72.3 days (SD = 38.2). The median compliance with the home rehabilitation program was 80.0%. However, the adherence rate exhibited a wide range (20.2%-100.0), signifying varying levels of commitment among the participants.

Table 1 provides detailed breakdowns of participant functional classifications (GMFCS, MACS, and CFCS) and comorbidities. Of the 462 goals, physiotherapy sessions represented the majority (284 goals, 61.5%), with occupational therapy targeting the remaining 178 goals (38.5%). Intensive training was utilized in only two instances (0.4%). Overall, this study demonstrated a high goal achievement rate of 87.0%. A goal quality assessment revealed that 53.2% of the goals were appropriately challenging, 25.7% were too easy, and 21.1% were too difficult. The overall GAS T score of 50.2 suggests tentatively appropriate goal difficulty.

Table 2 indicates substantial variation in goal achievement rates across therapeutic areas. Ambulation training goals demonstrated the highest achievement rate (96.8%), while cognitive training exhibited the lowest (60.0%). Ambulation, hand function, and passive goals were generally considered too easy (mean GAS T score > 50). Most other goals were classified as too difficult. Despite having the lowest achievement rate, cognitive goals appeared to be appropriately challenging, as evidenced by the wide range of GAS scores (-1 to +1).

The results highlight the relationships between CP classifications and therapeutic goals. High-functioning participants (GMFCS I-II, MACS I-II, and CFCS I-II) were most frequently assigned goals targeting ambulation, hand function, and ADLs. Conversely, low-functioning groups (GMFCS IV-V, MACS IV-V, and CFCS IV-V) primarily focused on sitting, swallowing, and neck and trunk control (Supplementary Data).

**Table 1.** Baseline participants' characteristics during goal-directed therapy rounds

| Characteristics | n (%) |
|---|---|
| Female gender | 284 (61.5) |
| CP type | |
| Spastic | 359 (77.7) |
| Dyskinetic | 1 (0.2) |
| Ataxic | 12 (2.6) |
| Mixed | 90 (19.5) |
| GMFCS level | |
| I | 32 (6.9) |
| II | 89 (19.3) |
| III | 118 (25.5) |
| IV | 116 (25.1) |
| V | 107 (23.2) |
| MACS level* | |
| I | 163 (35.3) |
| II | 125 (27.1) |
| III | 59 (12.8) |
| IV | 41 (8.9) |
| V | 58 (12.6) |
| CFCS level* | |
| I | 164 (35.5) |
| II | 80 (17.3) |
| III | 109 (23.6) |
| IV | 39 (8.4) |
| V | 44 (9.5) |
| Associated problems | |
| Epilepsy | 174 (37.7) |
| Hearing problem | 14 (3.0) |
| Visual problem | 203 (43.9) |
| Intellectual disability | 59 (12.8) |
| Frequency of therapy | |
| < 3 sessions per week | 460 (99.6) |
| ≥ 3 sessions per week | 2 (0.4) |
| Therapy | |
| Physical therapy | 284 (61.5) |
| Occupational therapy | 178 (38.5) |

*There is unknown data in MACS and CFCS level due to age not applicable. CP, cerebral palsy; GMFCS, Gross Motor Function Classification System; MACS, Manual Ability Classification System; CFCS, Communication Function Classification System

Univariable logistic regression revealed a statistically significant association between goal attainment and the following factors:

- GMFCS levels I-II and III compared to IV-V
- MACS levels I-II and III compared to IV-V
- CFCS levels I-II and III compared to IV-V
- Absence of epilepsy

Subsequent multivariable logistic regression analysis identified GMFCS levels I-II (compared to IV-V) as the sole factor independently associated with goal attainment (Table 3).

**Table 2.** Goal setting and attainment for participants, with overall GAS T scores

| Goal | n (%) | Goal attainment (%) | Overall GAS T score |
|---|---|---|---|
| PT | | | |
| Passive | 21 (4.5) | 20 (95.2) | 50.8 |
| Neck and trunk control | 30 (6.5) | 24 (80.0) | 44.1 |
| Sitting | 76 (16.4) | 66 (86.8) | 49.5 |
| Ambulation | 157 (33.9) | 152 (96.8) | 52.6 |
| OT | | | |
| Hand function | 92 (19.9) | 75 (81.5) | 51.0 |
| ADLs | 37 (8.0) | 29 (78.4) | 48.6 |
| Swallowing | 44 (9.5) | 33 (75.0) | 46.8 |
| Cognition | 5 (1.1) | 3 (60.0) | 50.0 |
| Overall | 462 (100.0) | 402 (87.0) | 50.2 |

GAS, Goal Attainment Scale; PT, physiotherapy; OT, occupational therapy; ADLs, activities of daily living

**Table 3.** Logistic regression: factors influencing goal attainment

| Factors | Univariable logistic analysis | | Multivariable logistic analysis | |
|---|---|---|---|---|
| | Unadjusted OR (95%CI) | *p*-value | Adjusted OR (95%CI) | *p*-value |
| Sex | | | | |
| Male | 1.69 (0.93, 3.07) | 0.08 | 1.52 (0.76, 3.00) | 0.23 |
| Female | Reference | | Reference | |
| Age (year) | | 0.78 | | 0.47 |
| ≤ 3 | 0.92 (0.51, 1.65) | | 1.30 (0.64, 2.66) | |
| > 3 | Reference | | Reference | |
| Type | | | | |
| Spastic | 1.25 (0.66, 2.40) | 0.50 | 0.69 (0.30, 1.55) | 0.38 |
| Dyskinetic | NA | NA | NA | NA |
| Ataxic | NA | NA | NA | NA |
| Mixed | Reference | | Reference | |
| GMFCS | | | | |
| I - II | 4.45 (1.83, 10.80) | 0.001* | 3.18 (1.05, 9.60) | 0.04* |
| III | 2.05 (1.03, 4.07) | 0.04* | 1.50 (0.65, 3.45) | 0.34 |
| IV - V | Reference | | Reference | |
| MACS | | | | |
| I - II | 3.55 (1.93, 6.55) | < 0.001* | 1.37 (0.52, 3.61) | 0.52 |
| III | 2.51 (1.01, 6.24) | 0.05 | 2.18 (0.80, 6.71) | 0.12 |
| IV - V | Reference | | | |
| CFCS | | | Reference | |
| I - II | 4.25 (2.13, 8.47) | < 0.001* | 2.46 (0.66, 9.24) | 0.18 |
| III | 1.60 (0.80, 3.23) | 0.19 | 1.14 (0.40, 3.26) | 0.81 |
| IV - V | Reference | | Reference | |
| Epilepsy | | | | |
| Yes | Reference | | Reference | |
| No | 1.94 (1.12, 3.34) | 0.02* | 1.06 (0.45, 2.48) | 0.89 |
| Hearing impairment | | | | |
| Yes | Reference | | - | - |
| No | 0.51 (0.07, 3.95) | 0.52 | - | - |
| Visual impairment | | | | |
| Yes | Reference | | Reference | |
| No | 1.43 (0.83, 2.46) | 0.20 | 1.34 (0.68, 2.64) | 0.40 |
| Intellectual impairment | | | | |
| Yes | Reference | | Reference | |
| No | 0.89 (0.38, 2.06) | 0.78 | 1.68 (0.62, 4.57) | 0.31 |
| Intensive training | | | | |
| Yes | Reference | | Reference | |
| No | 6.80 (0.42, 110.13) | 0.18 | 4.82 (0.25, 92.62) | 0.29 |

OR, odds ratio; CI, confidence interval; GMFCS, Gross Motor Function Classification System; MACS, Manual Ability Classification System; CFCS, Communication Function Classification System

## Discussion

This ambidirectional cohort study demonstrated that children with GMFCS levels I-II are highly likely to achieve therapeutic goals. These findings align with previous studies that have identified GMFCS as a key prognostic factor for gross motor function.[10,11,23] These results underscore the strong influence of the GMFCS on goal attainment, particularly the increased success observed in ambulatory children compared to non-ambulatory participants.

Prior research highlights that for individuals with CP classified as GMFCS level IV or V, the primary clinical focus is on improving range of motion and reducing muscle tone (passive goals) as primary goals of botulinum toxin A treatment.[24] Furthermore, studies indicate that severity, type of CP, and ambulation status are considered when setting individual goals for botulinum toxin injections.[25-27]

Based on these findings, the GMFCS should be regarded as an essential tool when establishing appropriate therapeutic goals in GDT for individuals with CP. In this study, high-functioning children (GMFCS levels I-III) were commonly set goals related to improving ambulation, hand function, and ADLs. In contrast, low-functioning children (GMFCS levels IV-V) prioritized goals such as improving neck and trunk control, enhancing hand function, and improving swallowing. This disparity suggests that active goals may be more suitable for individuals with higher functional levels. In comparison, passive goals—focused on preventing complications and promoting early motor milestones—may be more suitable for individuals with lower functional levels. Healthcare professionals can incorporate the GMFCS into routine clinical practice to support individualized goal setting and optimize therapeutic outcomes.

Despite a high overall goal achievement rate and generally appropriate goal setting, some specific goals remain challenging or unattainable, particularly those targeting neck and trunk control, swallowing, sitting, and ADLs. Although multidisciplinary teams may establish appropriate therapeutic goals, achieving active goals in low-functioning children presents significant challenges. However, some participants with GMFCS levels IV-V successfully achieve active goals, potentially due to their younger age at enrollment and the associated increased neuroplasticity, which enhances treatment efficacy.[28]

While prior research suggests a link between intensive therapy and improved gross motor development,[29] this study did not identify a statistically significant association between intensive training and goal attainment. This finding may be attributed to the low number of participants receiving intensive training (0.4%). This limited sample size impedes a definitive analysis of the potential influence of therapy frequency at the hospital on goal achievement rates.

To address this limitation and to potentially increase overall treatment intensity, home programs were provided to all participants for completion by caregivers. This approach aligns with studies demonstrating higher home program compliance in GDT groups.6 Notably, despite the limited use of intensive training, the high home program compliance rate (approximately 80.0%) suggests that such alternative methods can still facilitate goal attainment for most participants.

Previous research has established a link between comorbidities affecting function (cognitive, intellectual, communication or vision impairment, and epilepsy) and functional outcomes in children with CP.[9-15] Although our univariable analysis identified epilepsy and CFCS levels I-II as potential influences on goal achievement, subsequent multivariable logistic regression highlighted GMFCS as the primary determinant. This finding may be due to the fact that the GMFCS level strongly reflects CP severity, which is closely associated with both epilepsy (particularly in GMFCS levels IV-V) and CFCS levels I-II. When accounting for the influence of the GMFCS level, the independent impact of these other factors on goal attainment becomes less pronounced.

This study observed instances of nonattainment of passive goals, for which primary responsibility typically falls on caregivers. The inability to achieve these goals could be attributed to various caregiver-related factors. These include age, educational level, number of children requiring care, financial constraints, and time availability.

Furthermore, when comparing children with CP and adult stroke patients, baseline functional status as measured by motor impairment or the Functional Independence Measure (FIM) emerges as a critical predictor of rehabilitation outcomes.[30,31] Given that both CP and stroke are neurological disorders, recovery potential during rehabilitation is heavily influenced by baseline function. Therefore, comprehensive initial functional assessments should be conducted to guide goal setting and inform tailored rehabilitation planning for optimal outcomes.

This study has several limitations that warrant consideration. First, as this was an observational study conducted at a single university hospital, the generalizability of the findings may be limited. Multicenter or national-level studies are needed to validate these results. Second, the absence of long-term goals in this study restricted the conclusions. Further research with long-term goal assessment is required to confirm these findings. Third, excluding participants who had a medical illness that prevented them from completing the therapy sessions introduced selection bias, as the medical illness itself could be a negative independent factor affecting the patients' ability to achieve their goals. Unfortunately, the study utilized cohort data from a routine CP clinical tracer database which employed a complete case analysis; therefore, data on drop-out patients were not available for analysis. Fourth, the use of a single therapist for both goal setting and GAS evaluation may have introduced bias. Lastly, the limited number of ataxic and dyskinetic participants prevented an analysis of factors specific to these types of CP. Further studies with more diverse and larger samples are needed to better understand the factors influencing goal attainment in children with CP.

## Conclusions

Children with CP who demonstrate higher gross motor function (GMFCS levels I-II) are significantly more likely to achieve therapeutic goals. The GMFCS should guide the selection of appropriate goals for individuals with CP. High-functioning children may benefit from active goals that target ambulation and hand function. In contrast, passive goals focused on preventing complications and promoting early motor milestones may be more suitable for children with lower functioning.

## Conflicts of interest declaration

The authors confirm that there is no conflict of interest related to the manuscript.


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## Data availability

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

## Author contribution

Chanapong Lertpanyawattanakul: conceptualization, data curation, analysis, methodology, project administration, writing - original draft preparation,

Teerada Ploypetch: conceptualization, methodology, funding acquisition, supervision, validation, analysis, writing - review & editing,

Wannika Nuanta: conceptualization, data collection,

Kanit Khlaijang: conceptualization, data collection,

Ruamporn Pinijpong: conceptualization, data collection.

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