FUNCTIONAL SEVERITY AND REHABILITATION DEMAND IN PEDIATRIC CEREBRAL PALSY: A CROSS SECTIONAL STUDY

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Abstract

Background and aim: Cerebral palsy present heterogeneous motor impairments that complicate the planning of rehabilitation in pediatric populations. Although the Gross Motor Function Classification System (GMFCS) is used to describe functional severity, its translation into actual rehabilitation demand in practice remains insufficiently explored. The aim of this research paper is to examine if functional severity serves as a variable related to rehabilitation demand in children with cerebral palsy.

Participants and methods: A cross-sectional observational research were conducted with 30 children and adolescents with cerebral palsy, recruited from rehabilitation and disability centers in North Macedonia. Data were collected with structured caregiver interviews conducted in the home environment. Motor severity was classified with GMFCS (from I to V level). Rehabilitation demand was assessed with structured questionnaire that obtained the type, intensity, and frequency of rehabilitation interventions. Descriptive statistical analyses were performed, followed by Spearman's rank correlation to examine the association between GMFCS level and the need for rehabilitation. Group differences were analyzed with independent samples t-tests, and effect sizes were calculated. Associations between categorical variables were examined with Fisher's exact test.

Results: No significant association was found between GMFCS level and rehabilitation demand ($r_s = 0.017$, $p = 0.928$), indicating variability in rehabilitation needs in functional severity levels. In contrast, age showed as a significant association, with children classified as having high rehabilitation demand being older than those with low to moderate levels of demand ($t(28) = 2.31$, $p = 0.028$) in combination with a large effect size (Cohen's $d = 0.86$).

Conclusions and implications: These results show that rehabilitation demand in children with cerebral palsy cannot be predicted by motor severity alone. Age and developmental factors appear to be important, supporting the need for personalized, developmentally informed planning of the rehabilitation beyond functional classification systems.

Keywords: *Cerebral palsy, GMFCS, pediatric rehabilitation, functional severity, motor impairment*

INTRODUCTION

Cerebral palsy is the most common cause of chronic motor difficulties in childhood and is characterized by a group of permanent disorders of movement and posture that result in disturbances in the developing fetal or infant brain (Rosenbaum et al., 2007; Sadowska et al., 2020). Although the neurological lesion itself is not progressive, the functional consequences develop over time and are influenced by growth, environmental factors and access to rehabilitation (Rezaei et al., 2022; Perret et al., 2025). As a result, children with cerebral palsy show a wide range of functional abilities, activity limitations, and restrictions in participation, making the planning

for personalized rehabilitation important (Sharifi et al., 2014; de Leeuw et al., 2021).

In clinical and rehabilitation care, differences in functional abilities in cerebral palsy complicates the process of determining the type, intensity, and frequency of rehabilitation (Albesher et al., 2025; Majnemer et al., 2010; Zimonyi et al., 2024). Functional classification systems have become important tools for categorizing severity and helping guide clinical decisions (Paulson & Vargus-Adams, 2017). Among these, the Gross Motor Function Classification System (GMFCS) is the most widely accepted and globally recognized classification for categorizing gross motor function in children with cerebral palsy (Rosenbaum et al., 2008). This system provides a standardized description of motor abilities across five levels, indicating functional mobility and postural control rather than specific motor impairments (Alriksson-Schmidt et al., 2017).

While the Gross Motor Function Classification System (GMFCS) is used to describe functional severity and predict motor development, its practical translation into rehabilitation demand remains poorly explored especially in daily clinical practice (Park, 2018; Deville et al., 2015). In many health systems the planning of rehabilitation is influenced by subjective judgment, availability of services or institutional constraints rather than by a clear relationship between functional severity and actual need for rehabilitation and this gap could lead to under-treatment or over-treatment, poor use of available resources and uneven rehabilitation approaches for children with this condition (Waterworth et al., 2024; Skempes et al., 2022; Neill et al., 2023; Leite et al., 2022). Understanding rehabilitation as a multidimensional construct with the type of therapeutic modalities, the intensity and frequency of sessions and the need for continuous rehabilitation helps improve the quality of care (Faccioli et al., 2024; Ibarra-Rodríguez, 2024). However, evidence relating functional severity as defined by GMFCS levels with rehabilitation demand are still limited especially in smaller clinical populations and contexts with limited resources (Palisano et al., 2000; Shetty et al., 2023). Existing literature often focuses on treatment outcomes or motor function changes, while fewer research papers show how functional classification translates into practical rehabilitation requirements (Kelmanson et al., 2023; Opheim et al., 2025). For example, rehabilitation approaches such as robotic-assisted devices can lead to greater improvements in motor function in children with cerebral palsy (Arsovski et al., 2024). On the other hand, greater mobility impairments in persons with cerebral palsy are associated with increased dependency in daily activities such as feeding and the need for specific adaptations, showing the broader functional implications of motor severity beyond mobility alone (Chichevska-Jovanova et al., 2025).

Although motor severity is an important clinical characteristic of cerebral palsy, it does not determine the extent of rehabilitation services required. Rehabilitation demand may also be influenced by contextual and environmental factors such as age, family resources, access to rehabilitation services and participation requirements related to school and daily activities. Distinguishing between functional motor severity and broader determinants of rehabilitation service use is important when examining rehabilitation needs in children with cerebral palsy.

In this context, examining the relationship between functional severity and rehabilitation demand will provide clinically relevant findings for personalized planning of the treatment and service organization. By evaluating rehabilitation needs with GMFCS levels, healthcare workers and special educators can better match functional status with therapy, support the continuity of care and enable fairer access to rehabilitation. This kind of approach is relevant for pediatric populations where early and appropriately dosed rehabilitation is important for supporting the best possible functional abilities. Therefore, the aim of this research paper was to examine whether functional severity as classified by the GMFCS serves as a relationship of rehabilitation demand in children with cerebral palsy. By examining how rehabilitation needs vary across GMFCS levels with structured assessments, this research paper aims to add evidence in support of approach that is focused on function and personalized needs for planning the pediatric rehabilitation.

METHODOLOGY

Study design and research aim

This research paper used a cross-sectional observational design with aim of assessing the correlation between the degree of motor impairment and the level of need for rehabilitation in persons with cerebral palsy. The methodological approach was designed to find functional severity and rehabilitation demand at a single point in time, without the application of experimental or interventional procedures.

Participants and recruitment setting

The research sample consisted of 30 participants with confirmed diagnosis of cerebral palsy. Participants were recruited in collaboration with centers for persons with disabilities located in Makedonski Brod, Prilep and Bitola, Republic of North Macedonia. Recruitment was carried out with convenience sampling method, showing the availability and accessibility of participants within the collaborating centers. Participation in the research was voluntary.

Inclusion and exclusion criteria

The inclusion criteria were confirmed medical diagnosis of cerebral palsy and availability of a parent or legal guardian able to participate in the data collection process. Exclusion criteria were the presence of severe cognitive impairments that prevented effective communication with parents or guardians, as well as lack of informed consent for participation in the research.

Data collection procedure

Data collection was conducted in the family home allowing assessment within their usual living environment. Information was collected through structured interviews with parents or legal guardians, which enabled systematic collection of functional, rehabilitation and demographic data.

Data collection followed a standardized procedure. All interviews were conducted using the same structured questionnaire and identical question sequence to ensure consistency across participants. Interviews were performed by the researchers during home visits, allowing clarification of questions when needed and reducing the risk of inconsistent responses.

Assessment instruments and variables

Rehabilitation need was assessed with a structured questionnaire administered to parents or legal guardians. The questionnaire collected information about the utilization of rehabilitation services including the type of therapy, frequency of sessions and general intensity of rehabilitation interventions received by the child. Reported rehabilitation modalities included kinesitherapy, occupational therapy, speech and language therapy, hydrotherapy and other supportive rehabilitation services where applicable. The frequency of rehabilitation interventions was recorded as the number of therapy sessions per week. Based on the reported frequency and intensity of rehabilitation services, participants were categorized into three levels of rehabilitation demand - low rehabilitation need that means occasional rehabilitation services or less than one therapy session per week, moderate rehabilitation need - regular rehabilitation services from one to two sessions per week and high rehabilitation need - intensive rehabilitation services with three or more therapy sessions per week or participation in multiple rehabilitation modalities. This categorization defined the operationalization of rehabilitation demand as indicator of the intensity of therapeutic support required by the child.

In this research, rehabilitation need/demand refers to the viewed caregiver-reported need for rehabilitation for children with cerebral palsy. This construct shows the viewed necessity and frequency of rehabilitation interventions based on the functional limitations of the child in daily activities, motor performance, and participation. Rehabilitation need was assessed with a structured questionnaire completed by caregivers, developed based on existing literature on rehabilitation service in children with cerebral palsy and used functional assessment frameworks in pediatric rehabilitation. The questionnaire included items

addressing the need for physiotherapy, occupational therapy, speech therapy, assistive support and other rehabilitation interventions. Each item was rated using a three-point Likert scale where 0 means no rehabilitation need, 1 means occasional rehabilitation need and 2 means frequent rehabilitation need. The total score was calculated by summing the responses in all items. Based on the total score, rehabilitation need/demand was categorized into three levels - low rehabilitation need, moderate rehabilitation need, and high rehabilitation need and this shows increasing levels of required rehabilitation support.

Gross motor function severity was classified using the Gross Motor Function Classification System (GMFCS). GMFCS levels were assigned based on information obtained from parents during structured interviews and verified according to the standardized GMFCS level descriptions appropriate for the age group of the child.

Statistical analysis

Collected data were analyzed with methods of descriptive statistics including frequencies and percentages for categorical variables and means with standard deviations for continuous variables. The association between the degree of motor impairment - the level of GMFCS and the need for rehabilitation was examined with Spearman's rank correlation coefficient given the ordinal nature of both variables. For group comparisons, the need for rehabilitation was dichotomized into high and low to moderate categories based on the predefined classification derived from caregiver-reported therapy frequency. Differences in age between these groups were analyzed with independent samples t-test. The magnitude of group differences was quantified with Cohen's d and Hedges' g reported as a correction for small sample size. 95% confidence intervals for effect size estimates were calculated. Associations between categorical variables including the type of cerebral palsy and the need for rehabilitation were examined with Fisher's exact test due to small sample size and expected cell counts below five. Odds ratios - OR were calculated to estimate the strength of associations. The level of statistical significance was set at $\alpha = 0.05$. All analyses were conducted in accordance with standard statistical practices for small-sample observational research papers.

During statistical analysis, rehabilitation demand was treated both as a three-level categorical variable (low, moderate, high) and as a dichotomized variable for specific comparisons (high versus low-to-moderate rehabilitation demand). The dichotomization was performed to allow group comparisons using parametric tests. All questionnaires were completed in full and no missing data were found in the dataset, allowing all 30 participants to be included in the statistical analyses.

Ethical considerations

Participation in the research was voluntary and informed consent was retrieved from parents or legal guardians prior to data collection. All collected data were managed confidentially and analyzed anonymously in accordance with ethical principles governing research involving human participants.

RESULTS

Table 1 *Gender of the participants.*

Gender	n	%
Male	18	60
Female	12	40
Total	30	100

Table 1 shows the distribution of participants according to their gender. The values are shown as absolute frequencies and percentages. In this research were included 18 male participants and 12 female participants.

Table 2 *Age of the participants.*

Years of the participants	n	%
5-7 years	6	20
8-10 years	9	30
11-13 years	8	26.7
14-17 years	7	23.3
Total	30	100.0

According to Table 2, the sample of this research consisted of 30 children and adolescents with cerebral palsy, represented across four relevant age groups. The largest proportion of participants was found in the 8-to-10-year age group (n=9; 30%), followed by children from 11 to 13 years old (n=8; 26.7%) and 14 to 17 years old (n=7; 23.3%). The youngest age group included 6 participants (20%). The mean age of the participants was 10.4 years (SD=3.2), with general age range from 5 to 17 years.

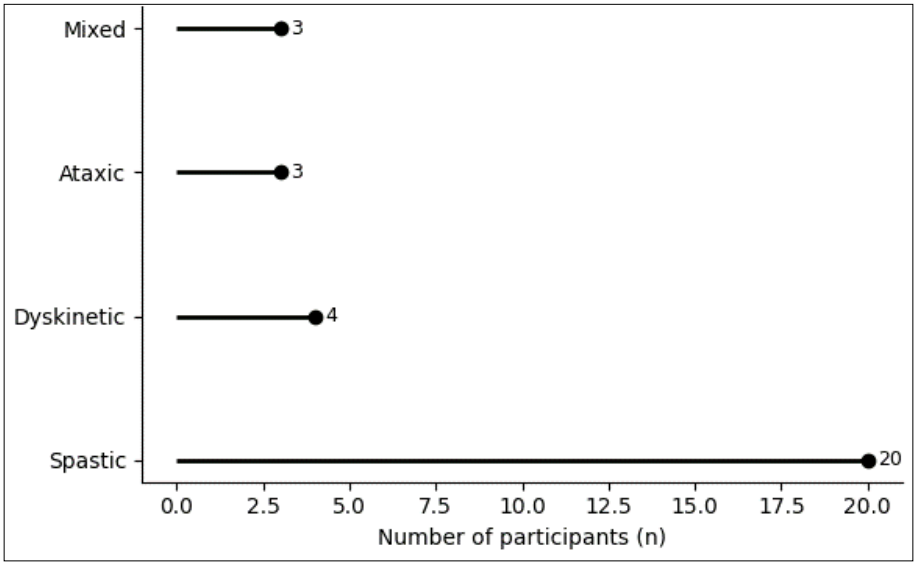

Figure 1 *Types of cerebral palsy.*

Figure 1 shows the types of cerebral palsy. Spastic cerebral palsy was the main type in 20 participants. Dyskinetic cerebral palsy was present in four participants, while ataxic and mixed types were each present in three participants.

Table 3 *Distribution of GMFCS levels.*

GMFCS level	n	%
I	5	16.6
II	3	10
III	8	26.7
IV	9	30
V	5	16.7
Total	30	100

The gross motor functional severity results are presented in Table 3. Children classified within higher GMFCS levels were more frequently represented, with GMFCS level IV making up the largest proportion of participants (30%), followed by level III (26.7%). Lower functional severity levels were less common, with 16.7% of children classified as GMFCS level I and an equivalent proportion classified as level V, while GMFCS level II represented the smallest subgroup (10%). The sample showed the majority of moderate to severe functional limitations, as more than half of the participants (56.7%) were classified within GMFCS levels III and IV and this distribution shows the heterogeneity of motor functioning among children with cerebral palsy.

Table 4 *Cross-tabulation of GMFCS levels and rehabilitation need.*

GMFCS level	Low need, n (row %)	Moderate need, n (row %)	High need, n (row %)	Row total, n (%)
I	1 (20)	1 (20)	3 (60)	5 (16.7)
II	1 (33.3)	0	2 (66.7)	3 (10)
III	2 (25)	4 (50)	2 (25)	8 (26.7)
IV	3 (33.3)	1 (11.1)	5 (55.6)	9 (30)
V	1 (20)	1 (20)	3 (60)	5 (16.7)
Column total, n (%)	8 (26.7)	7 (23.3)	15 (50)	30 (100)

Table 4 shows the cross-tabulation between GMFCS levels and categories of the need for rehabilitation. Across the all GMFCS levels, a high rehabilitation need was the most frequently viewed category, accounting for half of the total sample (50%). Moderate need for rehabilitation was observed in 23.3% of participants, while low rehabilitation need accounted for 26.7%. Within individual GMFCS levels, children classified as GMFCS levels I, II, and V showed most cases of high need for rehabilitation, with 60% of children at GMFCS level I, 66.7% at level II, and 60% at level V categorized as having high rehabilitation needs. In contrast, children classified at GMFCS level III showed a moderate rehabilitation need (50%), while equal proportions of low and high need were found within this group (25% each). Among children classified as GMFCS level IV, high rehabilitation need was again the largest category (55.6%), followed by low rehabilitation need (33.3%), while moderate rehabilitation need was less frequently found (11.1%). Generally, the distribution of the need for rehabilitation varied across GMFCS levels, showing heterogeneity in rehabilitation demand within and across functional severity categories. Spearman's rank correlation analysis showed no significant association between GMFCS level and rehabilitation need ($r_s = 0.017$, $p = 0.928$).

Table 5 *Age difference between children with high versus low-to-moderate rehabilitation need.*

Comparison (Age, years)	n (High)	n (Low-Moderate)	t (df)	p-value	Cohen's d	Hedges' g	95% CI for d
High need vs Low-Moderate need	12	18	2.31 (28)	0.028	0.86	0.84	0.10 to 1.63

Table 5 shows the comparison of age between children classified with high rehabilitation need and those with low-to-moderate rehabilitation need. A statistically significant difference in age was found between the two groups ($t(28) = 2.31$, $p = 0.028$) showing that children with higher rehabilitation demand were older than those with lower levels of need. The magnitude of this difference was large, as showed by the effect size estimates (Cohen's $d = 0.86$; Hedges' $g = 0.84$), showing a clinically association despite the relatively small sample size. For additional analysis, rehabilitation demand was dichotomized into high rehabilitation demand versus not-high (low + moderate) categories in order to explore associations with the clinical type of cerebral palsy.

Table 6 *Association between cerebral palsy type and high rehabilitation need.*

Type of cerebral palsy	High need, n (row %)	Not-high (Low + moderate), n (row %)	Total
Spastic cerebral palsy	15 (75)	5 (25)	20
Other types of cerebral palsy	6 (60)	4 (40)	10
Total	21 (70)	9 (30)	30

Odds ratio (spastic vs other cerebral palsy): OR = 2.00, 95% CI: 0.36–11.17, p = 0.41.

Table 6 shows the distribution of high rehabilitation need across cerebral palsy types. A higher proportion of children with spastic cerebral palsy were classified as having high rehabilitation need compared with those with non-spastic forms (75% vs 60%). The estimated odds of high rehabilitation need were higher among children with spastic cerebral palsy (OR = 2.00, 95% CI: 0.36–11.17, p = 0.41).

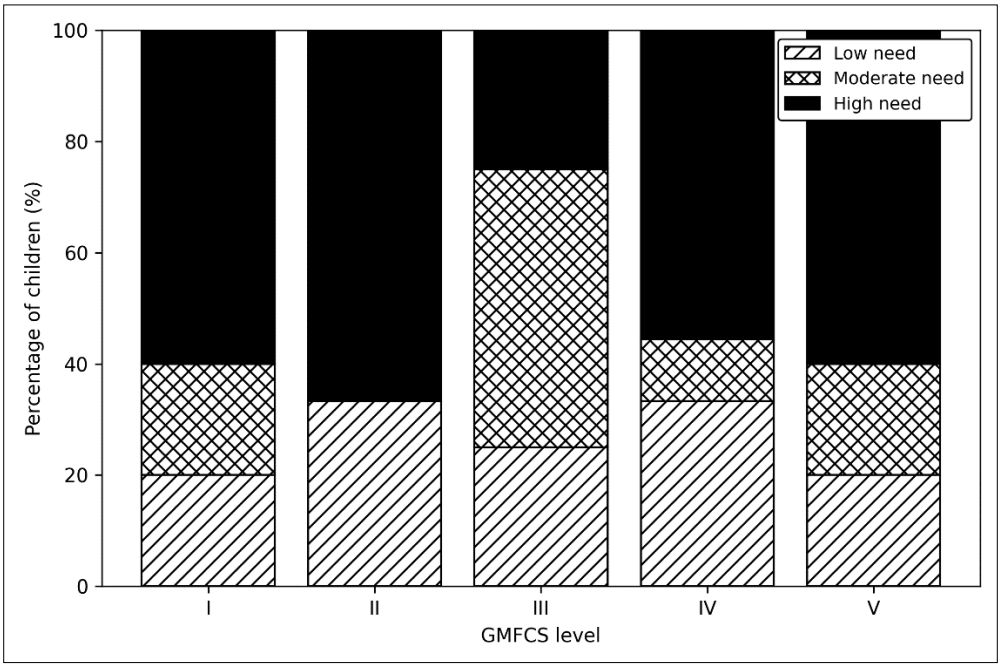

Figure 2 *Distribution of rehabilitation need among different GMFCS levels of the participants.*

Figure 2 shows the proportional distribution of categories for rehabilitation need across the GMFCS levels I to V. Each bar shows the percentage of children within a given GMFCS level classified according to rehabilitation demand. The distribution shows variability in the need for rehabilitation among functional severity levels, with high need for rehabilitation found not only among children with more severe motor impairment (GMFCS IV to V), but also within lower functional levels (GMFCS I to II). Children classified as GMFCS level III showed moderate need for rehabilitation.

DISCUSSION

This research assessed the relationship between motor function severity and the need for rehabilitation in persons with cerebral palsy, with aim to clarify whether higher functional impairment is associated with greater rehabilitation demand. The results show valuable information about the complexity of the planning for rehabilitation in this population, showing that the need for rehabilitation is influenced by many factors rather than motor severity alone. While gross motor function classification remains important clinical indicator, the results show variability in rehabilitation demand among the functional levels. In addition, age showed as an important factor associated with higher need for rehabilitation, showing the dynamic and cumulative nature of functional limitations over time. The finding that older children showed higher rehabilitation demand may have several possible explanations. First, rehabilitation needs may accumulate over time as children with cerebral palsy grow and experience progressive musculoskeletal complications such as contractures, postural problems and functional limitations. Also, older children may have greater exposure to rehabilitation services, leading caregivers to become more aware of available inter-

ventions and report higher perceived need. Finally, school participation may introduce additional functional demands such as prolonged sitting, fine motor activities, and social participation requirements which may increase the viewed necessity for rehabilitation interventions.

Previous large-scale research papers have showed that daily functioning and rehabilitation outcomes in children with cerebral palsy are determined by a complex interaction of motor severity, age, personal characteristics, and environmental factors. Tseng et al. (2011) found that age and severity of gross motor impairment are important determinants of daily function when analyzed within a comprehensive ICF-based framework. The results of our research paper partially align with these results. In our research, age showed as important factor associated with higher need for rehabilitation stressing that increasing age may show cumulative functional limitations and growing rehabilitation demands over time. This consistency supports the relevance of age as an important factor in planning the rehabilitation across different environments and sample sizes.

In a large national survey conducted in France, Cornec et al. (2021) found that satisfaction with motor rehabilitation in persons with cerebral palsy was influenced by organisational and factors associated with clinical practice such as pain management, coordination of care, and communication with rehabilitation workers, while motor severity showed a secondary but significant association with lower satisfaction. Our research shows that GMFCS level alone was not associated with the need for rehabilitation, but age showed as a significant determinant, showing that rehabilitation demand in children with cerebral palsy may depend more by developmental and cumulative factors than by motor severity per se.

In a registry-based research paper, Saleh et al. (2023) showed that functional mobility in children with cerebral palsy is determined by GMFCS level and varies across home, school, and community environments with additional contributions from the impairments related to the child such as visual impairment, scoliosis and interventions such as botulinum toxin, orthoses, and spasticity management. While this research found that GMFCS level is a primary factor of functional mobility across environments, our research found no significant monotonic association between GMFCS level and need for rehabilitation.

Using data from a large North American registry, Gannotti et al. (2024) reported that functional decline in adults with cerebral palsy is common and increases with age, with gross motor decline varying by GMFCS level, while hand function and communication decline were not associated with motor severity. The most important part in this research is that age also showed as a consistent factor of decline across functional categories, where types of cerebral palsy did not differentiate the outcomes. On the other hand, our research found age as an important association of rehabilitation demand, while GMFCS level alone was not associated with need for rehabilitation.

However, the interpretation of these results should be considered with caution due to the small sample size. The absence of a statistically significant association between GMFCS level and rehabilitation demand may partly show limited statistical power rather than the complete absence of a relationship. Future research with larger samples and longitudinal designs is necessary to examine the relationship between functional severity and rehabilitation demand in children with cerebral palsy.

CONCLUSIONS

The results of this study suggest that rehabilitation demand in children with cerebral palsy may not be determined only by functional motor severity. However, given the relatively small sample size, these results should be interpreted cautiously. Future studies with larger samples are needed to confirm the relationship between GMFCS level and rehabilitation demand. Although GMFCS as a system remains a practical approach for describing gross motor function, the absence of association between GMFCS level and the need for rehabilitation shows the multifactorial nature of the planning for rehabilitation in clinical practice. These results show the importance

of adopting a personalized, developmentally informed approach to rehabilitation in which age and changing functional demands are considered alongside motor classification. From a clinical perspective, this suggests the need to look beyond motor severity as the sole indicator for service intensity and toward more dynamic models of rehabilitation based on individual needs planning. Future research with larger, longitudinal samples is needed to explore how age and functional trajectories to better understand need for rehabilitation across the lifespan in persons with cerebral palsy.

Conflict of interest statement

The authors declare that there are no conflicts of interest related to this research. No financial, professional, or personal relationships have influenced the research design, data collection, analysis or interpretation of results. Also, no external funding or sponsorships were received that could have impacted the objectivity of the research paper. The research was conducted with full academic integrity and in compliance with ethical guidelines to ensure unbiased results.

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