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FEEDING CHALLENGES, DIETARY ADAPTATIONS, AND NUTRITIONAL SUPPORT IN INDIVIDUALS WITH CEREBRAL PALSY

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Abstract: *Background: Cerebral palsy is a neurodevelopmental disorder that affects movement, muscle tone, and motor skills, often causing feeding difficulties. Individuals with cerebral palsy experience dysphagia, prolonged meal durations, and increased dependency on caregivers for feeding assistance. It is important to understand the relationship between mobility impairments, feeding dependency, and dietary adaptations for optimising nutritional intake and quality of life.*

Objective: *This research aims to analyse the feeding difficulties faced by individuals with cerebral palsy, assess the influence of mobility limitations on feeding dependency, and examine dietary adaptations required to ensure adequate nutrition.*

Methods: *A cross-sectional study, involving 37 participants with cerebral palsy, was conducted using caregiver-reported questionnaires. Variables examined include mobility status, feeding dependency, meal duration, dietary preferences, and feeding methods. Statistical analyses (χ^2 tests, Mann-Whitney U tests, and Kruskal-Wallis tests) were used to determine the relationship between feeding dependency, nutritional intake, and mobility impairments.*

Results: *The results showed correlation between mobility limitations and feeding dependency ($\chi^2 = 42.83$, $p < 0.001$). Participants with greater mobility impairments were more likely to consume blended or liquid diets and experience prolonged meal durations ($H = 20.03$, $p < 0.001$). Caregiver support played an important role in feeding adaptation and efficiency.*

Conclusion: *Feeding difficulties in individuals with cerebral palsy are influenced by mobility impairments and dietary adaptations. The study focuses on the need for individualised nutritional plans, assistive feeding tools, and structured meal environments. Multidisciplinary approaches with speech therapists, dietitians, and occupational therapists are important for feeding independence and improving general health outcomes in individuals with cerebral palsy.*

Keywords: *cerebral palsy, rehabilitation, caregivers, deglutition disorders, nutritional support, feeding and eating disorders of childhood*

INTRODUCTION

Cerebral palsy is one of the most common motor impairments in childhood, defined as a group of permanent, non-progressive neurodevelopmental disorders that affect movement, muscle tone, and motor skills due to early brain damage during the child's development (Gulati & Sondhi, 2018). The global prevalence of cerebral palsy is approximately three cases per 1,000 live births, with higher rates observed among males (Vitrikas et al., 2020). Developed countries report lower prevalence of cerebral palsy compared to developing countries, likely due to differences in prenatal care, healthcare, and early intervention services (Gbonjubola et al., 2021). Beyond motor impairments, cerebral palsy is accompanied by sensory, cognitive, communication, and behavioural disturbances, which further complicate the ability to perform basic daily activities (Parkes et al., 2010).

Daily activities such as eating, dressing, bathing, and maintaining personal hygiene (washing hands, face, and teeth) are learned and mastered in early childhood (Velevska et al., 2023). For most individuals such activities become habitual and form part of a routine, but for those with cerebral palsy, these tasks are difficult to perform independently (Chichevska-Jovanova & Rashikj-Canevska, 2021). Impairments such as limited motor control, spasticity, and poor coordination create some challenges that increase dependency on caregivers for assistance with these activities (Dlamini et al., 2023).

Among these daily tasks, feeding is one of the most critical challenges (Marques & Sá, 2016). Feeding challenges are prevalent among 30-40% of individuals with cerebral palsy, primarily comprising of oromotor dysfunction, dysphagia, and gastrointestinal conditions (gastroesophageal reflux disease) (Calis et al., 2008). Dysphagia, characterised by difficulty in swallowing, can impair nutritional intake and lead to malnutrition, aspiration, and an increased risk of respiratory infections (Costa et al., 2021). To address these limitations, many individuals with cerebral palsy use adaptive tools such as specialised eating utensils and they follow customised dietary regimens to improve their feeding process and general quality of life (Bell & Samson-Fang, 2013).

Caregivers play an important role in managing these feeding difficulties by ensuring that appropriate adaptive tools and specialised meals are provided, and that consistent feeding routines are maintained (Taylor et al., 2022). On the other hand, caregivers often face challenges such as inadequate training, insufficient support, and limited access to necessary resources (Liu et al., 2020). These difficulties can increase caregiver challenges and limit the effects of care, highlighting the need for research that explores both the physical and social dimensions of feeding challenges (Vadivelan et al., 2020).

OBJECTIVE

The objective of this research study was to investigate the feeding difficulties experienced by individuals with cerebral palsy and to analyse the role of caregivers in providing nutritional support. By examining factors such as meal duration, the use of adaptive tools, and dietary preferences, this study seeks to offer practical recommendations for improving the health and quality of life for this population. These results will contribute to the development of multidisciplinary approaches that address the complex needs of individuals with cerebral palsy, thus promoting their physical and social well-being.

RESEARCH QUESTION AND HYPOTHESIS

The research questions addressed in this study are:

1. How do mobility impairments influence feeding dependency among individuals with cerebral palsy?
2. What is the relationship between feeding dependency and meal duration in individuals with cerebral palsy?
3. How do dietary modifications, such as blended or liquid diets, affect meal duration and nutritional intake in individuals with cerebral palsy?

The hypotheses of this study are:

H1: Individuals with severe mobility impairments are more likely to require extensive caregiver assistance for feeding.

H2: There is a significant correlation between feeding dependency and prolonged meal durations in individuals with cerebral palsy.

H3: Individuals with cerebral palsy who consume blended or liquid-based diets will exhibit longer meal durations compared to those on solid diets.

METHODOLOGY

This study was designed to explore the feeding challenges experienced by individuals with cerebral palsy and to analyse the role of caregivers in providing nutritional support. A quantitative research approach was used with descriptive methodology in order to systematically collect and analyse data. This study aimed to examine specific factors including the type of diet, the use of adaptive feeding tools, the duration of meals, and the prevalence of dietary restrictions and food allergies.

This research was conducted between September and November 2022 across several locations in North Macedonia, including primary schools with resource centres, such as the "Dr. Zlatan Sremec" Primary School with a Resource Centre for Rehabilitation and the "Idnina" Primary School with a Resource Centre in Skopje, as well as several local support groups for individuals with cerebral palsy and their families. These locations were selected to ensure a diverse and representational sample of participants. Data were collected using a structured questionnaire developed by the authors, consisting of 20 questions that were grouped into the following categories:

- Questions about gender, age, type of cerebral palsy, and mobility status - to provide demographic information about the participants.
- Questions focused on dependency levels during meals, the use of adaptive utensils, and meal durations - to assess the level of support required.
- Questions focused on the adherence of the participants to specific dietary regimens, presence of food allergies or intolerances, primary nutrition sources (solid, blended, or liquid), and methods of food intake (using utensils, tube feeding, or bottle/straw). The aim of these questions was to identify both dietary needs and functional limitations during feeding.
- Questions identifying routine meal schedules, activities during meals, meal preferences, and favourite foods and drinks.

Participants were selected through convenience sampling and a total of 37 individuals diagnosed with cerebral palsy were included in this study. For minor children, primary caregivers were responsible for completing the questionnaires on behalf of their children or wards. Participants ranged in age from infancy to adulthood, reflecting a broad spectrum of cerebral palsy and associated feeding challenges. To maintain ethical standards, all participants and their caregivers were informed about the aims of the study and their verbal consent was obtained prior to participation. Anonymity and confidentiality were ensured throughout the research process by de-identifying all survey responses. The names of the participants and personal identifiers were not collected, and all data were anonymised before analysis. Surveys were conducted digitally using a secure platform, and data were stored in a password-protected database that was accessible only to the principal researchers.

All data were analysed using SPSS (ver. 27, IBM). A combination of descriptive and inferential statistics was applied. For descriptive statistics, frequencies and percentages were used for categorical variables, while means and standard deviations were used for continuous variables (meal duration). For the inferential statistics, frequencies and percentages were used to examine the relationship between gender and type of cerebral palsy, type of mobility, feeding dependency, dietary preferences, and feeding assistance. To examine whether individuals who were fully dependent on their caregivers for eating had longer meal durations than those who could eat independently, the Mann-Whitney U test was used to compare the medians between the two groups. Additionally, to test H2, Spearman's rank correlation was used to assess the relationship between feeding dependency and meal duration. The Kruskal-Wallis test was used to analyse the differences in meal duration across nutrition sources and feeding methods, while Spearman correlation was used to assess the relationship between age at diagnosis and meal duration, favourite food and feeding dependency and activities during meals and meal duration.

RESULTS

Table 1 shows the gender distribution of the participants included in this research study. Among the 37 participants, 14 (37.8%) were male, while 23 (62.2%) were female. This distribution shows a higher proportion of female participants in the study sample.

Table 1. *Gender distribution of participants*

Gender	Frequency	Percentage (%)
Male	14	37.8
Female	23	62.2

Table 2. *Age distribution of participants*

Age group (Years)	Frequency	Percentage (%)
0-6	6	16.2
7-10	9	24.3
11-20	11	29.7
21-31	3	8.1
32-40	8	21.6

Table 2 shows the age distribution of participants. The age groups were selected to show key developmental stages in feeding independence. The 0-6 year age group represents early childhood, where feeding skills are actively developing. The 7-10 and 11-20 year age groups cover school-age children and adolescents, where feeding habits and assistance needs may potentially change. The 21-31 and 32-40 year age groups represent adults with cerebral palsy, where dietary adaptations and assistance levels may differ.

Table 3. *Age at diagnosis of participants*

Age at diagnosis	Frequency (N = 37)	Percentage (%)
At birth	7	19.0
3-6 months	5	13.5
7-11 months	8	21.6
1-3 years	13	35.1
4+ years	4	10.8

Table 3 shows the variability in the age at which participants were diagnosed with cerebral palsy, with the majority (35.1%) receiving a diagnosis between 1 and 3 years of age. This was followed by participants (21.6%) who were diagnosed between 7-11 months and those who were diagnosed at birth (19%). A smaller percentage of the included participants (13.5%) were diagnosed between 3 and 6 months, and only 10.8% received a diagnosis after the age of four years. These results show the importance of early detection and diagnosis, since early intervention can significantly impact developmental outcomes and access to appropriate therapeutic and support services.

Figure 1. *Distribution of the types of cerebral palsy included in this research*

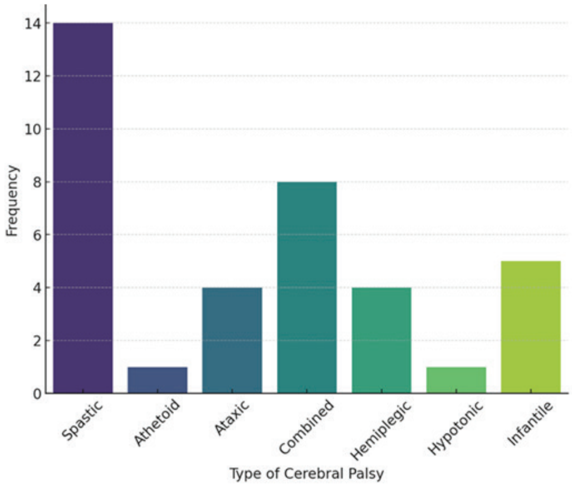

Figure 1 illustrates the distribution of different types of cerebral palsy among the included participants. The spastic type of cerebral palsy is the most prevalent, followed by the combined type of cerebral palsy. Other types, including ataxic, hemiplegic, and infantile cerebral palsy, occur less frequently, while the athetoid and hypotonic types of cerebral palsy are the least prevalent.

Table 4. *Relationship between gender and type of cerebral palsy*

Analysis	Statistic	p-value	Interpretation
χ^2 for gender versus type of cerebral palsy	$\chi^2 = 37.0$	0.001	Significant association
Post-hoc analysis (the highest standardised residuals)	Spastic cerebral palsy (Male: 3.78, Female: -2.95)	Not applicable, post-hoc	Males are more likely to have the spastic type of cerebral palsy
Cramer’s V	1.0	Not applicable, effect size	Large effect size, strong relationship

The chi-squared test (χ^2) revealed a statistically significant relationship between gender and the type of cerebral palsy ($\chi^2 = 37.0$, $p < 0.001$; Table 4). The post-hoc standardised residuals indicated that males are more likely to have the spastic type of cerebral palsy (Residual = 3.78), whereas females are less likely to have it (Residual = - 2.95). The Cramer's V effect size (1.0) indicates a strong and meaningful relationship, suggesting that gender plays important role in the distribution of the type of cerebral palsy.

Table 5. *Assessing the mobility type and dietary preference based on feeding assistance among participants*

Test	χ^2	p-value	Significance ($\alpha = 0.05$)
Type of mobility vs feeding assistance	42.83	0.001	Significant
Dietary preferences vs feeding assistance	7.56	0.0228	Significant

Table 5 shows the relationship between mobility type and feeding assistance dependency. The chi-squared test (χ^2) results indicate a statistically significant relationship ($\chi^2 = 42.83$, $p < 0.001$), suggesting that individuals with different mobility statuses exhibit varying levels of feeding dependency. Participants who are non-mobile or use assisted mobility devices are more likely to be fully dependent on feeding assistance, whereas those who are independent require less support. This defines the impact of mobility limitations on feeding independence, focusing on the need for customised interventions in rehabilitation and assistive care. In addition, the results reveal a statistically significant relationship between dietary preferences and feeding assistance dependency ($\chi^2 = 7.56$, $p = 0.0228$), indicating that individuals with dietary restrictions (lactose intolerance, gluten allergy) are more likely to require feeding assistance. Participants with specific dietary needs may require more structured or individualised feeding support, possibly due to difficulties in handling certain textures or food modifications.

These results support the first hypothesis (H1), since the analysis demonstrates a significant relationship between mobility limitations and feeding dependency ($\chi^2 = 42.83$, $p < 0.001$). Participants with non-mobile or assisted mobility statuses were more likely to be fully dependent on caregiver assistance for feeding. Conversely, those with better mobility exhibited greater independence in eating and required minimal support.

Figure 2. *Meal duration among fully dependent and independent eaters: a violin plot analysis*

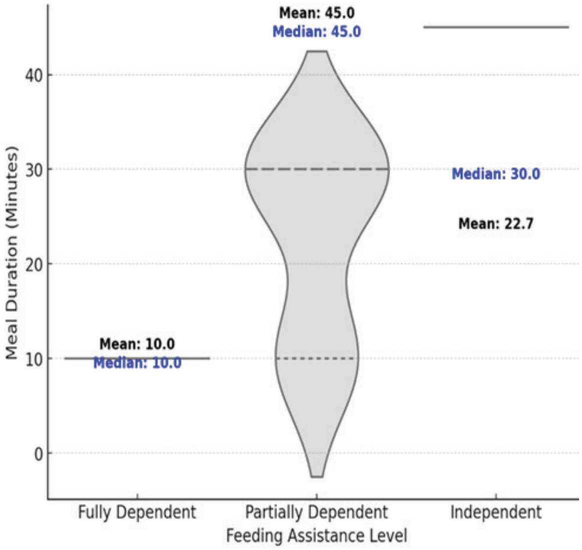

Figure 2, represented as a violin plot, visualises the distribution of meal durations for fully dependent and independent eaters among the included respondents, providing information about the variability and density of meal times within each group. The wider sections of the violin plot indicate more frequent values. The fully dependent group exhibits a broader distribution, indicating that meal times vary among these participants. Conversely, the independent group displays a more compact distribution, suggesting their meal durations are more consistent. The quartile lines delineate the spread of meal durations within each category. This analysis confirms that fully dependent eaters take longer to complete their meals than independent eaters. To strengthen the results, the Mann-Whitney U test was employed, which revealed a statistically significant difference ($p < 0.001$). The results highlight the need for individualised feeding interventions to support individuals requiring assistance, as their meal times are both longer and more variable.

These results strongly support the second hypothesis (H2), indicating a statistically significant difference in meal duration between fully dependent and independent eaters. The results of the Mann-Whitney U test (p < 0.001) confirm that participants who are more dependent on caregivers for feeding take longer to complete their meals. The violin plot analysis further demonstrates a broader distribution of meal durations among dependent eaters, suggesting variability in feeding efficiency based on assistance levels.

Table 6. *Assessing meal duration across primary nutrition source*

Kruskal-Wallis test	H-Statistic	p-value	Significance (α = 0.05)
Meal duration across primary nutrition source	20.03	0.001	Significant
Meal duration across method of food intake	20.03	0.001	Significant

Table 6 examines whether there are differences in meal duration between individuals who consume normal/solid food, those who eat blended/pureed food, and those who are on liquid-based diets. The H-statistic (20.03, p-value 0.000045) indicates a statistically significant difference (p < 0.05) between the groups. This suggests that meal duration varies depending on the type of nutritional source consumed. These results confirm that individuals consuming liquid or blended/pureed meals take different amounts of time to eat compared to those consuming normal/solid meals. The second test examined methods of food intake and meal duration and found that the H-statistic (20.03, p-value 0.000045) indicates a statistically significant difference (p < 0.05) between the groups. This suggests that persons who use different methods to consume food take varying amounts of time to eat. The results confirm that meal duration is influenced by the method of food intake, with persons using feeding tubes or bottle/straw methods taking different amounts of time to eat compared to those using utensils. Individuals using utensils tend to have a more efficient and controlled eating process, facilitating quicker meal completion. Those relying on tube feeding might have longer or shorter durations depending on the flow rate, medical assistance, and feeding schedule, since they do not engage actively in the eating process. Individuals consuming food via a bottle or straw may require more time due to factors such as suction difficulties, swallowing coordination, or texture modifications needed for safe consumption. These results highlight the importance of individualised feeding strategies and assistive technologies (adaptive utensils, modified diet textures, or specialized feeding interventions) to improve eating efficiency. Speech therapists, nutritionists, and other rehabilitation professionals should collaborate to develop alternative feeding methods that provide adequate nutrition while optimising meal duration and promoting independence among individuals with cerebral palsy.

These results support the third hypothesis (H3), showing that meal duration differs depending on the primary nutrition source. The Kruskal-Wallis test results (H = 20.03, p < 0.001) indicate that participants consuming blended or liquid-based diets tend to have longer meal durations compared to those eating solid foods. Similarly, meal duration was influenced by feeding method, with tube-fed individuals showing different time patterns than those using utensils (Table 6).

Table 7. *Assessing favourite food and drink preferences*

Spearman's correlation	Spearman's rank correlation coefficient (ρ)	p-value	Significance (α = 0.05)
Favourite food vs duration of the meal	- 0.9673	0.001	Significant
Favourite drink vs duration of the meal	0.3226	0.0515	Not significant
Favourite food vs feeding dependency	0.8037	0.001	Significant

Table 7 presents three relationships tested using Spearman's rank correlation. The first part, which examines the relationship between favourite food and meal duration, shows a strong negative correlation (ρ = - 0.9673, p < 0.001), suggesting that individuals who prefer unhealthy foods tend to have shorter meal durations, while those favouring healthy foods take longer to eat. This may indicate that healthier food options require more time to chew, process, or digest compared to soft, processed foods. In addition to the relationship between favourite drinks and meal duration, a weak positive correlation was found ($\rho = 0.3226$, $p = 0.0515$), suggesting a mild trend where individuals who consume healthier drinks (such as water, tea, and juices) may take slightly longer to eat compared to those consuming sugary drinks such as Coca Cola. However, this result is not statistically significant ($p > 0.05$). In the relationship between favourite food and feeding dependency, a strong positive correlation ($\rho = 0.8037$, $p < 0.001$) suggests that individuals who require more feeding assistance tend to consume softer, pureed, or liquid-based foods. This indicates that feeding dependency affects food choices, highlighting the need for nutritional adaptations for individuals requiring feeding support. The results show that individuals who favour soft, processed foods tend to have shorter meal durations, while those consuming healthier, fibrous foods take longer to eat. Additionally, feeding dependency plays an important role in food selection, with those requiring assistance often opting for pureed, blended, or liquid-based meals. Drink preferences did not demonstrate a strong correlation with meal duration, suggesting that food texture has a more direct impact on feeding efficiency.

DISCUSSION

The results of the present study provide insights into the feeding challenges, dietary adaptations, and nutritional habits of individuals with cerebral palsy. The findings indicate the impact of feeding dependency, mobility status, and dietary preferences on meal duration and food intake methods. A key finding was the strong relationship between mobility type and feeding dependency. Additionally, it was revealed that the primary nutritional sources (solid vs. blended vs. liquid-based meals) influenced meal duration, with participants consuming blended or liquid-based diets taking longer to complete their meals. This suggests that dietary modifications may be a necessary adaptation to enhance nutritional intake efficiency in individuals with cerebral palsy. The findings of this research focus on the need for individualised feeding interventions (adaptive utensils, structured meal environments, and individualised nutrition plans) to improve feeding independence and efficiency in individuals with cerebral palsy.

The findings of Andrew et al. (2012) highlight the significance of feeding difficulties in children with cerebral palsy, focusing on their impact on growth, nutrition, health, and social development. Their study focuses on the multifactorial nature of feeding impairments, where oromotor dysfunction, mobility limitations, and environmental factors contribute to prolonged meal times and increased caregiver dependency. Importantly, they advocate for a multidisciplinary approach to assessment and intervention, ensuring that children receive customised nutritional support and feeding adaptations. These conclusions are consistent with our results, further supporting the need for structured meal environments, assistive feeding strategies, and early interventions to enhance feeding independence and general well-being in individuals with cerebral palsy.

Another study by García Rona et al. (2019) highlighted the strong correlation between dysphagia, motor impairment, and nutritional status in individuals with cerebral palsy. Their research demonstrated that greater motor impairment was associated with higher levels of dysphagia. Specifically, those with severe motor dysfunction exhibited the highest prevalence of feeding difficulties, requiring extensive modifications in food texture and feeding methods. These findings are consistent with our results, which indicate that feeding dependency was strongly associated with mobility limitations and dietary modifications. Our analysis demonstrated that individuals with greater mobility impairments were more likely to rely on blended or liquid-based diets, experience prolonged meal durations, and require significant caregiver support for feeding.

Dahlseng et al. (2011) reported a high prevalence of feeding difficulties and malnutrition in children with cerebral palsy, with 21% being fully dependent on assistance and 14% requiring gastrostomy-tube feeding. Their findings indicated that undernutrition was common, with 20% of children below -2 standard deviations in weight or height, while 16% were overweight or obese. Our study aligns with these findings, showing that feeding dependency was strongly associated with dietary modifications and prolonged meal durations. Based on the Kruskal-Wallis test results, we confirmed that feeding methods impacted meal duration, highlighting the need for timely feeding interventions.

Mehta et al. (2019) focused on the severity of neurological and muscular impairments in cerebral palsy, along with the associated feeding challenges and nutritional risks. Their review emphasises the importance of early identification, structured feeding interventions, and multidisciplinary care to optimise growth, health, and quality of life. Our study supports these findings, indicating that feeding dependency and mobility limitations influence dietary choices and meal duration. Using Spearman's correlation analysis, we confirmed that individuals requiring greater feeding assistance were more likely to consume blended or liquid-based diets, while the Kruskal-Wallis test indicated that feeding methods influenced meal duration.

Nur et al. (2019) reported a high prevalence of feeding difficulties (78%) and malnutrition (78%) in children with cerebral palsy, with severe motor impairments identified as key risk factors. Their results are consistent with ours, showing that feeding dependency was strongly correlated with mobility limitations, dietary modifications, and prolonged meal duration. Additionally, Boudokhane et al. (2021) reported a high prevalence of feeding problems (dysphagia 55%, constipation 67.5%, gastroesophageal reflux 70%) and malnutrition (67.5% underweight) in children with cerebral palsy, particularly those with multiple disabilities. Their results identified age and constipation as key predictors of malnutrition, emphasising the need for early screening and nutritional interventions. These results are consistent with our findings, where feeding difficulties, prolonged meal durations, and dietary modifications were strongly associated with feeding dependency and mobility impairments.

Kamal et al. (2022) found that food texture modification is crucial for safe feeding in individuals with cerebral palsy, however, the lack of standardised guidelines creates challenges for caregivers. Their review indicates that modified textures improve swallowing safety, nutritional intake, and quality of life. However, uncertainties in preparation may contribute to undernourishment and caregiver stress. Consistent with these findings, our research demonstrated that feeding dependency and dietary modifications were strongly correlated with prolonged meal duration and nutritional challenges.

CONCLUSION

The results of this research study emphasise the impact of feeding dependency, mobility limitations, and dietary modifications on meal duration and nutritional intake in individuals with cerebral palsy. This study demonstrated that individuals with greater mobility impairments are more likely to rely on blended or liquid-based diets, experience prolonged meal durations, and require caregiver support for feeding. The strong relationship between mobility type and feeding assistance suggests that participants with a non-mobile or assisted mobility status are at higher risk of feeding dependency, highlighting the need for individualised rehabilitation and assistive care interventions. Additionally, it was shown that the primary nutritional source and feeding method influenced meal duration, confirming that participants consuming liquid or blended diets require different amounts of time to eat than those on solid foods. Feeding dependency plays a significant role in food selection, and individuals who require assistance are more likely to consume softer, pureed, or liquid-based foods.

These results emphasise the importance of structured meal environments, adaptive feeding tools, and individualised dietary plans to enhance feeding efficiency and independence. The data also highlight the need for multidisciplinary approaches, incorporating speech therapists, nutritionists, and rehabilitation workers to optimise feeding strategies for individuals with cerebral palsy. The variability in meal duration, feeding assistance, and dietary preferences focus on the necessity for individualised nutritional interventions to improve health outcomes and quality of life in this population.

LIMITATIONS AND FUTURE DIRECTIONS

Despite the valuable insights provided by this study, several limitations should be acknowledged. This research included only 37 participants, which limits the generalisability of the findings. However, given the population of individuals with cerebral palsy in North Macedonia, this sample size is justified. A larger sample size would offer a more comprehensive representation of feeding challenges among individuals with cerebral palsy. The study relied on convenience sampling, which may have introduced selection bias, since participants were drawn from specific educational and rehabilitation centres, rather than from a randomised population. Data collection was based on caregiver-reported questionnaires, which may be subject to reporting bias and subjectivity in assessing feeding difficulties. Additionally, this research examined only a single time point, rather than tracking feeding habits, nutritional changes, or the effectiveness of interventions over time. Factors such as cognitive abilities, socioeconomic status, and caregiver stress levels were not directly controlled for, which may influence feeding behaviours and nutritional outcomes.

CONFLICT OF INTEREST STATEMENT

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

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