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Role of L-Carnitine in Alleviating Constipation in Children with Cerebral Palsy: An Exploratory Study

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ABSTRACT: Background: Constipation is common in children with cerebral palsy (CP), and additional treatment options warrant investigation. This exploratory study assessed L-carnitine as an adjunct to standard care for improving bowel movement frequency, stool consistency and associated gastrointestinal symptoms.

Objective: This exploratory study aimed to assess the effect of L-carnitine supplementation, added to standard care, on constipation in children with CP, particularly bowel movement frequency and stool consistency.

Methods: In this prospective, controlled study, the reported baseline analysis included 45 children with CP and constipation (25 receiving standard care plus oral L-carnitine for 3 months and 20 receiving standard care only). Bowel movement frequency, Bristol stool score, gastrointestinal symptoms and serum L-carnitine were assessed. Follow-up results were available for 25 intervention and 16 control participants.

Results: Within the intervention group, mean bowel movement frequency increased from 2.2 ± 0.5 to 5.2 ± 1.6 per week and mean Bristol score from 1.4 ± 0.5 to 2.5 ± 0.7 ($P < 0.001$ for both). At follow-up, bowel movement frequency was significantly higher in the intervention group than in controls (5.2 ± 1.6 versus 4.1 ± 2.2 per week; $P = 0.039$). Lower serum L-carnitine was reported in participants with severe constipation. L carnitine had statistically significant positive correlations with frequency of bowel movement, and stool consistency. Grade V GMFCS had statistically significant lower frequency of bowel movement.

Conclusion: L-carnitine supplementation is essential in children with CP as it improves stool consistency and increases the frequency of defecation.

1 INTRODUCTION

Cerebral palsy (CP) remains one of the most common causes of motor impairment in children. A systematic review reported a pooled prevalence of 2.11 per 1,000 live births (Oskoui et al., 2013). Gastrointestinal (GI) manifestations, including

constipation, are common in children with CP. Feeding difficulties, nutritional disturbances, and impaired gastrointestinal motility may contribute to constipation and associated symptoms such as fecal impaction and abdominal pain (Del Giudice et al., 1999; Mosiello et al., 2021).

Feeding difficulty due to oromotor dysfunction may reduce dietary fiber and fluid intake and exacerbate GI symptoms (Sdravou et al.,2021). Children with severe motor impairment frequently have feeding and gastrointestinal problems, which may contribute to malnutrition and require coordinated management (Erkin et al., 2010). Poor fiber diet and decreased fluid intake, limited physical activity, neurological impairment, and medication use may affect bowel motility (Sadeghvand et al., 2025). Feeding difficulties and impaired abdominal and pelvic muscle function may further complicate defecation (Erkin et al., 2010). Dietary measures and laxatives can improve constipation, although some children require additional management (Arya et al., 2024; Mosiello et al., 2021).

L-carnitine is involved in energy metabolism and is obtained from dietary sources, including meat, dairy products, and fish, as well as endogenous synthesis in the liver and kidneys (Rebouche, 2004). Restricted dietary intake and some medications may contribute to secondary carnitine deficiency; these factors may be relevant to children with CP and feeding difficulties (Flanagan et al., 2010). Carnitine deficiency can affect muscle function, providing a biological rationale for investigating its association with gastrointestinal function (Flanagan et al., 2010). In children with severe motor and intellectual disabilities, an association between free carnitine levels and constipation severity was reported, with improvement after supplementation (Murata et al., 2017). These findings support further investigation of L-carnitine as an adjunct to constipation management in children with CP.

This exploratory study aimed to assess the effect of L-carnitine supplementation, added to standard care, on constipation in children with CP, particularly bowel movement frequency and stool consistency.

PATIENTS AND METHODS

Study design and setting

This was a prospective, exploratory study with parallel treatment groups and pre- and post-intervention assessments. Group 1 received dietary fiber and a laxative (standard care) plus L-carnitine as an add-on therapy, while Group 2 received standard care alone. The study was conducted at the Outpatient Clinics of General Pediatrics and Pediatric Physiotherapy, October 6th University Hospital, Egypt. Recruitment was described over a 6-month period, with follow-up for 3 months.

Participants and sample size

The methods described an enrollment of 50 CP children, with 25 assigned to each treatment group. The available baseline analysis included 45 children: 25 in Group 1 and 20 in Group 2. Follow-up analyses included 25 and 16 children, respectively (missed during the study).

Eligibility criteria

The protocol specified children of either sex aged 3–12 years with CP diagnosed from clinical and neuroimaging findings and constipation established using Rome IV criteria, based on caregiver reports and/or medical records. The analyzed age ranges were 3–13 years in Group 1 and 3–12 years in Group 2. Patients diagnosed with celiac disease or other malabsorption disorders, metabolic disorders affecting carnitine metabolism, and medications known to significantly affect GI motility were excluded.

Clinical and feeding assessments

A comprehensive clinical history was obtained from caregivers, including the type and severity of motor impairment, functional status, comorbidities such as GI disorders, and medication history, particularly antiepileptic drugs. Swallowing difficulties such as dysphagia, choking or coughing, and current or previous tube feeding. Motor function was assessed using the GMFCS by the attending and supervising physiotherapist (Palisano et al., 1997).

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Gastrointestinal assessments

Constipation was assessed using Rome IV criteria and stool consistency using the Bristol Stool Form Scale. Bowel movement frequency per week, stool consistency, and associated symptoms, including abdominal pain, distension, vomiting and irritability, were recorded.

Biochemical Assay of serum L- Carnitine:

Three milliliters of venous blood were drawn from each participant under complete aseptic conditions using a sterile needle and collected into plain tubes. Afte 30 minutes of samples' collection, the samples were processed using centrifugation for 15 minutes at 3000 rpm for serum separation. Serum samples were stored appropriately at -20°C until analysis. Serum LC levels were measured utilizing the Enzyme-Linked Immunosorbent Assay (ELISA) method, using commercial kit, according to the manufacturer's instructions ((ELK, Biotechnology, USA). Baseline measurements were reported for both groups, and pre- and post-treatment measurements were reported for Group 1.

Intervention and follow-up

Both groups received dietary fiber and a laxative as standard care. Group 1 additionally received oral L-carnitine at 70 mg/kg/day in two divided doses for 3 months. Group 2 received standard care alone. Participants were monitored every 2 weeks and formally evaluated monthly. Assessments included bowel movement frequency, Bristol stool score, GI symptoms, feeding tolerance and changes in meal duration. Treatment adherence and adverse effects were described as monitored, but corresponding results were not supplied.

Ethical considerations

The study protocol was approved by the Research Ethics Committee, Faculty of Medicine, October 6 University. Written informed consent was obtained from caregivers before participation, and participants could withdraw without affecting their medical care. The protocol specified anonymized data stored in password-protected databases accessible only to the research team.

Statistical analysis

Data were coded and entered with double-entry verification and analyzed using IBM SPSS version 24. Continuous variables were summarized as mean ± standard deviation (SD) or median and range, and categorical variables as frequencies and percentages. The stated analysis plan used chi-square tests for categorical variables, paired t-tests or Wilcoxon signed-rank tests for within-group comparisons, and independent t-tests or Mann–Whitney U tests for between-group comparisons. Study outputs also included one-way analysis of variance, correlation coefficients and receiver operating characteristic (ROC) analysis. The stated significance threshold was $P < 0.05$.

RESULTS

Our study included 45 children with CP suffered constipation: 25 in Group 1 (standard care plus L-carnitine) and 20 in Group 2 (standard care only). There was no statistically significant difference between intervention and control groups regarding age, sex, residence, consanguinity, child order (Table 1).

Table 1: Sociodemographic data of the studied groups

		Group 1		Group 2		Test	P value
		N=25	%	N=20	%		
Age (years)	Mean ± SD	9.1±3.2		8.8±3.3		t=0.31	0.71
	Range	3-12		3-12			
Sex	Female	14	56.0%	10	50.0%	X^2=0.16	0.68

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		Group 1		Group 2		Test	P value
		N=25	%	N=20	%		
	Male	11	44.0%	10	50.0%		
Residence	Rural	7	28.0%	9	45.0%	X^2=1.4	0.23
	Urban	18	72.0%	11	55.0%		
Consanguinity	negative	10	40.0%	11	55.0%	X^2=1.1	0.31
	positive	15	60.0%	9	45.0%		
Etiology	Head trauma	0	0.0%	1	5.0%	X^2=5.1	0.53
	Hypoxia	23	92.0%	18	90.0%		
	Kernicterus	2	8.0%	1	5.0%		
GMFCS	II	5	20.0%	3	15.0%	X^2=3.4	0.33
	III	5	20.0%	8	40.0%		
	IV	2	8.0%	0	0.0%		
	V	13	52.0%	9	45.0%		
Child order	Median	3rd		3rd		t=0.9	0.35
	Range	1st-7th		1st-7th			

X2: Chi-square test, t: Student t-test, SD: standard deviation, GMFCS: gross motor function classification system

Table 2 showed that there was no statistically significant difference between Group 1 and Group 2 regarding epilepsy, use of antiepileptic drug or duration.

Table 2: Frequency of Epilepsy in the studied groups

		Group 1		Group 2		Test	P value
		N=25	%	N=20	%		
Epilepsy		14	56.0%	8	40.0%	X^2=2.3	0.21
Use of		14	56.0%	8	40.0%	X^2=2.3	0.21
Type of AED	Valproate and Levetiracetam	10	40.0%	7	35.0%	X^2=0.65	0.88
	Valproate	2	8.0%	1	5.0%		

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		Group 1		Group 2		Test	P value
		N=25	%	N=20	%		
	Levetiracetam	2	8.0%	1	5.0%		
Duration of AED use (years)	Mean ± SD	6.1±2.8		5.8±1.9		t=1.1	0.31
	Range	2-11		3-9			

AED: antiepileptic drugs, X^2: Chi-square test, t: Student t-test, SD: standard deviation

Regarding GI manifestations and serum L-carnitine level, table 3 showed that there was no statistically significant difference between both groups.

Table 3: frequency of GI manifestations and serum level of L-carnitine in the studied groups

		Group 1		Group 2		Test	P value
		N=25	%	N=20	%		
Choking/coughing during feeding		22	88.0%	14	70.0%	X^2=2.3	0.13
Dysphagia		22	88.0%	16	80.0%	X^2=0.58	0.75
Abdominal pain		19	76.0%	14	70.0%	X^2=0.21	0.65
Abdominal distension		18	72.0%	18	90.0%	X^2=2.3	0.13
Vomiting		5	20.0%	7	35.0%	X^2=1.3	0.25
Previous use of laxatives		25	100.0%	20	100.0%	-	-
Type of laxative used	Glycerin supp	0	0.0%	2	10.0%	X^2=2.6	0.27
	Lactulose	25	100.0%	18	90.0%		
Frequency of bowel movements/ week	Mean ± SD	2.2±0.5		2.3±0.5		t=0.98	0.32
	Range	1-3		1-3			
Stool consistency (Bristol)	Mean ± SD	1.4±0.5		1.5±0.5		t=0.56	0.58
	Range	1-2		1-2			
Serum L-carnitine level	Mean ± SD	2180.4±665		2300.5±1162		t=1.1	0.28
	Range	590-3200		290-5100			

X^2: Chi-square test, t: Student t-test, SD: standard deviation

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After treatment, frequency of GI manifestations significantly decreased in group 1 compared with group 2 apart from vomiting and stool consistency (Table 4).

Table 4: Follow up GI manifestations in the studied groups after treatment

		Group 1		Group 2		Test	P value
		N=25	%	N=16	%		
Abdominal pain (follow-up)		6	24.0%	10	62.5%	X^2=5.4	<0.001*
Abdominal distension (follow-up)		8	32.0%	10	62.5%	X^2=3.8	<0.001*
Vomiting (follow-up)		3	12.0%	4	25.0%	X^2=1.9	0.25
Change in stool frequency		17	68.0%	4	25.0%	X^2=6.1	<0.001*
Change in Bristol score		17	68.0%	5	31.3%	X^2=4.6	<0.001*
Improvement status		23	92.0%	4	25.0%	X^2=12.5	<0.001*
Frequency of bowel movements/ week	Mean ± SD	5.2±1.6		4.1±2.2		t=2.1	0.039*
	Range	3-7		2-7			
Stool consistency (Bristol)	Mean ± SD	2.5±0.7		2.1±0.6		t=1.8	0.08
	Range	1-3		1-3			

X^2: Chi-square test, t: Student t-test, *: significant, SD: standard deviation

GI manifestations, frequency of bowel movements and serum L-carnitine level were all significantly improved after treatment (Table 5).

Table 5: GI manifestations and L-carnitine in cases group, before and after treatment with L-carnitine

		Before		After		Test	P value
		N=25	%	N=25	%		
Abdominal pain		19	76.0%	6	24.0%	X^2=8.2	<0.001*
Abdominal distension		18	72.0%	8	32.0%	X^2=6.3	<0.001*
Vomiting		5	20.0%	3	12.0%	X^2=1.3	0.21
Frequency of bowel movements/ week	Mean ± SD	2.2±0.5		5.2±1.6		Pt=9.8	<0.001*
	Range	1-3		3-7			
Stool consistency (Bristol)	Mean ± SD	1.4±0.5		2.5±0.7		Pt=5.3	<0.001*

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		Before		After		Test	P value
		N=25	%	N=25	%		
	Range	1-2		1-3			
Serum L-carnitine level	Mean ± SD	2180.4±665		3433±719		Pt=6.2	<0.001*
	Range	590-3200		1780-4500			

X^2: Chi-square test, Pt: Paired sample t-test, *: significant, SD: standard deviation

Exploratory ROC analysis for severe constipation reported an area under the curve of 0.761 (95% CI 0.621–0.901; P = 0.003*****). Serum L-carnitine cutoff <2030 on the reported assay scale had sensitivity of 70.8% and specificity of 76.2% (Figure 1).

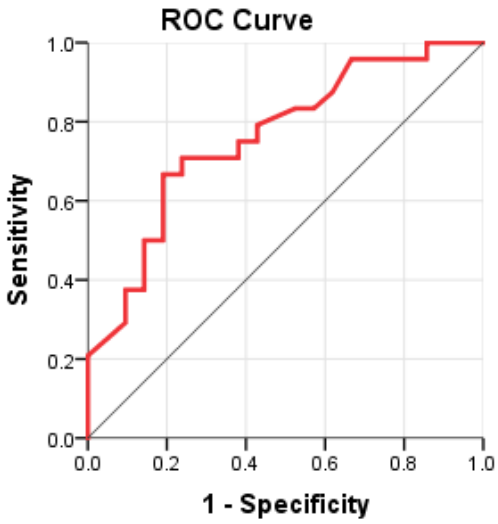


Figure 1: ROC curve of performance of L-carnitine to detect severe constipation in the studied groups.

Serum L-carnitine level was lower among children receiving antiepileptic drugs, with the lowest recorded mean in the valproate subgroup (Table 6).

Table 6: L-carnitine levels in the studied groups regarding disease criteria

		Serum L-carnitine level (baseline)		Test	P value
		Mean ± SD	Range		
Sex	Female	2093.8±748.0	1160.0-4300.0	t=0.65	0.47
	Male	2221.0±1075.9	290.0-5100.0		
Epilepsy	Yes	1948.0±802.0	590.0-4300.0	t=1.9	0.044*
	No	2345.8±977.4	290.0-5100.0		

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		Serum L-carnitine level (baseline)		Test	P value
		Mean ± SD	Range		
Use of antiepileptic drugs	Yes	1858.2±842.2	290.0-4300.0	t=2.4	0.028*
	No	2435.2±893.4	1160.0-5100.0		
Type of AED	Levetiracetam	2253.3±1884.5	590.0-4300.0	F=6.3	0.009*
	Valproate and Levetiracetam	1868.7±690.6	290.0-3100.0		
	Valproate	1522.5±255.0	1300.0-1890.0		
	No	2435.2±893.4	1160.0-5100.0		

t: Student t-test, F: F value of one way ANOVA, *: significant, SD: standard deviation

Table 7 shows lower recorded mean L-carnitine level in CP children with dysphagia, abdominal pain or abdominal distension.

Table 7: L-carnitine levels in the studied groups regarding nutritional history and GI manifestations.

		Serum L-carnitine level (baseline)		Test	P value
		Mean ± SD	Range		
Choking/coughing during feeding	No	2130.0±1380.7	290.0-5100.0	t=0.10	0.92
	Yes	2158.9±773.5	590.0-4300.0		
Dysphagia	No	2300.0±1048.9	1300.0-4100.0	F=7.8	0.022*
	Yes	2057.8±1043.2	290.0-5100.0		
Abdominal pain	No	2330.0±801.2	1160.0-4100.0	t=2.5	0.021*
	Yes	1993.1±954.1	290.0-5100.0		
Abdominal distension	No	2308.0±850.6	1160.0-4100.0	t=2.7	0.009*
	Yes	1966.0±934.0	290.0-5100.0		
Vomiting	No	2262.2±797.5	590.0-4300.0	t=1.5	0.19
	Yes	2090.8±1171.6	290.0-5100.0		

t: Student t-test, F: F value of one way ANOVA, *: significant, SD: standard deviation

Serum L-carnitine level was positively correlated with bowel movement frequency (r = 0.255, P=0.048*) and Bristol score (r = 0.466, P=<0.001*) (figure 2).

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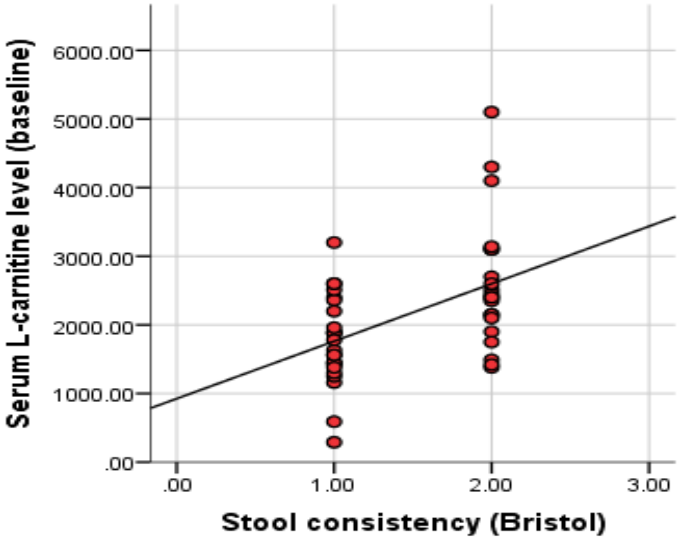


Figure 2: Correlations between L-carnitine levels and stool consistency.

Table 8 shows that lowest bowel movement frequency in GMFCS level V.

Table 8: Patients criteria, GI manifestations and L-carnitine level regarding GMFCS

		GMFCS								Test	P value
		II		III		IV		V			
		N=8	%	N=12	%	N=3	%	N=22	%		
Age (years)	Mean ± SD	7.9±2.9		7.6 ±3.3		5.3 ±3.7		8.6 ±3.7		F=2.7	0.43
	Range	4-12		3-12		3-10		3-13			
Sex	Female	6	75.0%	6	50.0%	3	100.0%	9	40.9%	X^2=5.5	0.14
	Male	2	25.0%	6	50.0%	0	0.0%	13	59.1%		
Swallowing difficulty		7	87.5%	9	75.0%	3	100.0%	17	77.3%	X^2=1.4	0.62
Choking during feeding		7	87.5%	9	75.0%	3	100.0%	17	77.3%	X^2=1.3	0.71
Dysphagia		6	75.0%	11	91.7%	3	100.0%	18	81.8%	X^2=9.3	0.15
Abdominal pain		5	62.5%	9	75.0%	1	33.3%	17	77.3%	X^2=2.8	0.41
Abdominal distension		6	75.0%	9	75.0%	2	66.7%	18	81.8%	X^2=1.6	0.34
Vomiting		2	25.0%	5	41.7%	1	33.3%	5	22.7%	X^2=1.4	0.69

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		GMFCS								Test	P value
		II		III		IV		V			
		N=8	%	N=12	%	N=3	%	N=22	%		
Frequency of bowel movements/ week	Mean ± SD	2.5±0.5		2.1±0.4		2.3±0.5		1.5±0.6		F=9.5	0.023*
	Range	1-3		1-3		1-3		1-3			
Stool consistency (Bristol)	Mean ± SD	1.6±0.5		1.4±0.4		1.3±0.5		1.5±0.6		F=3.4	0.33
	Range	1-2		1-2		1-2		1-2			
L-carnitine	Mean ± SD	2385±774		2225 ±608		2039 ±812		1462 ±312		F=5.2	0.15
	Range	1420-4100		290-5100		1450-3200		1160-3200			

X2: Chi-square test, F: F value of one way ANOVA, *: significant

Table 9 show lower recorded serum L-carnitine in the severe-constipation category (1763 ± 660) than in the mild-to-moderate category (2599 ± 958).

Table 9: GI manifestations and L-carnitine regarding constipation severity

		Severe		Mild-moderate		Test	P value
		N=24	%	N=21	%		
Choking/ coughing during feeding		18	75.0%	18	85.7%	X^2=0.84	0.37
Dysphagia		19	79.2%	19	90.5%	X^2=2.1	0.35
Abdominal pain		17	70.8%	15	71.4%	X^2=0.2	0.96
Abdominal distension		18	75.0%	17	81.0%	X^2=0.33	0.63
Vomiting		7	29.2%	6	28.6%	X^2=0.2	0.96
L-carnitine	Mean ± SD	1763±660		2599±958		t=6.2	<0.001*
	Range	290-3200		1380-5100			

X^2: Chi-square test, t: Student t-test, *: significant

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DISCUSSION

This study aimed to assess the effect of L-carnitine supplementation on improving gastrointestinal complaints, particularly reducing constipation in children with CP. CP is a common childhood motor disorder associated with lasting limitations in movement and posture (Rosenbaum et al., 2007). GI problems such as constipation add to the burden experienced by affected children and caregivers (Mosiello et al., 2021). Constipation, which usually has a multifactorial etiology, is directly related to factors such as dietary habits, motor dysfunctions and spasticity (Sadeghvand et al., 2025).

It has been observed that as spasticity severity increases, bowel movements slow down, and stool stays in the intestine longer, becoming harder (Mosiello et al., 2021).

In the current study, GI manifestations showed no statistically significant difference between studied groups. Asgarshirazi et al. (2017) reported that prevalence of swallowing disorders was 82% and for gastro-esophageal reflux disease was 66% in CP children. Otapowicz et al. (2010) reported that dysphagia symptoms were found in 61% of studied children, most frequently referring only to the oral phase.

The neurological lesion associated with CP may impact on the muscles of the jaw, cheeks, lips, tongue, palate and pharynx, which manifest functionally as difficulties with controlling saliva, eating, drinking, swallowing and speaking (Benfer et al., 2017). Eating and drinking are complex sensori-motor activities, which can be described in four phases, including the oral preparatory, oral (propulsive), pharyngeal and esophageal phases of the swallow. Children with CP may have impairments in any of four phases of swallowing (Benfer et al., 2017). Children with CP may also have pharyngeal phase impairments or silent aspirations (Asgarshirazi et al., 2017).

Children with CP are reported to have specific dietary needs and often experience difficulty consuming solid foods. Inadequate fiber intake has been observed to exacerbate constipation by increasing stool hardness, which negatively affects bowel movements (Toğuç et al., 2025).

Carnitine contributes to mitochondrial fatty acid transport and energy metabolism, and deficiency can affect several organ systems (Flanagan et al., 2010). The recorded mean serum L-carnitine levels were lower in children with dysphagia, abdominal pain, abdominal distension and severe constipation. Murata et al. (2017) also observed that levels of free carnitine were significantly lower in the constipation group compared with the non-constipation group ($P < 0.01$) and was correlated with constipation severity ($R = 0.7604$, $P < 0.01$).

Murata and coresearchers found that children on a diet deficient in carnitine, had gastrointestinal dysmotility manifested by postprandial vomiting, oral drooling and delayed gastric emptying and infrequent bowel movements they also found an association between free carnitine levels and constipation severity in patients with severe motor and intellectual disabilities (Murata et al., 2017). In addition, Nassar et al. (2024) reported improved gastric motility in children receiving ketogenic diet therapy with L-carnitine. Sanders and his collaborators stated that proper mitochondrial function and ATP production are critical for smooth muscle contraction and neuronal signaling, which suggests that a metabolic modulator such as L-carnitine might theoretically affect motility (Sanders et al.,2012).

After treatment, GI manifestations, frequency of bowel movements and serum L-carnitine level were all significantly improved after treatment. Our results run in accordance with Murata et al. (2017) who reported that the severity of constipation (frequency of defecation and form of feces) in constipation group was significantly relieved after supplementation with L-carnitine ($P < 0.001$). This was comparable with Nassar et al. (2024) who studied impact of L-carnitine supplementation on gastric emptying and bowel function in pediatrics, there was highly significant increase in the frequency of defecation in L-carnitine supplementation group by 50%. Although there was a decrease in the median (IQR) of GI symptoms score in the patients on L-carnitine supplementation in comparison to other group indicating clinical improvement in GI symptoms, and an increase in the median (IQR) of the Bristol stool scale, these results didn't reach statistical significance. Nassar et al. (2024) studied children with drug-resistant epilepsy receiving ketogenic diet therapy. Their population and dietary intervention differ from those in the present study, limiting direct comparison.

Children with CP require long-term measures for prevention and treatment of chronic constipation. Therefore, the treatment modality used should be safe, effective, and without significant side effects. Moreover, it should be cost-friendly and should

not confer additional financial burden on the caregivers of these children, especially in resource-limited countries (Arya et al., 2024).

Fifty-two percent of Group 1 and 45% of Group 2 had GMFCS level V, P = 0.33. Our results also run in accordance with Ying et al. (2021) who reported that more than half of their patients classified as level IV (21.4%) and level V (38.4%) in GMFCS. While Fortin et al. (2021) reported that the majority of the CP patients (60%) had a GMFCS of I–III. And Meehan et al. (2017) reported that 25% (n=445) of CP patients had a severe gross motor impairment (GMFCS levels IV/V). In the current study, the recorded bowel movement frequency was lowest in GMFCS level V. This was comparable with Toğuç et al. (2025) who reported that constipation complaints of CP patients increased with increasing GMFCS grades. It was found that GMFCS grade 2 had a significantly higher Bristol score compared to grades 4 and 5. As GMFCS grades rise from one to five, decreased mobility, increased muscle tone and spasticity, and feeding difficulties may exacerbate constipation complaints.

Wahyuni stated that motor function limitations make defecation processes difficult by negatively affecting intestinal motility. Constipation is more common in children with low levels of gross motor function and limited independent movement worsens this situation. In addition to motor dysfunctions, spasticity also increases the risk of constipation by making it difficult to control intestinal muscles (Wahyuni, 2023).

In the current study, there was no statistically significant difference between Group 1 and Group 2 regarding epilepsy, use of antiepileptic drug or duration. Our results were in agreement with Kürtül Çakar and Cinel (2021), who reported that 85.5% of children with CP were under antiepileptic. While Fortin et al. (2021) reported that 34% of CP cases had epilepsy. And Meehan et al. (2017) reported that 28% of their patients had epilepsy. The recorded serum L-carnitine means were lower in children with epilepsy or using antiepileptic drugs, particularly those receiving valproate. These associations may reflect medication use, nutritional intake and neurological severity; the available data do not separate these potential influences. These findings are consistent with Yokoyama et al. (2022) who noticed that valproate treatment significantly decreased the blood carnitine level ($P < 0.01$). El-Niny et al. (2019) reported lower plasma carnitine in children with idiopathic epilepsy receiving valproate than in controls.

This was in agreement with a previous study by Castro-Gago et al. (1998) who examined serum levels of carnitine in patients with seizures, before and after 3, 6, and 12 months of treatment with valproic acid, carbamazepine, or phenobarbital. In all three treated groups, both free and total carnitine levels showed a significant decline with respect to pretreatment levels which was most marked and most consistent in patients treated with valproic acid. In 35% of the patients in this group, carnitine deficiency was observed by month 12. These findings support further study of carnitine status in children receiving antiepileptic drugs, particularly valproate.

Investigating the effect of L carnitine supplementation on reducing GI manifestations, particularly constipation is one of our study strengths as previous data is scarce in this domain. The small sample and incomplete control follow-up were one of our study limitations. Concurrent laxative and dietary regimens were not sufficiently detailed to establish treatment standardization.

Future studies should standardize concurrent treatment, nutritional management with larger sample size in a multicentered study is recommended. Evaluation of possible carnitine deficiency in selected children with restricted intake, severe constipation or antiepileptic exposure should be guided by clinical assessment.

CONCLUSION

L-carnitine supplementation is essential in children with CP as it improves stool consistency and increases the frequency of defecation. Severity of constipation in children with CP is higher in patients with severe gross motor impairment.

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Data availability statement

The corresponding author can provide data of this study upon reasonable request, subject to ethical restrictions.

Authors contribution

Ahmed Saad El-Gayed worked on study design. Alzahraa Azmy Mohammed contributed to data collection and clinical assessment. Ahmed Saad El-Gayed and Sarah Abdelrashid conducted data analysis and interpretation. The biochemical analysis and laboratory data interpretation was carried out by Hala M. Zeidan. Shaimaa Shawki Mohammed Amin performed physical therapy assessments, including GMFCS classification Sarah Abdelrashid wrote the manuscript. Ahmed Saad El-Gayed revised the manuscript. The final version of the manuscript was reviewed and approved by all authors.

Declarations

Ethics approval and consent to participate

The study was conducted following approval from the Institutional Review Board of October 6 University. Written informed consent was secured from parents or legal guardians.

Competing interests

The authors declare that they have no competing interests

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