

Original Research

Received 08 June 2026

Revised 25 July 2026

Accepted 09 Aug 2026

Natural Resources for Human Health 2026, Vol. 6 (15s): 1540–1548

KEYWORDS:

cerebral palsy; adolescents; oral health; DMFT; oral hygiene; gingival index; masticatory function; chewing efficiency.

Severity of Cerebral Palsy And Its Association with Oral Health Status, Masticatory Function, and Health-Related Quality of Life in Adolescents: A Cross-Sectional Study

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ABSTRACT: Background: Cerebral palsy (CP) is the most prevalent cause of chronic motor disability originating in childhood. While traditionally managed as a motor disorder, contemporary evidence recognizes CP as a multisystem condition with significant oral health, masticatory, and psychosocial consequences. Adolescents with CP represent a particularly vulnerable group due to neuromuscular dysfunction, impaired oral motor control, and reduced access to specialized dental care. However, limited research has simultaneously evaluated oral health status, masticatory function, and health-related quality of life (HRQoL) in this population, particularly in Central Asian regions.

Objective: To investigate the relationship between cerebral palsy severity and oral health status, masticatory function, and health-related quality of life among adolescents with cerebral palsy, and to identify key clinical factors associated with reduced quality-of-life outcomes.

Methods: A cross-sectional observational study was conducted between January 2025 and February 2026 at multidisciplinary rehabilitation and neurological assessment centers affiliated with Tashkent State Medical University. The study included 60 adolescents aged 12–16 years: 40 with spastic cerebral palsy (main group) and 20 age- and sex-matched neurotypical controls. Cerebral palsy severity was classified using the Gross Motor Function Classification System (GMFCS). Oral health was assessed using the DMFT index, Oral Hygiene Index-Simplified (OHI-S), and Gingival Index (GI). Masticatory function was evaluated using a standardized two-color chewing gum mixing test. HRQoL was measured using the Pediatric Quality of Life Inventory Version 4.0 (PedsQL 4.0). Statistical analyses included Student's t-test, Mann–Whitney U test, one-way ANOVA, χ^2 test, Spearman correlation, and multiple linear regression.

Results: Adolescents with CP demonstrated significantly poorer oral health compared with controls, with mean DMFT scores of 4.1 ± 1.9 versus 1.8 ± 0.9 ($p < 0.001$). A progressive deterioration in oral health was observed with increasing GMFCS level: DMFT scores increased from 2.4 ± 1.1 (GMFCS I–II) to 5.8 ± 1.7 (GMFCS IV–V), while OHI-S and GI scores similarly worsened ($p < 0.001$ for all). Gingival inflammation prevalence reached 84.6% among adolescents with severe motor impairment compared with 27.8% in those with mild impairment ($p < 0.001$), and 92.3% of GMFCS IV–V participants required caregiver-dependent oral hygiene. Masticatory function declined substantially with neurological severity: chewing efficiency decreased from $82.4 \pm 8.6\%$ (GMFCS I–II) to $49.6 \pm 10.4\%$ (GMFCS IV–V) versus $91.5 \pm 5.8\%$ in controls ($p < 0.001$), while chewing time more than doubled in severe CP. All PedsQL domains were significantly reduced in the CP group, with the greatest decline in physical and social functioning among GMFCS IV–V adolescents (total PedsQL score 48.7 ± 8.6 versus 89.9 ± 4.5 in controls; $p < 0.001$). Strong correlations were identified between GMFCS level and DMFT ($r = 0.62$), OHI-S ($r = 0.59$), GI ($r = 0.58$), chewing efficiency ($r = -0.71$), and PedsQL ($r = -0.67$) ($p < 0.001$ for all). Chewing efficiency emerged as the strongest independent predictor of quality of life after adjustment for age, sex, and neurological severity ($\beta = 0.49$, $p < 0.001$).

Conclusion: Increasing severity of cerebral palsy is closely associated with progressive deterioration in oral health, impaired masticatory performance, and reduced health-related quality of life in adolescents. Masticatory dysfunction demonstrated the strongest association with quality-of-life impairment and independently predicted adverse psychosocial and functional outcomes. These findings emphasize the importance of integrating preventive dental care, oral motor rehabilitation, and regular oral health monitoring into comprehensive multidisciplinary management programs for adolescents with cerebral palsy. Future longitudinal multicenter studies are warranted to clarify causal relationships and evaluate targeted oral rehabilitation interventions.

INTRODUCTION

Cerebral palsy (CP) remains the most prevalent cause of chronic motor disability originating in childhood and continues to represent a major public health concern worldwide. The condition encompasses a heterogeneous group of permanent disorders affecting movement and posture that are attributed to non-progressive disturbances occurring in the developing fetal or infant brain [1,2]. Despite advances in neonatal intensive care and early rehabilitation, the global prevalence of cerebral palsy remains relatively stable, ranging from 2.0 to 3.5 cases per 1,000 live births, with considerable socioeconomic and healthcare implications extending throughout the lifespan [3,4].

Historically, research on cerebral palsy has focused primarily on gross motor impairment, mobility limitations, spasticity management, and orthopedic complications. However, contemporary evidence increasingly suggests that CP should be considered a multisystem condition involving a broad spectrum of neurological, cognitive, nutritional, communicative,

psychosocial, and oral health disturbances [5,6]. These secondary complications often contribute substantially to disability burden and may exert a greater influence on daily functioning and quality of life than motor impairment alone [7].

Among the less frequently investigated consequences of cerebral palsy are disorders affecting oral health and masticatory function. Oral health is increasingly recognized as an integral component of general health and well-being. The World Health Organization emphasizes that oral diseases represent some of the most common noncommunicable health conditions worldwide and disproportionately affect vulnerable populations, including individuals with disabilities [8]. Adolescents with cerebral palsy constitute a particularly high-risk group due to the combined effects of neuromuscular dysfunction, impaired oral motor control, difficulties in self-care, feeding disorders, and reduced access to specialized dental services [9,10].

Several pathophysiological mechanisms may contribute to the development of oral health problems in individuals with cerebral palsy. Neuromuscular incoordination of facial, lingual, and masticatory muscles may impair chewing efficiency and swallowing function, resulting in prolonged feeding times and altered dietary habits [11]. Abnormal muscle tone affecting the temporomandibular region may interfere with jaw movements, while impaired fine motor skills often limit the ability to perform adequate oral hygiene procedures independently [12]. Furthermore, involuntary movements, oral hypersensitivity, malocclusion, and persistent primitive oral reflexes may create additional barriers to effective oral care and dental treatment [13].

Numerous studies have reported a higher prevalence of dental caries, gingivitis, periodontal disease, enamel defects, malocclusion, bruxism, and temporomandibular dysfunction among children and adolescents with cerebral palsy compared with neurotypical peers [14–16]. The severity of these abnormalities appears to increase with the degree of neurological impairment, suggesting a possible relationship between motor disability and oral health outcomes. Nevertheless, published findings remain inconsistent, and significant variations in methodology, age groups, and assessment tools limit direct comparison across studies [17].

Masticatory function represents another important yet frequently overlooked aspect of health in cerebral palsy. Effective mastication is essential not only for food processing and digestion but also for craniofacial development, nutritional adequacy, speech production, and social participation [18]. Adolescents with CP often demonstrate reduced bite force, impaired chewing coordination, prolonged chewing cycles, and decreased masticatory efficiency [19]. These dysfunctions may contribute to selective eating behaviors, nutritional deficiencies, growth disturbances, and reduced participation in family and social activities involving food consumption [20].

Recent investigations have highlighted the close interaction between oral health and quality of life in pediatric populations. Oral pain, chewing difficulties, dental esthetic concerns, and limitations in oral function may adversely affect emotional well-being, self-esteem, school participation, interpersonal relationships, and overall life satisfaction [21,22]. In adolescents with chronic neurological disorders, these effects may be particularly pronounced due to increasing awareness of social differences and greater expectations regarding independence and participation in daily activities [23].

The concept of health-related quality of life (HRQoL) has emerged as an important outcome measure in contemporary rehabilitation medicine. Unlike traditional clinical indicators, HRQoL provides a multidimensional assessment of physical, emotional, social, and school functioning from the patient's perspective [24]. Previous studies have consistently demonstrated lower HRQoL scores among children and adolescents with cerebral palsy compared with healthy peers [25,26]. However, most investigations have focused predominantly on motor disability, communication difficulties, and participation restrictions, while the contribution of oral health and masticatory dysfunction to quality-of-life outcomes remains insufficiently understood [27]. The Gross Motor Function Classification System (GMFCS) is currently regarded as the international standard for assessing functional severity in cerebral palsy. The system categorizes individuals into five levels according to self-initiated movement and mobility limitations, providing a reliable and clinically meaningful measure of disease severity [28]. Several researchers have suggested that higher GMFCS levels are associated with poorer oral health status, increased dependence on caregivers, and greater feeding difficulties [29]. Nevertheless, evidence regarding the magnitude and clinical significance of these associations remains limited, particularly during adolescence—a developmental period characterized by rapid physical growth, hormonal changes, increasing autonomy, and evolving psychosocial needs [30].

Adolescence represents a critical transitional stage during which oral health behaviors become established and long-term health outcomes are shaped. For adolescents with cerebral palsy, the coexistence of motor disability, oral dysfunction, and psychosocial challenges may create a complex cycle of reduced self-care, worsening oral health, impaired nutrition, and diminished quality of life [31]. Understanding the interrelationship between these factors is therefore essential for designing effective multidisciplinary interventions that integrate neurological rehabilitation, dental care, nutritional support, and psychosocial assistance.

Despite growing recognition of oral health disparities among individuals with disabilities, significant gaps remain in the literature. First, relatively few studies have focused specifically on adolescents with cerebral palsy. Second, existing investigations rarely evaluate oral health status, masticatory function, and quality of life simultaneously within the same population. Third, limited evidence is available regarding the influence of neurological severity, as measured by GMFCS classification, on these interconnected outcomes. Finally, data from Central Asian countries remain scarce, highlighting the need for region-specific research capable of informing local healthcare strategies and rehabilitation programs.

Given these considerations, a comprehensive evaluation of oral health, chewing performance, and health-related quality of life across different levels of motor disability may provide valuable insights into the broader impact of cerebral palsy during adolescence. Such information may facilitate early identification of high-risk individuals and support the development of targeted preventive and rehabilitative approaches aimed at improving both oral and general health outcomes.

Therefore, the aim of the present study was to investigate the relationship between cerebral palsy severity and oral health status, masticatory function, and health-related quality of life among adolescents with cerebral palsy, as well as to identify the key clinical factors associated with reduced quality-of-life outcomes.

MATERIALS AND METHODS

Study Design and Participants. A cross-sectional observational study was conducted between January 2025 and February 2026 at the multidisciplinary rehabilitation and neurological assessment centers affiliated with Tashkent State Medical University. The study was designed to investigate the relationship between cerebral palsy severity, oral health status, masticatory function, and health-related quality of life among adolescents.

The study included a total of 60 adolescents aged 12–16 years. The main group consisted of 40 adolescents diagnosed with spastic cerebral palsy, while 20 age- and sex-matched neurotypical adolescents formed the control group. The diagnosis of cerebral palsy was established according to international clinical criteria and confirmed by pediatric neurologists with more than 10 years of professional experience [32,33].

Participants with cerebral palsy were recruited from outpatient neurological and rehabilitation services. Control participants were selected from secondary educational institutions and underwent screening to exclude neurological, psychiatric, developmental, and severe chronic somatic disorders.

Inclusion Criteria. The inclusion criteria for the cerebral palsy group were: confirmed diagnosis of spastic cerebral palsy; age between 12 and 16 years; stable neurological status during the previous six months; ability to undergo dental and neurological examinations; informed consent obtained from parents or legal guardians.

Exclusion Criteria. Participants were excluded if they had: progressive neurological diseases; genetic syndromes associated with craniofacial abnormalities; severe intellectual disability preventing cooperation during assessment; acute infectious diseases at the time of examination; previous maxillofacial surgery; orthodontic treatment initiated within the previous year; severe systemic disorders affecting oral health.

The study protocol complied with the ethical principles of the Declaration of Helsinki and was approved by the Local Biomedical Ethics Committee of Tashkent State Medical University (Protocol No. 04/2025). Written informed consent was obtained from parents or legal representatives prior to participation [34].

Demographic Characteristics

Among the 40 adolescents with cerebral palsy, 24 (60.0%) were boys and 16 (40.0%) were girls. The mean age was 13.9 ± 1.4 years. The control group included 12 boys (60.0%) and 8 girls (40.0%) with a mean age of 14.1 ± 1.2 years.

The predominance of male participants corresponds to epidemiological studies demonstrating a higher prevalence of cerebral palsy among boys compared with girls [35].

Table 1. Demographic and Clinical Characteristics of Study Participants

Variable	CP Group (n=40)	Control Group (n=20)	p-value
Age (years)	13.9 ± 1.4	14.1 ± 1.2	0.57
Boys, n (%)	24 (60.0)	12 (60.0)	1.00
Girls, n (%)	16 (40.0)	8 (40.0)	1.00
BMI (kg/m^2)	18.6 ± 2.4	21.1 ± 2.2	<0.01

Feeding difficulties, n (%)	26 (65.0)	1 (5.0)	<0.001
Oral motor dysfunction, n (%)	29 (72.5)	0	<0.001

Assessment of Cerebral Palsy Severity The severity of motor impairment was classified using the Gross Motor Function Classification System (GMFCS), which categorizes functional mobility into five levels according to self-initiated movement capabilities [28].

Participants with CP were distributed as follows: GMFCS I – 8 adolescents (20.0%); GMFCS II – 10 adolescents (25.0%); GMFCS III – 9 adolescents (22.5%); GMFCS IV – 7 adolescents (17.5%); GMFCS V – 6 adolescents (15.0%).

For analytical purposes, participants were additionally grouped into: Mild motor impairment (GMFCS I–II; n=18); Moderate motor impairment (GMFCS III; n=9); Severe motor impairment (GMFCS IV–V; n=13). This stratification allowed evaluation of progressive changes in oral health, masticatory function, and quality-of-life indicators according to neurological severity.

Oral Health Assessment Dental examinations were performed by two calibrated pediatric dentists who were blinded to neurological severity classification. The following internationally accepted indices were used:

Decayed, Missing, and Filled Teeth Index (DMFT) The DMFT index was employed to quantify cumulative dental caries experience according to World Health Organization recommendations [36]. The index was calculated as: DMFT = D + M + F where: D = decayed teeth; M = missing teeth due to caries; F = filled teeth. Higher values indicated poorer dental health status.

Oral Hygiene Index-Simplified (OHI-S) Oral hygiene status was assessed using the Greene and Vermillion Oral Hygiene Index-Simplified [37]. The index evaluates: soft plaque accumulation; calculus deposition. Scores range from 0 to 6, with higher scores indicating poorer oral hygiene. **Gingival Index (GI)** Gingival inflammation was evaluated using the Löe and Silness Gingival Index [38]. The assessment included: gingival color; swelling; bleeding tendency. Scores ranged from: 0 = healthy gingiva; 3 = severe inflammation.

Assessment of Masticatory Function. Masticatory performance was evaluated using a standardized two-color chewing gum mixing test widely applied in oral rehabilitation studies [39]. Participants were instructed to chew the test material for 20 chewing cycles under standardized conditions. Chewing efficiency was subsequently analyzed using digital image processing software. Results were expressed as percentage efficiency scores ranging from: 0% = extremely poor mastication; 100% = optimal mastication. The chewing gum mixing test was selected because of its high reliability, reproducibility, and applicability in adolescents with neurological disorders [40].

In addition, the following parameters were recorded: chewing time (seconds); number of chewing cycles; oral motor coordination score; lip closure competence.

Health-Related Quality of Life Assessment. Health-related quality of life was assessed using the Pediatric Quality of Life Inventory Version 4.0 (PedsQL 4.0), a validated instrument frequently employed in neurological and rehabilitation research [41]. The questionnaire consists of four domains: Physical Functioning; Emotional Functioning; Social Functioning; School Functioning. Total scores range from 0 to 100 points. Higher scores indicate better quality of life. Both adolescents and their caregivers participated in questionnaire completion under researcher supervision.

Statistical Analysis. Statistical analyses were performed using SPSS Statistics Version 29.0 (IBM Corp., USA). Quantitative variables were presented as mean $\pm$ standard deviation ($M \pm SD$). Qualitative variables were expressed as frequencies and percentages. Data normality was evaluated using the Shapiro–Wilk test. Comparisons between groups were performed using: Student's t-test; Mann–Whitney U test; One-way ANOVA with Bonferroni correction; χ^2 test. Associations between variables were examined using Spearman correlation analysis. Multiple linear regression models were constructed to identify independent predictors of health-related quality of life. A p-value <0.05 was considered statistically significant.

Study Hypothesis. We hypothesized that increasing neurological severity of cerebral palsy would be associated with: progressive deterioration of oral health indicators; reduced masticatory efficiency. lower quality-of-life scores; stronger dependence on caregiver-assisted oral hygiene; poorer social and emotional functioning. Furthermore, we hypothesized that masticatory dysfunction would serve as an independent predictor of quality-of-life impairment after adjustment for age, sex, and neurological severity.

RESULTS.

Oral Health Status According to Cerebral Palsy Severity

Significant differences in oral health indicators were observed between adolescents with cerebral palsy and neurotypical controls. The mean DMFT score in the CP group was 4.1 ± 1.9 compared with 1.8 ± 0.9 in the control group ($p < 0.001$). Similarly, oral hygiene and gingival health were significantly compromised among adolescents with CP.

A progressive deterioration in oral health status was observed with increasing GMFCS level. Adolescents classified within GMFCS IV–V demonstrated the highest prevalence of untreated dental caries, gingival inflammation, and poor oral hygiene.

Table 2. Oral Health Indicators According to GMFCS Severity

Parameter	GMFCS I–II (n=18)	GMFCS III (n=9)	GMFCS IV–V (n=13)	Control (n=20)	p-value
DMFT score	2.4 ± 1.1	4.0 ± 1.3	5.8 ± 1.7	1.8 ± 0.9	< 0.001
OHI-S	1.2 ± 0.5	2.0 ± 0.7	3.1 ± 0.8	0.9 ± 0.4	< 0.001
Gingival Index	0.8 ± 0.3	1.4 ± 0.4	2.1 ± 0.5	0.5 ± 0.2	< 0.001

The prevalence of gingival inflammation reached 84.6% among adolescents with severe motor impairment compared with 27.8% among those with mild impairment ($p < 0.001$). Furthermore, caregiver-dependent oral hygiene was reported in 92.3% of participants classified as GMFCS IV–V.

Masticatory Function Assessment. Chewing performance decreased substantially with increasing neurological severity. Adolescents with severe motor impairment demonstrated prolonged chewing time, reduced oral motor coordination, and lower chewing efficiency scores.

Table 3. Masticatory Function Indicators

Parameter	GMFCS I–II	GMFCS III	GMFCS IV–V	Control	p-value
Chewing efficiency (%)	82.4 ± 8.6	67.3 ± 9.2	49.6 ± 10.4	91.5 ± 5.8	< 0.001
Chewing time (sec)	18.6 ± 4.2	26.1 ± 5.1	35.8 ± 6.4	15.2 ± 3.7	< 0.001
Oral motor coordination score	8.1 ± 1.4	6.2 ± 1.3	4.3 ± 1.1	9.2 ± 0.9	< 0.001

Analysis revealed that adolescents with severe CP required more than twice the chewing time of neurotypical peers. Reduced chewing efficiency was frequently accompanied by food selectivity, avoidance of hard-textured foods, and prolonged meal duration.

Health-Related Quality of Life. Significant reductions in all PedsQL domains were observed among adolescents with cerebral palsy.

Table 4. PedsQL Scores According to Neurological Severity

Domain	GMFCS I–II	GMFCS III	GMFCS IV–V	Control	p-value
Physical functioning	71.4 ± 8.3	60.8 ± 7.5	45.2 ± 8.1	91.3 ± 4.8	< 0.001
Emotional functioning	74.6 ± 9.2	66.4 ± 8.8	54.3 ± 9.5	88.2 ± 5.1	< 0.001
Social functioning	78.2 ± 7.4	67.5 ± 8.1	51.7 ± 9.7	92.4 ± 4.7	< 0.001
School functioning	69.1 ± 8.8	59.3 ± 9.4	43.6 ± 10.2	87.6 ± 5.6	< 0.001
Total PedsQL score	73.3 ± 7.6	63.5 ± 7.9	48.7 ± 8.6	89.9 ± 4.5	< 0.001

The greatest decline was observed in physical and social functioning domains, particularly among adolescents with GMFCS IV–V.

Correlation Analysis. Strong and statistically significant associations were identified between neurological severity, oral health parameters, masticatory function, and quality of life.

Table 5. Correlation Analysis

Variables	Spearman r	p-value
GMFCS vs DMFT	0.62	<0.001
GMFCS vs OHI-S	0.59	<0.001
GMFCS vs Gingival Index	0.58	<0.001
GMFCS vs Chewing Efficiency	-0.71	<0.001
GMFCS vs PedsQL	-0.67	<0.001
DMFT vs PedsQL	-0.54	<0.001
OHI-S vs PedsQL	-0.49	0.002
Chewing Efficiency vs PedsQL	0.73	<0.001

Multiple linear regression analysis demonstrated that chewing efficiency remained the strongest independent predictor of quality of life after adjustment for age, sex, and neurological severity ($\beta=0.49$, $p<0.001$)

DISCUSSION

The present study demonstrated that increasing severity of cerebral palsy is associated with progressive deterioration in oral health, impaired masticatory performance, and reduced health-related quality of life among adolescents. The findings support the growing concept that oral health should be considered an integral component of comprehensive neurological rehabilitation. The observed increase in DMFT scores across GMFCS levels is consistent with previous reports indicating that reduced manual dexterity, dependence on caregivers, and impaired oral motor control contribute significantly to poor dental outcomes among individuals with cerebral palsy. Adolescents with severe motor impairment experienced nearly threefold higher caries burden than healthy peers, highlighting the cumulative effect of inadequate oral hygiene and limited access to preventive dental care. Masticatory dysfunction emerged as one of the most clinically significant findings. Reduced chewing efficiency was strongly associated with neurological severity and independently predicted quality-of-life impairment. This observation suggests that oral motor dysfunction may influence not only nutritional status but also psychosocial adaptation, social participation, and emotional well-being.

Another important finding was the strong relationship between oral health indicators and PedsQL scores. Poor oral hygiene, gingival inflammation, and dental caries were all associated with lower quality-of-life measures. These results support contemporary evidence indicating that oral health contributes substantially to physical comfort, self-esteem, communication, and social integration.

The study highlights the necessity of multidisciplinary management approaches incorporating neurologists, pediatric dentists, rehabilitation specialists, speech therapists, nutritionists, and psychologists. Early identification of oral health problems may reduce secondary complications and improve long-term outcomes.

CONCLUSION

The severity of cerebral palsy is closely associated with oral health deterioration, impaired masticatory performance, and reduced health-related quality of life in adolescents.

Adolescents with severe motor impairment demonstrated significantly higher DMFT scores, poorer oral hygiene, increased gingival inflammation, lower chewing efficiency, and substantially reduced PedsQL scores compared with adolescents with mild motor disability and neurotypical controls.

Masticatory dysfunction showed the strongest association with quality-of-life impairment and emerged as an independent predictor of adverse psychosocial and functional outcomes.

These findings emphasize the importance of integrating preventive dental care, oral motor rehabilitation, and regular oral health monitoring into comprehensive multidisciplinary management programs for adolescents with cerebral palsy.

Future longitudinal studies involving larger multicenter cohorts are warranted to clarify causal relationships and evaluate the effectiveness of targeted oral rehabilitation interventions.

ACKNOWLEDGEMENTS

The authors express their sincere gratitude to all adolescents and their families who participated in this study. The authors also acknowledge the staff of the Department of Neurology and folk Medicine and the participating dental specialists for their valuable assistance during data collection and clinical assessments.

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