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Dental Caries in Children and Youth With Cerebral Palsy: A Nationwide Study of Oral Health in Aotearoa New Zealand

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ABSTRACT

Aim: To assess oral health outcomes for children with cerebral palsy (CP) in Aotearoa New Zealand and examine whether the level of motor impairment, using the Gross Motor Function Classification System (GMFCS), is associated with increased dental caries at ages 5 and 12 years.

Methods: Longitudinal study linking clinical data from New Zealand Cerebral Palsy Register (NZCPR) for 1220 individuals with CP (aged ≤ 21 years) to national Community Oral Health Service records, 2008–2023. Oral health outcomes were measured using dmft/DMFT indices (decayed, missing, filled teeth) for primary and permanent dentitions.

Results: 981 (80%) participants had ≥ 1 dmft/DMFT records. 306/429 (71%) with recorded dmft at age 5 years and 167/230 (73%) with recorded DMFT at age 12 years were caries-free. Caries-free rates did not vary across GMFCS levels. Adjusting for confounders, dental decay was more common in children of NZ Māori, Pacific Peoples and Asian ethnicities compared to European children at age 5 years, [OR 3.60 (1.91, 6.80), OR 5.11 (2.36, 11.05), OR 3.06 (1.38, 6.79) respectively] and in NZ Māori at 12 years [OR 3.18 (1.42, 7.12)].

Conclusions: GMFCS was not associated with poorer oral health outcomes. However, significant ethnic disparities highlight the need for culturally responsive oral health interventions.

1 | Introduction

Cerebral Palsy/Hōkai Nukurangi [1] (CP) is a clinically heterogeneous condition of movement, posture, and motor function attributed to an early non-progressive and permanent insult or interference to fetal or infant brain development, occurring before movement and coordination patterns are established [2, 3]. While the initial brain insult is “non-progressive”, secondary co-morbidities are multiple and often lifelong. The physical impacts of CP are significant and range from problems with balance and coordination through to severe impairment, lacking

head control and needing full care. The Gross Motor Function Classification System (GMFCS) is used to classify the level of functional abilities in children with CP into five distinct levels, with those at levels I and II least affected by motor impairment and those at level V experiencing significant physical impairment [4]. In Aotearoa New Zealand (NZ), $\approx 2,500$ children live with CP, with approximately 120 new diagnoses a year, based on a prevalence of 1 in 500 live births [5]. Within the wider group of new diagnoses, an estimated 30% of children will be wheelchair users and classified as GMFCS IV or V [6].

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Previous studies investigating dental caries in children and adolescents living with CP have predominantly been conducted in low- and middle-income countries, reporting caries prevalence ranging from 55% to 77%, whilst also indicating substantially higher caries rates in permanent teeth than in the general population [7–9]. Risk factors for dental caries experience are broad, complex, and often interrelated. Individuals with greater health needs and physical limitations may be at increased risk, alongside contributory factors including caregiver capacity and support needs, oral health literacy, dietary practices, and reduced toothbrushing frequency [7, 10, 11]. Individuals with CP commonly experience impaired voluntary motor control, making independent tooth brushing difficult or impossible and resulting in reliance on caregivers for daily oral hygiene [12]. Parents and caregivers frequently report challenges in maintaining their children's oral health care due to behavioral and communication difficulties, reluctance to engage in oral hygiene routines stemming from oral-motor dysfunction, and difficulty fitting toothbrushing into an already demanding care schedule [13].

Gastroesophageal reflux disease is also a frequent comorbidity in this population, particularly in those classified as GMFCS IV or V [14], and often presents with regurgitation and/or vomiting of meals [15]. The regurgitation of gastric acid can contribute to dental erosion by compromising tooth integrity and increasing susceptibility to dental caries [16]. Furthermore, motor impairments in CP affect oral and pharyngeal coordination, leading to recommendations to modify food texture and consistency, to reduce the risk of aspiration [17]. These foods are often soft, sticky and retentive and tend to be more cariogenic [18].

In NZ, Community Oral Health Services (COHS) provide free oral health care for children from birth until the end of school year eight (approximately 12–13 years of age), delivering care through a combination of fixed clinics and mobile dental units or vans. After year eight, oral health services for children up to age 18 are provided through local private dental practices contracted by the Ministry of Health. The delivery model and frequency of care vary across the country and have changed within regions over time. These variations and historical changes have not always been well documented, but before 2006, children were enrolled at age 5, when they started school. Since 2006, children have been enrolled in COHS from birth by their Well Child Provider. The dmft is recorded whenever a comprehensive examination is performed, and represents the number of decayed, missing (due to extraction for decay) or filled teeth. This is abbreviated as dmft in the deciduous dentition and DMFT in the permanent dentition. The dmft /DMFT at age five years and at year eight (12–13 years) are reported annually to the Ministry of Health (now Health New Zealand) and summarized on Health New Zealand public-facing websites [19]. Rates of dental decay remain high in NZ despite significant investment in oral health care, with only 57% of 5-year-old children being caries-free in 2024 and with COHS attendance at 5 years of age declining by 19.2% between 2000 and 2019 [20].

While the challenges of oral health care for children with more severe CP are well described, most dental literature does not classify CP by motor impairment, meaning that the impact of variations in of motor impairment, as measured by GMFCS, is not examined as a contributing factor to adverse dental

caries outcomes. The primary aim of this study, therefore, was to investigate the prevalence of reported dental caries among children and youth with CP at approximately 5 and 12 years of age, with a focus on variations in CP gross motor functional abilities, as measured by the GMFCS. We hypothesized that increasing health and support needs of CP, as measured by higher GMFCS levels, would be associated with higher rates of dental caries. The secondary aims were to explore outcomes for different ethnicities and school quintiles at each age group. We hypothesized significant inequities in dental caries experience based on socioeconomic and ethnic backgrounds.

2 | Methods

2.1 | Study Design and Ethics

A longitudinal study matching data extracted on the 30th of April 2024, for 1261 children and young adults, aged 21 years and under, registered with the New Zealand Cerebral Palsy Register / Te Rēhita a Hōkai Nukurangi Aotearoa (NZCPR) with dmft /DMFT data held within COHS databases across the country for the years 2008–2023. There were 41 participants who were deceased by 30th April 2024. These participants were excluded from the final dataset, leaving 1220 participants included in the linkage and time-to-event analyses. The primary outcome measure was the number of children at each GMFCS level who were caries free at the age of five and age in year 8 at school (approximately 12 years of age). The secondary outcome measures were dmft/DMFT scores across ethnicities and school quintiles. An ethics amendment approved the matching of the register data (HDEC 2024 AM 2575). This study adheres to STROBE RECORD data linkage reporting recommendations by providing transparent descriptions of data sources and the linkage mechanism, and by reporting linkage completeness and missing data [21].

2.2 | Data Sources

The NZCPR is a national register established in 2015, with ethics approval (HDEC 13/NTA/130), to collect health data and information relevant to CP (including demographic and clinical information, such as GMFCS) [6]. Ethnicity is collected from the electronic health record at the time of data entry; ethnic groups were aligned with Statistics New Zealand level 1 categories for national standards reporting. These groupings were NZ Māori, Pacific Peoples, Asian, other (including Middle Eastern/Latin American/African), and European (both New Zealand and other European) [22].

Publicly funded oral health providers in New Zealand, including sixteen regional COHS and hospital dental services, have access to the Titanium oral health record as a clinical data management system, to enter indicators of oral health status and treatment of patients, including information on the number of decayed, missing, filled teeth since 2008 [20]. In New Zealand, regional providers usually record the dmft/DMFT at each visit and are required to report on the oral health status of children at age 5 years and in school year eight (12–13 years of age) to the Ministry of Health [23].

Until 2023, the New Zealand education system used a decile system, derived from the census of population and dwellings, to prioritise resourcing schools with children from the lowest socio-economic families. This was a broad measure to identify children from the lowest socio-economic backgrounds and target resourcing to schools with a higher proportion of these students. It provides a broad measure of relative poverty, with decile 1 schools being the 10% of schools with the highest proportion of students from low socio-economic communities, and decile 10 the reverse [24]. School decile is also routinely reported in the oral health dataset.

2.3 | Data Extraction, Linkage and Statistical Analysis

The 1220 eligible participants had a median age at data extraction of 15 years (range 1–21), and 721 (60%) were male. Ninety-six were < 5.0 years of age at data extraction and 363 were ≤ 12 years of age. The NZCPR ethnicity distribution for the total cohort was comparable to the NZ general population for this age group [25]. GMFCS was missing for 26 (2%) of participants, whilst 367 (30%) were classified as GMFCS IV or V, comparable to GMFCS distribution in Australia [26]. Consistent with prior literature grouping GMFCS levels by functional mobility, GMFCS levels were categorized as follows: independently ambulatory (GMFCS I), ambulatory with some limitations or requiring a hand-held mobility device (GMFCS II–III), and non-ambulatory (GMFCS IV–V) [27].

The National Health Index (NHI) was used to match NZCPR data with oral health data, creating the final de-identified dataset for analysis. The NHI is an electronic health number unique to the individual, assigned at birth or at the point of first contact with either the public or private healthcare system. The NHI is used to identify every health care user in NZ and is recorded each time an individual has contact with the health system [28].

A dmft/DMFT score of zero was defined as being caries-free. Ethnicity from the oral health dataset was used to analyse participants with oral health status data. School deprivation deciles were converted into quintiles, with Quintile (Q1) representing a school with the highest proportion of students from low socio-economic communities and Quintile (Q5) representing the lowest proportion. The school quintile ratings used in this study are therefore a proxy for area-based deprivation and not true measures of individual deprivation status.

Descriptive statistics were used to summarise cohorts using frequencies or medians with interquartile ranges (IQRs), and *p*-values were obtained from chi-square tests or Hodges-Lehmann non-parametric tests. Logistic regression was performed to assess the association between the binary outcome variable, caries-free status, and independent factors. Kaplan–Meier time-to-event analyses were undertaken to examine age at first recorded dmft within COHS. In this context, the “event” was defined as the age (in years) at which a child first had a recorded dmft score. Participants who had not yet had a recorded dmft at the time of data extraction were treated as right-censored. Separate Cumulative Probability Curves were generated to compare the time to the first recorded oral health assessment across ethnic groups

and GMFCS categories. Multivariable logistic regression was performed to determine if caries-free rates differed by GMFCS group, controlling for potential confounders: Sex, ethnicity, and school quintile. There was a substantial proportion of missing data for school quintiles, which affected our ability to generalize the findings related to quintiles and necessitated running multivariable analyses both with and without school quintile data. Statistical analysis was carried out using SAS v9.4 (SAS Institute, Cary, NC, USA).

3 | Results

There were 239 (19.6%) of the 1220 NZCPR participants who had no recorded oral health data (Table 1); 150 (63%) were male; 135 (57%) European and 98 (41%) classified as GMFCS IV or V. These 239 participants were younger at the time of data extraction (mean age 10.1 years vs. 13.9 years, *p* < 0.001), with 77 (32%) aged < 5 years, and included more individuals classified as GMFCS IV or V (Chi square, *p* < 0.0001 compared to GMFCS levels I, II and III).

Of the NZCPR participants, 981 (80%) had at least one recorded dmft/DMFT measure. For these participants, documented gender and age matched across the NZCPR and COHS datasets. Ethnicity data in the oral health dataset showed slightly greater numbers of parent-reported Pacific Peoples and Asian ethnicity than in the NZCPR dataset, and a compensatory reduction in the number categorized as European 500 (51%) compared to 574 (59%) (Table 1). Ethnicity defined by the oral health dataset was used for subsequent outcome analyses.

3.1 | Age at First Recorded Oral Health Data

The median age of the 981 NZCPR participants at their first recorded dmft was 3.0 years (IQR = 1–5 years), indicating that 75% had been seen before the age of 5 years. No differences were found for age at first recorded dmft across different ethnicities (Figure 1A). Those children classified as GMFCS IV or V were older at the time of first recorded dmft (median age 4 years, IQR: 2–6 years) compared to children classified as either GMFCS I (median age 3 IQR: 2–5), or II / III (median age 3 years, IQR = 1–5 years) (*p* < 0.0001) (Figure 1B).

3.2 | Oral health status of children with CP at age 5–5.99 years

Nineteen of the 981 children with recorded dmft data were under the age of 5 years at data extraction and therefore not included in this specific analysis. For those assessed at age 5 years, the dmft recorded dates ranged from 2008 to 2023, were available for 429 of the remaining 962 children (45%), and are presented in Table 2. Overall, 306 (71%) were caries-free, and 123 (29%) had evidence of prior or present caries. In the latter group, 89 (72%) had decayed teeth, 17 (14%) had missing teeth due to decay, and 58 (47%) had filled teeth, with a median dmft of 3 (IQR 2–7).

Analysis by GMFCS levels: There was no difference in the caries-free rate at age 5 across GMFCS groups in univariable or multivariable analyses.

TABLE 1 | Characteristics of children from the New Zealand Cerebral Palsy Register ($n = 1220$) with and without oral health status data.

	No oral health status data			With oral health status data			<i>p</i> value
	<i>n</i> = 239			<i>n</i> = 981			
	<i>N</i>	<i>n</i>	%	<i>N</i>	<i>n</i>	%	
Gender							
Male	239	150	62.8	981	571	58.2	0.22
Female		89	37.2		407	41.5	
Other		0	0		3	0.3	
^a NZCPR Collected Ethnicity							
NZ Māori	239	57	23.8	981	233	23.8	0.98 ^b
Pacific Peoples		20	8.4		83	8.5	
Asian		22	9.2		85	8.7	
NZ European/Other		135	56.5		574	58.5	
Don't know		5	2.1		6	0.6	
^c COHS Collected Ethnicity							
NZ Māori		NA		981	245	25.0	NA
Pacific Peoples					110	11.2	
Asian					106	10.8	
NZ European/Other					500	51.0	
Don't know					20	2.0	
^d GMFCS Grouped							
I	239	62	25.9	981	338	34.5	< 0.0001
II/III		61	25.5		366	37.3	
IV/V		98	41.0		269	27.4	
missing		18	7.5		8	0.8	
^e Age at DoE	239	10.1	5.9	981	13.9	4.2	< 0.001

^aNZCPR: New Zealand Cerebral Palsy Register.^bChi-square *p* value excludes the “don't know” group.^cCOHS: Community Oral Health Services.^dGMFCS: Gross Motor Function Classification System.^eDate of Extraction from the New Zealand Cerebral Palsy Register dataset.

Analysis by ethnicity and school quintile: Of the 429 children, 198 (84%) of European ethnicity were caries-free at ages 5–5.99 years, compared with 53 (58%) NZ Māori, 24 (46%) Pacific Peoples and 26 (60%) Asian children. Children who were of NZ Māori, Pacific Peoples and Asian ethnicity had significantly higher odds of having evidence of dental decay (dmft > 0) compared to European children at age five years [OR = 3.84 (2.23, 6.62); OR = 6.24 (3.26, 11.94); OR 3.50 (1.73, 7.08)]. Children attending schools in Q1 (schools serving the most economically disadvantaged communities) were four times more likely to have evidence of dental decay (dmft score > 0) [OR = 4.06 (1.96, 8.43)] compared to children attending a Q5 school (Table 2). After adjusting for confounders, multivariate analysis showed that children with CP of NZ Māori, Pacific Peoples, and Asian Ethnicities were still much more likely to have dental decay [OR = 3.60 (1.91, 6.89), OR = 5.11 (2.36, 11.05), OR = 3.06 (1.38, 6.79)] compared with their European counterparts (Table 2).

Analysis by age at first dmft and number of recorded dmft measurements before age 6 years: The age at first recorded dmft was

the same for both the caries free and caries group; dmft = 0, median age 3 years and dmft > 0, mean age 3.5 years. The number of recorded dmft measurements before the age of six years were also similar for both groups, with both groups having a median of three recorded dmft measures.

3.3 | Oral Health Status of Children With CP at 12–12.99 Years

363 of 981 children were aged <12 years at the time of NZCPR data extraction and therefore had no data for this time point, excluding them from this outcome analysis. The DMFT scores for the 12–12.99 years age group, with recorded dates ranging from 2012 to 2023, were reported for 230 of the remaining 618 eligible children ≥ 12 years (37%) and are presented in Table 3. In this age group, 167 (73%) were reported as caries-free, and among the 63 (27%) with caries, the median DMFT was 2.0 (IQR 1–3). Nineteen of the 63 (30%) were recorded as having decayed teeth at the time

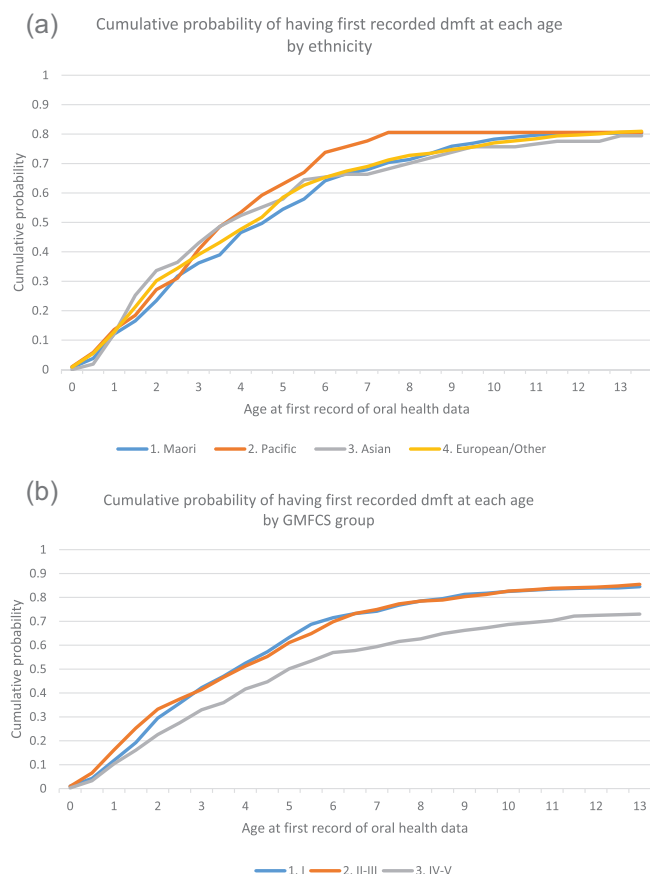


FIGURE 1 | Cumulative probability curves for age at first recorded health data versus ethnicity (A) and GMFCS levels (B).

of examination, 11 (17%) had missing teeth due to decay, and 45 (71%) had filled teeth.

Analysis by GMFCS levels: In univariate analysis, there was no difference in recorded DMFT scores across GMFCS levels among children with CP at 12 years of age.

Analysis by ethnicity and school quintile: By the age of 12 years, fewer differences were observed, but multivariate analysis showed that NZ Māori ethnicity remained statistically associated with greater dental decay [OR = 3.18 (1.42, 7.12)] compared with European data. The effects of other ethnic groups did not reach statistical significance.

Analysis by age at first dmft and number of recorded dmft/DMFT measurements before age 13 years: The difference in age at first recorded dmft was statistically significant ($p = 0.04$) for the two groups with dmft > 0 seen later (median age 5.5 years vs dmft = 0, median 5.0 years). Those with caries had a median of 5 previous DMFT records, compared with 7 for those who were caries-free at age 12–12.99 years [OR 0.89 (0.81, 0.98)].

4 | Discussion

This study provides the first insight into the recorded oral health of a large cohort of children living with CP by linking the NZCPR with nationally recorded oral health data. Of the 1220

eligible participants, 80% were successfully linked to oral health records. For those with successfully linked records, no differences in oral health were found across GMFCS levels, even though those with higher health and support needs (GMFCS levels IV or V) appeared to be seen later for their first comprehensive oral health examination by community oral health services. There were striking inequities in oral health outcomes at five years of age across ethnicities, with NZ Māori, Pacific and Asian children with CP all having poorer oral health outcomes compared with European/ other (who were 84% caries free at age five years). These differences across ethnicity did not appear to be associated with reduced level of engagement with the community oral health service, as measured by the proxy of age at first recorded dmft.

Overall, our findings are consistent with a recent systematic review and meta-analysis evidence, which found no significant differences in dental caries experience, or enamel defects, between individuals with and without CP, although the certainty of evidence was very low, and individuals were not stratified by level of motor limitations [29]. A complete-case analysis was used because oral health outcomes were available only for participants with linked COHS records; however, the overrepresentation of GMFCS IV-V participants among those without COHS data may have introduced selection bias, and the absence of an observed association between GMFCS level and dental caries in this study should be interpreted with caution.

Across New Zealand, an estimated 77% of 5-year-olds had reported COHS data in 2010, declining to 63% in 2019. Suggested reasons for the decrease in reporting include difficulties accessing the clinic, data-collection and reporting issues, and use of other oral healthcare providers. The caries-free proportion of children with reported COHS data ranged from 52% to 61% between 2001 and 2017 and has never exceeded 60% since then [30]. Better outcomes are seen in older NZ children in year eight (approximately 12 years old), with a caries-free proportion of 70.5% in 2021. By comparison, fewer children in our NZCPR cohort had a recorded dmft at ages 5 and 12 years, but among those with recorded data, 71% were caries-free at age 5 years and 73% at age 12 years. One reason for this may be that children with CP under 5 years have many more interactions with visiting health care professionals, such as speech language therapists and community nurses, than children without CP [31, 32]. This could lead to greater opportunities to provide and discuss effective, safe oral hygiene routines with the child's family at an earlier age. The numerous interactions with health care services may also explain why children classified as GMFCS IV or V had their first COHS visit and corresponding dmft recording at a later age than their peers. These children often have the most complex health needs of the group as a whole, with multiple medical and community appointments, meaning attendance at oral health clinic appointments may not be feasible or prioritized during the early years [31].

These data have some limitations. Twenty percent of the 1220 NZCPR participants had no dental records at any age within the oral health dataset. Missing linked data from the COHS dataset likely reflects a combination of non-attendance at Community Oral Health Services, coupled with regional variations in record completeness. Other possibilities include increased use of other providers, such as acute care hospital dental clinics or private

TABLE 2 | Prevalence, univariate and multivariate analysis of dmft and caries free in children and young adults with cerebral palsy at 5–5.99 years of age for gender, GMFCS, ethnicity and school deprivation quintile.

	dmft >0			caries free (^a dmft = 0)			<i>p</i>	Univariate		Multivariate		Multivariate (excl. school quintile)	
	<i>n</i> = 123			<i>n</i> = 306				Odds Ratio (95% CI)		Odds Ratio (95% CI)		Odds Ratio (95% CI)	
	<i>N</i>	<i>n</i>	%	<i>N</i>	<i>n</i>	%							
dmft score (median, IQR)	123	3.0	2.0–7.0	NA									
First recorded dmft in years (median, IQR)	123	3.5	2.0–5.0	306	3.0	1.5–5.0	0.09						
Number dmft records < 6 years (median, IQR)	123	3.0	2.0–4.0	303	3.0	2.0–4.0	0.43	0.98 (0.87, 1.11)					
dmft components at age 5–5.99 years													
deciduous decayed teeth (mean, sd)	89	3.3	2.9										
deciduous missing teeth (mean, sd)	17	4.4	3.8										
deciduous filled teeth (mean, sd)	58	3.5	3										
Gender	<i>N</i>	<i>n</i>	%	<i>N</i>	<i>n</i>	%		Odds Ratio (95% CI)		Odds Ratio (95% CI)		Odds Ratio (95% CI)	
Male	123	77	62.6	306	188	61.4		1.04 (0.68, 1.61)		1.29 (0.77, 2.17)		1.11 (0.70, 1.77)	
Female		46	37.4		117	38.2		Ref		Ref		Ref	
Another gender		0	0.0		1	0.3							
^c GMFCS (Grouped)													
I	123	50	40.7	306	120	39.2		Ref		Ref		Ref	
II-III		41	33.3		117	38.2		0.84 (0.52, 1.37)		0.96 (0.53, 1.73)		0.88 (0.52, 1.48)	
IV-V		32	26.0		69	22.5		1.11 (0.65, 1.90)		0.74 (0.38, 1.42)		0.79 (0.44, 1.41)	
Ethnicity													
NZ Māori	123	38	30.9	306	53	17.3		3.84 (2.23, 6.62)		3.60 (1.91, 6.80)		4.03 (2.31, 7.02)	
Pacific Peoples		28	22.8		24	7.8		6.24 (3.26, 11.94)		5.11 (2.36, 11.05)		6.54 (3.38, 12.66)	
Asian		17	13.8		26	8.5		3.50 (1.73, 7.08)		3.06 (1.38, 6.79)		3.59 (1.76, 7.31)	
NZ European/Other		37	30.1		198	64.7		Ref		Ref		Ref	
Unknown		2	1.6		5	1.6							

(Continues)

TABLE 2 | (Continued)

	a dmft >0				caries free (^a dmft = 0)				Multivariate (excl. school quintile)			
	n = 123		N		n = 306		N		Univariate		Multivariate	
									Odds Ratio (95% CI)		Odds Ratio (95% CI)	
	N											
School Quintile (^b Q)												
Q1	123	29	23.6	306	25	8.2			4.06 (1.96, 8.43)		2.36 (1.05, 5.32)	
Q2		24	19.5		64	20.9			1.31 (0.66, 2.60)		0.88 (0.41, 1.86)	
Q3		23	18.7		46	15.0			1.75 (0.86, 3.54)		1.53 (0.72, 3.26)	
Q4		8	6.5		49	16.0			0.57 (0.23, 1.40)		0.41 (0.16, 1.10)	
Q5		20	16.3		70	22.9			Ref		Ref	
missing		19	15.4		52	17.0						

^adecayed missing or filled deciduous teeth

^bQuintile

^cGross Motor Function Classification System.

practitioners. Of the remaining 981 participants with oral health data, three-quarters had intersected with COHS before age 5, suggesting good reach into younger age groups. However, this group were less likely to have the standard recorded dmft dental records at both age five-six years and 12–13 years of age than the NZ population. While recorded dmft indicates attendance at an oral health service, it was also not possible to understand why the child did or did not attend at that time, what services were delivered, and whether there were other visits that did not link to a recorded dmft. The lifetime exposure of each child to fluoridated drinking water could not be determined due to missing data and unaccounted-for changes in residence over time.

However, this study also highlights the strengths of matching a national register data to nationally collected oral health data using a NHI number assigned at birth. The CP cohort was drawn from the NZCPR, which includes the GMFCS, an indicator of functional ability, and an important variable for understanding health and quality-of-life outcomes across the CP continuum [32–35]. Approximately 65% of all children with CP in New Zealand are represented in the NZCPR. The distribution across the five GMFCS levels is consistent with that reported in the Australian CP Register [26] and 26% of participants aged 0–21 years identified as NZ Māori at the time of NZCPR data entry. Notably, 46% of NZCPR participants live in the most deprived geographical areas, with a higher proportion of NZ Māori than non-Māori [6]. The oral health data were drawn from the COHS dataset, which has been used to describe oral health across NZ in specific groups with cleft palate and bronchiectasis [36, 37]. Using these data sources, CP phenotype and oral health outcomes can be accurately described at the national level. The information obtained includes a better understanding of those without oral health data, strengthened knowledge about oral health among children with CP in NZ, and supplementation of existing health reports.

Dental caries across all ages is the most prevalent chronic disease in NZ, with NZ Māori (and Pacific Peoples) populations showing long-standing and persistent inequities in oral health [38–40]. NZ Māori and Pacific children with CP in this study also experienced far higher rates of dental decay at age 5–5.99 years compared to their European counterparts. Similar findings of higher dental decay have been reported for NZ Māori and Pacific children across the general Auckland region and for those with chronic illness (bronchiectasis) compared to non-Māori and Pacific Peoples, with study authors recommending that “structures and systems that are committed to reducing inequities for NZ Māori and other underserved populations (including Pacific Peoples) need to be developed urgently” [41]. This includes the social structures that perpetuate poverty, which have been directly associated with poor oral health outcomes [42]. Of note, we did not find ethnic differences in age at first recorded dmft or the number of recorded dmft scores by the age of 6 years, suggesting that in this patient group with CP, NZ Māori and Pacific children are engaging with the service at the same rate as their European counterparts, but experiencing very different outcomes.

These findings have important implications for both clinical practice and health policy in Aotearoa New Zealand. While children with CP appear to achieve oral health outcomes comparable to population averages within a publicly funded system, the

TABLE 3 | Prevalence, univariate and multivariate analysis of DMFT and caries free in children and young adults with cerebral palsy at 12–12.99 years of age for gender, ethnicity, school deprivation quintile and GMFCS.

	caries free (^a DMFT = 0)						<i>p</i>	Univariate Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)	Multivariate (excl. school quintile) Odds Ratio (95% CI)
	^a DMFT >0		^a DMFT = 0							
	<i>N</i>	<i>N</i> = 63	<i>N</i>	<i>N</i> = 167						
DMFT score (median, IQR)	63	2.0	1.0–3.0	NA						
Age first recorded DMFT (median, IQR)	63	5.5	4.0–9.0	167	5.0	3.0–6.5	0.04			
Number DMFT records < 13 years (median, IQR)	63	5.0	3.0–8.0	167	7.0	5.0–9.0	0.02	0.89 (0.81, 0.98)		
DFMT components at age 12–12.99 years										
Permanent decayed teeth (mean, sd)	19	1.5	0.7	19						
Permanent missing teeth (mean, sd)	11	2.2	1.3	11						
Permanent filled teeth (mean, sd)	45	1.8	1.1	45						
	<i>N</i>	<i>n</i>	%	<i>N</i>	<i>n</i>	%				
Gender										
Male	63	40	63.5	167	102	61.1	1.11 (0.61, 2.02)	Ref	1.29 (0.66, 2.55)	1.19 (0.62, 2.26)
Female		23	36.5		65	38.9			Ref	Ref
*GMFCS Grouped										
I	63	25	39.7	167	61	36.5	Ref	Ref	Ref	Ref
II-III		28	44.4		68	40.7	1.01 (0.53, 1.91)		1.04 (0.51, 2.12)	1.12 (0.57, 2.19)
IV-V		9	14.3		38	22.8	0.58 (0.24, 1.37)		0.50 (0.19, 1.32)	0.56 (0.23, 1.41)
missing		1	1.6		0	0.0				
Ethnicity										
NZ Māori	63	22	34.9	167	31	18.6	2.59 (1.30, 5.14)		3.18 (1.42, 7.12)	2.67 (1.31, 5.41)
Pacific Peoples		7	11.1		13	7.8	1.96 (0.72, 5.38)		2.89 (0.90, 9.26)	2.51 (0.86, 7.27)
Asian		3	4.8		17	10.2	0.64 (0.18, 2.35)		0.45 (0.09, 2.11)	0.75 (0.20, 2.77)
NZ European/Other		28	44.4		102	61.1	Ref	Ref	Ref	Ref
Unknown		3	4.8		4	2.4				

(Continues)

TABLE 3 | (Continued)

School Quintile ([†] Q)	caries free ([‡] DMFT = 0)			p	Univariate		Multivariate		Multivariate (excl. school quintile)	
	[‡] DMFT >0		Odds Ratio (95% CI)		Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)			
	N	N = 63								
	N	N = 167								
Q1	63	4	6.3	167	16	9.6	0.65 (0.19, 2.26)	0.43 (0.10, 1.85)	Not in model	
Q2		22	34.9		36	21.6	1.59 (0.72, 3.53)	1.54 (0.62, 3.83)		
Q3		9	14.3		48	28.7	0.49 (0.19, 1.23)	0.44 (0.16, 1.23)		
Q4		11	17.5		23	13.8	1.24 (0.49, 3.16)	1.63 (0.60, 4.43)		
Q5		15	23.8		39	23.4	Ref	Ref		
missing		2	3.2		5	3.0				

Note: [‡]Decayed Missing or Filled permanent teeth; [†]Quintile; *Gross Motor Function Classification System.

persistence of marked ethnic inequities highlights that universal service provision alone is insufficient to ensure equitable outcomes. Clinically, this underscores the need for more targeted, culturally responsive, and whānau (family)-centered oral health interventions, particularly for NZ Māori and Pacific children, alongside enhanced support for caregivers, who play a central role in daily oral hygiene. It also highlights the importance of strengthening oral health practitioner capability through ongoing education, training, and support to deliver inclusive, culturally safe, and disability-responsive care [43].

From a policy perspective, these results support strengthening equity-focused approaches within COHS, including earlier engagement, improved accessibility for children with complex needs, integration with other health and disability services, and embedding Te Tiriti o Waitangi principles in service design and delivery. Work by Broughton et al. has described the need for a “Kaupapa context, which (.) honors and respects whakaute, the beliefs and core values of individuals, groups, organizations and communities” in prevention of early childhood caries for NZ Māori [44]. Greater attention to what is delivered during visits, not just access or attendance, may be critical to reducing disparities and improving long-term oral health outcomes [45].

5 | Conclusions

In conclusion, this study provides one of the first nationwide analyses linking CP severity and oral health outcomes, offering important insights into inequities and service gaps within a universal, government-funded healthcare system. Overall, children with CP seen by COHS services demonstrated oral health outcomes broadly comparable to population-level estimates across different levels of motor impairment. However, this finding should be interpreted cautiously, given missing data, potential selection bias, and limitations inherent in linking the two datasets. As with the general paediatric population, striking ethnic inequities in dental outcomes were seen at 5 years of age. Future work includes data linkage with dental hospital admissions data to capture children living with CP who may be accessing specialist hospital-based (tertiary) oral health services, including those who do not have a regular oral health provider, access care intermittently in community or primary care settings, or face structural and service-level barriers to engagement.

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Conflicts of Interest

No conflict of interest to declare from any of the authors.

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