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ORIGINAL RESEARCH

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Retrospective analysis of dental treatment under general anesthesia among children with early childhood caries in Malaysia

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Abstract

Many children are affected by early childhood caries (ECC) with some requiring dental treatment under general anesthesia (GA). In pediatric dentistry, GA is one of the established methods of behavior management. GA data is useful for understanding the caries burden among young children. This study aimed to determine the trends, patient characteristics, and types of treatments conducted under GA among young children in a Malaysian dental hospital over a 7-year period. A retrospective study using pediatric patient records from 2013 to 2019 was conducted on children aged 2–6 years (24–71 months) having ECC. Relevant data were collected and analyzed. In total, 381 children with a mean age of 49.8 months were identified. Some of the ECC cases were associated with abscesses (32.5%) and multiple retained roots (36.7%). Over a 7-year period, there was an upward trend of preschool children receiving GA. Of the 4713 carious teeth treated, 55.1% were extracted, 29.9% were restored, 14.3% had preventive procedures, and 0.4% were pulp treated. Mean extractions were significantly higher among preschoolers compared to toddlers ($p = 0.001$), while preventive treatment was markedly higher among toddlers. In terms of the type of restorative materials, almost similar distribution was observed between the two age groups with 86.5% treated using composite restorations. Dental treatment under GA was more frequently used among preschoolers than in toddlers, with extractions and restoration with composite resin being the common treatment options. The findings can help decision-makers or relevant parties address the burden of ECC and enhance oral health promotion activities.

Keywords

Behavior management; Early childhood caries; Children; General anesthesia; Pediatric dentistry

1. Introduction

Early childhood caries (ECC) is defined by the American Academy of Pediatric Dentistry as "the presence of one or more decayed, missing, or filled teeth or surfaces in any primary tooth in a child under the age of 6 years [1]." Left untreated, it can lead to poor oral and general health, thus compromising the child's quality of life [2]. ECC remains a significant public health issue worldwide, with its prevalence in 3-year-old children ranging from 22% to 61% in the Middle East and 38% to 45% in Africa [3]. Although caries trends in Malaysia have improved over the past decades, its prevalence in primary teeth among 5-year-old children remains high at 71.3%, with a mean dft of 4.83 [4]. However, no national data is available for toddlers and babies. High ECC prevalence has severe implications for children's well-being and their families. Its wide range of negative effects include pain, infections, and abscesses causing difficulty in eating and sleeping, as well as growth and development issues [2, 4].

Treating ECC can be difficult for dentists when multiple teeth are affected requiring extensive treatment. Dentists commonly attempt to treat children at the chairside using non-pharmacological behavioral management techniques [5]. However, such techniques are not always effective, especially for toddlers or preschoolers who tend to be extremely anxious, fearful, and uncooperative during dental treatment. In addition, local anesthesia is ineffective in some cases due to the presence of acute infections, resulting in unsuccessful treatment at the chairside. The complexity of treating ECC combined with the young age of the patients often requires the use of general anesthesia (GA). The application of dental general anesthesia (DGA) can facilitate comprehensive dental care in a single visit, reducing pain and infection, thus improving the patient's well-being [6].

Studies on the use of GA in dental treatment have been reported in Germany [7], Malaysia [8], and Taiwan [9]. How-

ever, existing studies frequently reported combined data for children under the age of 6 years. Only one study in Lithuania, provided a separate data analysis for dental treatment under GA in toddlers below the age of 4 years but limited its analysis over a 3-year period [10]. Hence published studies on DGA for toddlers over a longer time period are lacking. In Malaysia, national caries data among 5-year-old children is limited and the national survey is only conducted every 10 years. In the absence of more recent national data for younger children, DGA data can be utilized to better understand the caries burden among toddlers under the age of 4 years [11]. There is a lack of attention given to children under the age of 4 years and most of the national preventive programs are focusing only on preschool children. Hence, this study aimed to determine and compare the characteristics of DGA for toddlers (24–47 months/2–4 years) and preschoolers (48–71 months/2–4 years) who received GA for dental treatment in a tertiary dental hospital in Malaysia over a 7-year period. The findings will be beneficial to decision-makers in addressing the burden of ECC and enhancing oral health promotion activities.

2. Materials and methods

A cross-sectional study with retrospective data collection was designed and conducted in accordance with the Declaration of Helsinki. Records of children who received day-care GA treatment at a tertiary hospital in Kuala Lumpur from January 2013 to December 2019 were identified. The reason for selecting records from 2013 to 2019 was due to the availability of GA records during the data collection period (February to April 2020). Several incomplete patient records prior to 2013 contributed to missing data and were excluded. The patients comprised of children referred by general dental practitioners and medical practitioners or brought by their caregivers to the Pediatric Unit, University Malaya Medical Centre (UMMC), Kuala Lumpur, Malaysia. The inclusion criteria for patients who underwent DGA in the hospital were children who were unable to cooperate due to medical conditions, required complex restorative and/or surgical treatment, demonstrated failure in behavior management at chairside, were uncooperative, or had full-mouth advanced caries requiring extensive treatment.

The patients' records with caries were reviewed and relevant information extracted using a data extraction form in Microsoft Word. Data extracted from patient records included demographic characteristics (gender, age, ethnicity), treatment types, and restorative materials. Caries treatments were divided into four categories for analysis: (1) extractions; (2) preventive (fluoride therapy, fissure sealant, and prophylaxis); (3) restorations (composite, glass ionomer, compomer and stainless-steel crown); and (4) pulp therapy (pulpotomy and pulpectomy). ECC classification was based on that of the American Association of Pediatric Dentistry [1]. Children treated with DGA for other conditions such as supernumerary, mucocele, or dental trauma were excluded from this study. The children were categorized into two groups: (1) toddlers (24–47 months/2–4 years) and (2) preschoolers: (48–71 months/2–4 years) [12]. Data on socio-economic status was analyzed based on treatment fees. In regard to GA procedures, the UMMC offers two payment modes, namely private and public-funded fees. The former is significantly costlier, though it entails shorter waiting times.

The sample size calculation was based on caries prevalence among preschool children (71.3%) using the Malaysian National Survey [4], with a precision of 5% and confidence level of 95%. The minimum sample size required was 314. The available clinical records (n = 381) fulfilled the minimum sample size and all were included in the analysis. All statistical analyses were performed using the Statistical Package for the Social Sciences program for Windows version 24.0 (SPSS, Chicago, IL, USA) and tests of normality were conducted. Descriptive statistics were performed to determine frequency, mean, and percentage. Following data normality tests, the Chi-square, independent *t*-test, and Mann-Whitney tests were performed to examine the variables association between the age groups. A *p*-value of less than 0.05 was deemed significant.

3. Results

A total of 381 children aged 24 to 71 months (mean ± standard deviation (SD) = 49.8 ± 12.12 months) with caries were treated under DGA. More than half (59.3%) were preschoolers while the rest were toddlers (40.7%) (Table 1). Based on gender, males (57%) were significantly more than females (43%) ($p < 0.05$). Most of the children were Malay (53.5%) followed by Chinese (32.0%), Indian (6.6%) and others (7.9%). Medically-compromised children were significantly fewer at 12.6% than those who were not (87.4%). There was a significant difference ($p < 0.05$) between both groups of patients and DGA option fees, with more opting for private-funded fees (69.6%) than public-funded fees (30.4%). Only two of the children (0.5%) had a history of DGA.

The was an increase in the number of preschool children with ECC receiving treatment under GA in UMMC, except for the year of 2017 and 2019 (Fig. 1). The number of both preschooler and toddler GA patients doubled between 2013 and 2015. For the toddler group, the highest number of cases (n = 30) was in 2015, followed by a decline in 2016 (n = 22) and 2017 (n = 19), before reaching a plateau in 2018 and 2019 (Fig. 1).

In total, a higher proportion of preschool children was diagnosed with ECC (59.3%) compared to the toddler group (40.7%) (Table 2). In terms of severity, 32.5% and 36.7% had dental abscesses and multiple retained roots, respectively. A notably higher proportion of preschool children were diagnosed with ECC and dental abscesses compared to the toddler group ($p = 0.003$). Although higher cases of ECC with multiple retained roots was observed in preschoolers (24.1%) compared to toddlers (12.6%), the difference was not statistically significant ($p = 0.053$).

The number of carious teeth affected by abscesses (n = 421) was further analyzed based on teeth per quadrant (Fig. 2). First primary molars (n = 163) had the most dental abscesses followed by primary second molars (n = 140), and primary maxillary incisors (n = 100). Primary mandibular anterior teeth were the least affected.

Of the 4713 carious teeth treated under DGA, 55.1% (mean = 6.84) were extracted, 29.9% (mean = 3.71) were restored, 14.3% (mean = 2.19) had preventive procedures, and 0.4%

TABLE 1. Demographics of patients receiving dental treatment under general anesthesia.

Demographic variables	Toddlers	Preschoolers	TOTAL	*p*-value[a]
	n (%)	n (%)	n (%)	
	n = 155	n = 226	n = 381	
Gender				
Male	77 (49.7)	140 (61.9)	217 (57.0)	0.017*
Female	78 (50.3)	86 (38.1)	164 (43.0)	
Ethnicity				
Malay	85 (54.8)	119 (52.7)	204 (53.5)	
Chinese	51 (32.9)	71 (31.4)	122 (32.0)	0.771
Indian	8 (5.2)	17 (7.5)	25 (6.6)	
Others	11 (7.1)	19 (8.4)	30 (7.9)	
Medically compromised				
Yes	18 (11.6)	30 (13.3)	48 (12.6)	0.631
No	137 (88.4)	196 (86.7)	333 (87.4)	
DGA Fee				
Private fees (high to moderate income group)	118 (76.1)	147 (65.0)	265 (69.6)	0.021*
Public funded fees (low-income group)	37 (23.9)	79 (35.0)	116 (30.4)	
Previous DGA experience				
Yes	0	2 (0.9)	2 (0.5)	-
No	0	0	0	

[a] *Chi-square test. *Statistically significant. DGA, dental general anesthesia.*

TABLE 2. Classification of ECC cases treated under DGA.

	Age group			*p*-value[a]
	Toddler	Preschool	Total	
	n (%)	n (%)	n (%)	
ECC with multiple retained roots	48 (12.6)	92 (24.1)	140 (36.7)	0.053
ECC with dental abscess	37 (9.7)	87 (22.8)	124 (32.5)	0.003*
TOTAL children with ECC	155 (40.7)	226 (59.3)	381 (100.0)	0.003*

Values are number of patients and percentage.
[a] *Chi square test. *Statistically significant.*
ECC, early childhood caries.

(mean = 0.05) were pulp treated. In general, dental treatments under DGA were higher among preschool children than those aged 2 to 4 years ($p < 0.001$). As for types of treatment received, mean extractions were significantly higher among preschoolers (mean = 8.11) than toddlers (mean = 4.99) ($p = 0.001$) while preventive treatments dominating in the toddler age group (Table 3).

In terms of type of restorative materials used, there was no significant difference observed between the preschool and toddler age groups. Of the restored teeth, 86.5% (mean = 3.20) were composite restorations (Table 4). Slightly higher number of glass ionomer cement (3.9%) and compomer restorations (2.3%) were seen in the toddlers than in the preschooler group. However, the differences were not statistically significant. More stainless-steel crowns were used among the preschool children.

4. Discussion

This study highlights the utilization of DGA among young children with ECC in the capital city of Kuala Lumpur, Malaysia. The hospital is located in an urban area serving a mixed population with wide income inequalities. The findings indicate that the number of male children with ECC requiring treatment under GA was higher than female children. Similar findings were reported in a DGA study at the Lithuania University Hospital [10] and in epidemiology data on ECC [13]. In addition, many parents in the moderate to high socio-economic status groups chose the private fee option due to the shorter waiting time for DGA service. A possible reason for this finding could be that the population in the capital city comprise of working-class parents with stable incomes who have better access to dental treatment. The UMMC hospital is one out of two public teaching hospitals in Kuala Lumpur that provide

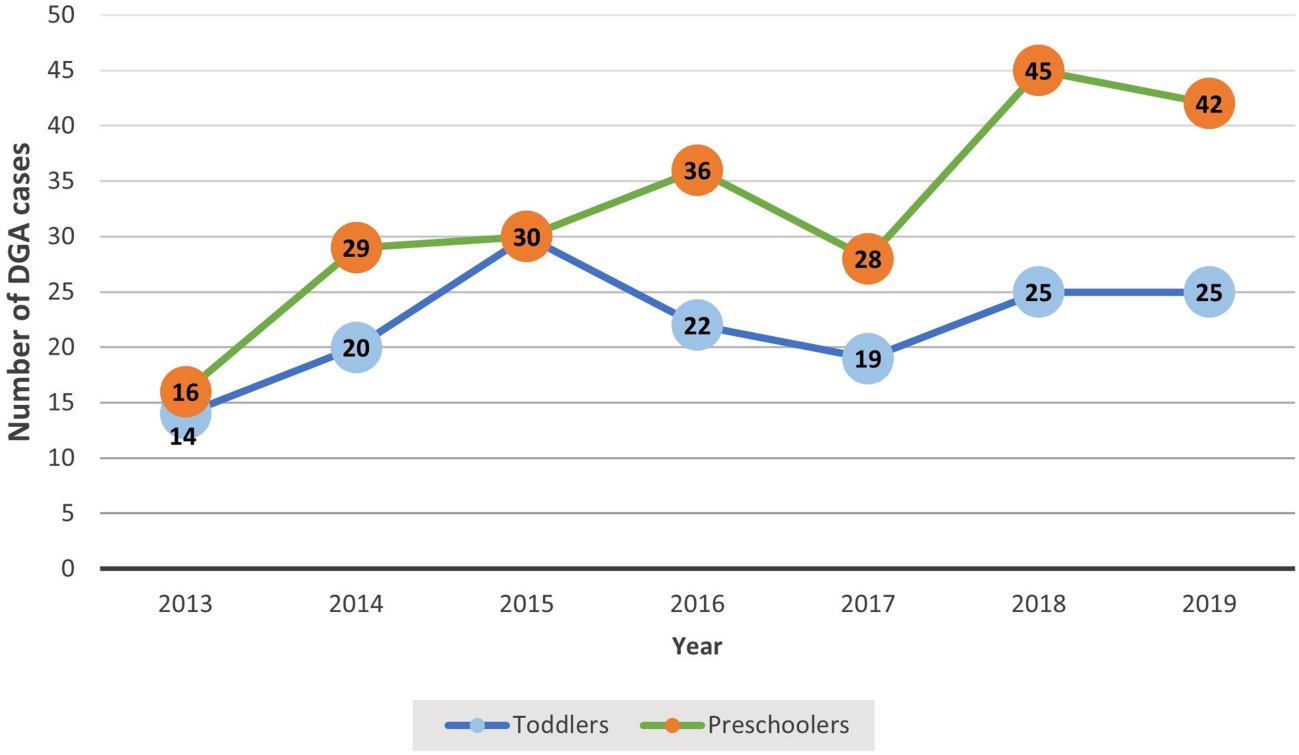

FIGURE 1. The number of dental general anesthesia (DGA) patients, 2013 to 2019.

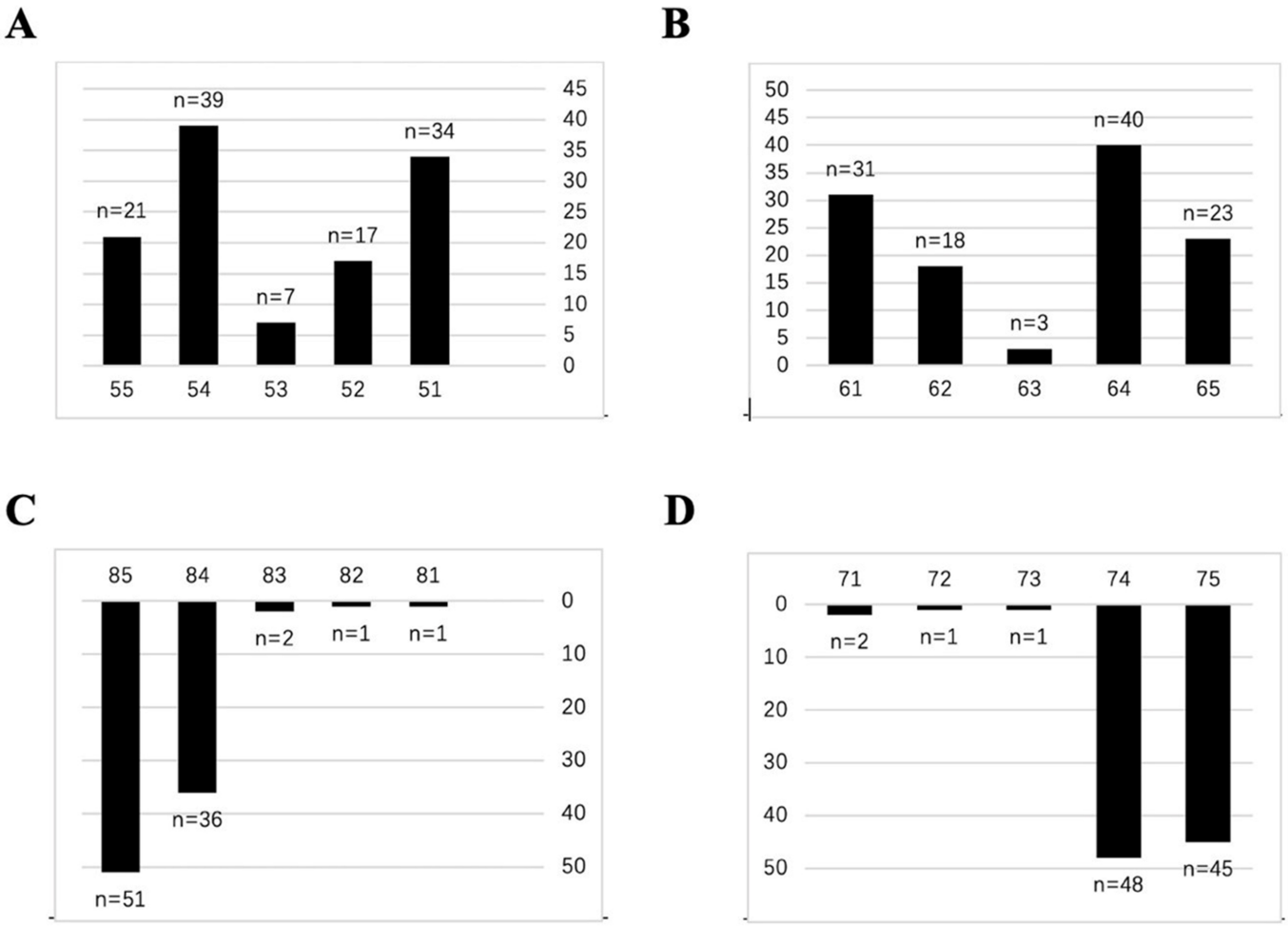

FIGURE 2. Number of primary teeth with abscesses due to early childhood caries (ECC). (A) upper right quadrant, (B) upper left quadrant, (C) lower right quadrant, (D) lower left quadrant.

TABLE 3. Distribution of ECC treatment performed under DGA by age group.

Treatment received	Toddler	Preschool	TOTAL	*p*-value
Preventive				
n (%)	339 (19.5)	339 (11.3)	678 (14.3)	**0.010
Mean (SD)	2.19 (2.45)	1.50 (1.95)	1.78 (2.19)	
Restorative				
n (%)	616 (35.4)	796 (26.6)	1412 (29.9)	*0.140
Mean (SD)	3.97 (3.12)	3.52 (2.80)	3.71 (2.93)	
Pulp therapy				
n (%)	5 (0.3)	13 (0.4)	18 (0.4)	*0.347
Mean (SD)	0.03 (0.21)	0.06 (0.29)	0.05 (0.26)	
Extraction				
n (%)	773 (44.5)	1832 (61.3)	2605 (55.1)	**0.001
Mean (SD)	4.99 (4.24)	8.11 (5.51)	c (5.25)	
TOTAL				
n (%)	1733 (36.8)	2980 (63.2)	4713 (100.0)	**0.001
Mean (SD)	11.22 (4.85)	13.22 (4.10)	12.40 (4.52)	

**Independent t-test, ** Mann-Whitney test (Analysis based on number of teeth).*
SD, standard deviation.

TABLE 4. Distribution of the type of restorative materials used under GA.

Restorative materials	Toddler (n = 616)	Preschool (n = 796)	TOTAL (N = 1412)	*p*-value
Composite restorations				
n (%)	529 (85.9 %)	692 (86.9 %)	1221 (86.5%)	**0.252
Mean (SD)	3.41 (2.82)	3.06 (2.66)	3.20 (2.73)	
Stainless steel crowns (SSCs)				
n (%)	49 (8.0 %)	74 (9.3 %)	123 (8.7 %)	*0.909
Mean (SD)	0.32 (0.98)	0.33 (0.93)	0.32 (0.95)	
Glass ionomer cements				
n (%)	24 (3.9 %)	30 (3.8 %)	54 (3.8 %)	*0.790
Mean (SD)	0.15 (1.08)	0.13 (0.53)	0.14 (0.79)	
Compomer restorations				
n (%)	14 (2.3 %)	0	14 (1.0 %)	**0.087
Mean (SD)	0.09 (0.80)	0	0.04 (0.51)	

Values are means ± standard deviation. (Analysis based on number of teeth).
**Independent t-test, ** Mann-Whitney test.*

dual treatment fee options as a means to improve sustainability and public access to healthcare. The public funded fee refers to treatment charges which are fully subsidized by the government and the private fee option refers to partially subsidized fees, where the patient would be required to partially cover the cost of treatment received with additional benefit of a shorter waiting time. However, these fees are lower than the average private hospital. Furthermore, some of the patients referred from nearby private clinics for GA dental management were among those who could afford such treatment. Although many studies have found a higher prevalence of ECC in socially disadvantaged children, they may have not used or had limited access to dental care including DGA [2, 11, 14]. Only 30.4% of the total studied population used the public funded fee DGA for management of ECC in this study. This indicates that there is the possibility of underutilization of DGA services among children from low socio-economic backgrounds due to the hospital's location, treatment costs, and longer waiting times. Another possible reason for contradicting findings from this study could be due to possibilities of parents with moderate to high income level being dependent on their domestic helpers to take care of their children while they are at work. The domestic helpers, especially those without any formal training may have a lower level of education and poor oral health literacy [4, 13].

Throughout the 7-year period from 2013 to 2019, DGA utilization among preschool children increased steadily except in 2017 and 2019. Despite the fluctuation, the general trend showed an increase of ECC treated under GA over the years. This trend may be attributed to an increase in access to DGA due to a growing number of specialists and trainees at the center. The decline in 2017 was due to the limited availability of operation theatres because of technical and maintenance challenges. This created a surge of cases in 2018 to handle the backlog when operating rooms became available. The slight decrease of cases in 2019, could be due to last-minute cancellations of the GA slots caused by multifactorial reasons including patient's health and administrative issues. A similar scenario was reported in Canada regarding challenges in scheduling DGA cases at public-funded hospitals [11]. Moreover, the high prevalence of caries in these young children may be explained by the rate of caries progression in primary teeth. A study conducted in Israel reported that it took approximately 1.4 years for carious lesions to progress from the dentin-enamel junction to the inner half of the dentine [15], while another study in Australia found that enamel lesions progressed into dentine within 10 months [16]. It can be postulated that the progression was more rapid in the studied population as they were in the high caries risk category. Children below 4 years of age had fewer cases because the teeth do not remain long enough in the mouth to show a greater progression [9].

This study implies that children aged 2 to 6 years have a significant burden of treatment needs for ECC under GA. Therefore, vigorous actions on early intervention for dental caries prevention should begin as early as in the prenatal period. A recent systematic review and meta-analysis reported that children whose mothers received prenatal oral health care had lower rates of ECC and *Streptococcus mutans* carriage [17]. Thus, it is crucial for pregnant women to maintain and improve their oral health as it is a promising step towards ECC prevention. An existing strategy in Malaysia is the integration of oral health care into the comprehensive maternal health care provided by the Ministry of Health to all expectant mothers. However, a local study found that some pregnant women avoid seeking or receiving oral care [18]. This could be due to a lack of oral health awareness, low referral cases from prenatal care team members to oral health care providers, or a lack of interprofessional education that includes oral health [19]. Currently, the National Oral Health Survey among preschool children is conducted every ten years, making it challenging to fully understand the ECC burden at the national scale. Analysis of hospital records of children with ECC can be utilized to complement epidemiology and clinical data to support further improvement of patient care and expand preventive strategies to reduce the burden of ECC. Based on current ECC data, it is imperative that dental and antenatal care teams review existing activities in order to identify barriers preventing expectant mothers from using oral health care services optimally and to improve the concept of integrated care during prenatal services.

Based on the findings of this study, the common DGA procedures were extractions and restorations, followed by preventive treatment. This suggests that DGA could be one of the options for treating young children that need extensive dental treatment or with behavioral challenges in a tertiary dental hospital for comprehensive dental treatment. This is in agreement with earlier studies conducted in England [20], Taiwan [9], and Canada [11] on the types of dental treatment provided to children under GA. Preventive treatment was found to be more prevalent in the toddler age group in an attempt to protect the remaining teeth through clinical prevention approaches such as sealants or fluoride therapy. The severity of carious lesions, whether associated with dental abscesses or loss of most of the tooth surfaces observed as retained roots, could explain the high number of dental extraction procedures. These two conditions are often associated with odontogenic infections and teeth with poor prognosis. Extractions are commonly done to reduce the use of antibiotics to control odontogenic infections and to reduce the lifelong treatment burden of repeated restorative interventions [3, 9].

Considering the higher number of teeth extracted among the preschoolers, and the greater number of restorative work involving toddlers, it is possible that composite restorations were mainly placed on shallow to moderate carious lesions or teeth with esthetic concerns [9]. The fact that Stainless Steel Crowns (SSCs) were more commonly used in preschoolers may be due to the extension of caries in primary molars. SSCs have been reported to be the ideal dental material for primary molars in children with ECC treated with DGA and for reducing the risk of repeat dental treatment with or without the need for GA [21]. However, SCCs may not be indicated for patients with badly broken molars or teeth of poor prognosis, perhaps explaining the low number of SSC use found in this study. In terms of composite materials, several factors influence composite restoration longevity, such as composite filler technology, operator skills, moisture control, and appropriate case selection [22]. A recent study suggested that restorative treatment failures in primary teeth are associated with children's behavior during placement [23]. However, the success rate increases if the composite restoration is placed in a controlled environment such as during GA, or on a tooth with vital pulp using a rubber dam [23]. These factors could possibly explain the types of materials used to manage ECC cases in this dataset.

ECC treatment in young children is necessary because the disease has a negative impact on their well-being and those who care for them. However, treating caries alone will not mitigate the child's susceptibility to the disease as the literature clearly documents that past caries experience is the main predictor of its future development [24]. Therefore, this study recommends more targeted prevention strategies and oral health promotion activities in Malaysia to prevent ECC. In previous studies, home and early dental visits on the first birthday have been demonstrated to improve oral health status in young children, particularly in developed countries such as in England [17] and Canada [11]. Additionally, training on the "lift the lip" technique for parents have been practiced to monitor their children's oral health status and detect early signs of caries [12, 25]. Early detection allows for treatment of affected teeth while preserving the health of unaffected teeth. These strategies can be incorporated into existing prevention programs in Malaysia. Currently, most prevention efforts focus on kindergartens; however, the data shows that caries

occur much earlier, and prevention programs should begin as early as possible, including the empowerment of carers at childcare centers and the enhancement of antenatal programs for pregnant mothers in both public and private maternity hospitals. In addition, parents should also play an exemplary role in educating their children at home to inculcate positive oral health attitude and behaviors at an early age. Social media can also be utilized to educate parents and carers about ECC and primary prevention [25].

There are several limitations to this study which should be acknowledged. The data for this study was based solely on a single center analysis of the day surgery GA list, and data were skewed towards the high-risk caries group and uncooperative patients. In addition, the nature of the retrospective study has elements of selection bias and limits the statistical inference. In-patient cases were excluded from the sample due to difficulty in accessing hospital records during the data collection period. Therefore, the findings should be interpreted with caution as they do not represent all ECC cases treated under GA in the capital city of Kuala Lumpur. Moreover, there is insufficient information on demographic characteristics, adverse effects, and follow-up data thus limiting the variables for analysis in this study. It could be argued that the cut-off points for toddlers and preschoolers participating in the study differ from other countries. It is believed that some countries apply different cut-off points to categorize the age groups such as 2–3 years for toddlers and 3–5 years for preschoolers [26]. To reflect the local context, the age groups for this study were based on the Malaysian Ministry of Health target groups for service delivery and the school age for preschoolers. Based on the findings, further research incorporating data from other Malaysian dental hospitals will be necessary to better highlight the real scenarios and burdens of ECC, as well as the impact of DGA on the children's quality of life.

5. Conclusions

GA was increasingly used over the 7-year period covered by this study to treat ECC, particularly in preschool children treated at UMMC Kuala Lumpur, Malaysia. Preschoolers had significantly more carious-teeth conditions associated with abscesses and retained roots compared to toddlers. The primary molars were the most affected by dental abscesses, while the mandibular anterior teeth were the least affected. Extractions and composite resin restoration were found to be the most common treatment options. The increased utilization of DGA services of children from moderate to high socio-economic backgrounds could be attributed to the hospital's location, treatment costs, and waiting times. The findings of the study provide important insights on the consequences of not treating ECC on time. They will be useful for policy-makers or other relevant authorities in addressing the burden of ECC and improving strategies for promoting oral health activities among pregnant women.

ABBREVIATIONS

ECC—early childhood caries; DGA—dental general anesthesia; GA—general anesthesia; SSC—stainless steel crown; SD—standard deviation.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

NAMN, NAI and SM—designed the research study. NAI—performed the research. NAMN, NZA and SM—provided assistance and advice on data collection while NAI and NAMN—analyzed the data. NAI, NAMN, NZA, TNF and ND—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was reviewed and approved by the Medical Ethics Committee, Faculty of Dentistry, University Malaya, Malaysia (Reference No.: DF CO2002/0006 (L)). Informed consent was obtained from parents prior to the GA procedures. Permission to use hospital data for research purposes was included in the informed consent.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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