

ORIGINAL RESEARCH

The use of aesthetic paediatric full coverage restorations among paediatric dental practitioners: an international survey

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Abstract

Despite the recent growing evidence in support of prefabricated zirconia crown use as a successful option in managing grossly carious anterior and posterior primary teeth, the use of such crowns remains controversial within the paediatric dental profession. This study aims to assess the use of aesthetic full coverage paediatric restorations among paediatric dentists worldwide, with emphasis on aesthetic prefabricated zirconia crowns. This was an online cross-sectional survey questionnaire study comprising of 38 multiple-choice questions disseminated worldwide through the contact lists of national, regional and international paediatric dental organisations and social media platforms. The survey was completed by 556 respondents thus achieving power, with 391 (70.3%) females and 165 (29.7%) males. The respondents were from 55 different countries spread across six continents. The use of aesthetic full coverage restorations was reported by 80% (n = 444) of the respondents. For restoring anterior teeth, participants mainly used either composite strip crowns (94.4%, n = 419) or zirconia crowns (73.6%, n = 327), while those who used aesthetic crowns for restoring posterior teeth mainly used zirconia crowns (68.2%, n = 303). Within the limitations of this study, the results have shown a wide use of full coverage aesthetic restorations, including the use of zirconia crowns, of primary teeth within this international sample of practicing dentists.

Keywords

Full coverage restorations; Prefabricated zirconia crowns; Paediatric dental practitioners; Primary teeth

1. Introduction

Early childhood caries is a global health problem with a worldwide pooled prevalence of 48% [1] with large numbers of children presenting with extensive multi-surface cavities on both anterior and posterior teeth. Full-coverage restoration of primary teeth is often indicated when two or more surfaces are affected by dental caries, or when crown damage is too extensive for the remaining tooth structure to support an intra-coronal restoration [2]. Children with high caries risk would benefit from full coverage restorations rather than multi-surface restorations [3].

A limited range of primary tooth aesthetic full coverage options, such as composite strip crowns, polycarbonate crowns and pre-veneered stainless-steel crowns (PV-SSCs) are available. However, several limitations prevent their routine use in children [4]. Despite the positive effects on the quality of life in preschool children, the extensive demand on public services with long waiting times, higher cost of such treatments in the private sector, the need for extensive preparation and the likely need for dental general anaesthesia (GA) in young children

requiring full mouth rehabilitation have been reported as some of the factors limiting their routine use [4–6].

The recent development of prefabricated zirconia crowns (PZCs) for both anterior and posterior primary teeth, offer patients an additional full coverage restorative option with strong, biocompatible, and superior aesthetics to all other available prefabricated crowns [5]. Correspondingly, there has been increased parental demand and expectations for more aesthetic restoration options. Yet, despite their advantages, the relatively high cost, lack of availability, need for special training, perceived lower retention, need for excessive tooth reduction with possible iatrogenic pulp exposures, gingival damage during preparation, and longer preparation time have resulted in slower adoption by paediatric dentists worldwide [6–9].

Therefore, the aim of this study was to assess the use of aesthetic full coverage paediatric restorations among paediatric dentists worldwide, with emphasis on aesthetic PZCs.

2. Methodology

This study was a cross-sectional survey questionnaire comprising of 38 multiple-choice questions. The questionnaire was developed using the Online Surveys platform (previously Bristol Online Survey). Prior to administration, the questionnaire was piloted on a group of experienced paediatric dentists, mainly to ensure clarity, ease of understanding and avoid ambiguity of answers, as well as ensure that answer options were comprehensive and that sufficient opportunities to provide free text was available. The questionnaire involved a set of multiple choice questions covering the following:

- Demographics: country of practice, type of practice, and specialty status.
- Frequency of using aesthetic full coverage restorations: “Do you use preformed aesthetic crowns (including strip crowns) in restoring primary teeth?”
- Brands of commercial primary aesthetic crowns used: “What is the brand that you usually use?”
- Barriers to the use of aesthetic crowns in paediatric dentistry: “What are the reasons for not using preformed aesthetic crowns?”
- Types of cements (Which cement do you use?), sterilisation methods (How do you disinfect contaminated crowns?), and complications encountered in using primary tooth zirconia crowns (In your experience, the use of Zirconia crowns in restoring primary teeth is associated with which of the following? Answers included: Frequent loss of crowns, Crown chipping, Crown discolouration, Tooth surface loss of opposing teeth, Gingival inflammation, Pulpal inflammation).
- The use of intracanal support in restoring grossly carious primary anterior teeth (Do you use intracanal support before crown placement in restoration of severely mutilated primary anterior teeth?).
- Restorative options used in managing permanent molars requiring multi-surface restorations with a focus on the use of PZCs (Which of the following restorative options would you use in restoring multisurface carious/hypomineralised permanent molars?).

Where applicable, questions included an option for the participants to indicate any other choice or reason to their answer. The survey was disseminated electronically to paediatric dentists worldwide through several platforms including the Arabian Academy of Paediatric Dentistry’s Facebook page <https://www.facebook.com/ArAPD2015>, the paediatric dentistry forum Facebook page <https://www.facebook.com/groups/paediatricdentistryforum/>, regional paediatric dental societies’ contact lists/social media channels such as the European Academy of Paediatric Dentistry and the South Asian Association of Paediatric Dentistry, as well as through personal contacts of paediatric dentists working around the world.

The survey questions were preceded by an introductory page containing information regarding the aims of this survey, details of the research team involved in this study and an invitation to complete this anonymous survey. Therefore, this was an opt-in survey where consent was implied through completion of the survey questions. The survey was conducted between March 2020 to June 2020, with the initial distribution date in

March 2020 and a follow up reminder in May 2020. Paediatric dental specialists and those practicing in the capacity of a paediatric dentist such as postgraduate paediatric dentists and those with special interest in paediatric dentistry and able to access and complete an English language survey were invited to take part in this study.

The sample size was calculated according to the average ratio of paediatric dentists to the population based on United States of America (USA) standards. The USA has a population of 325 million with around 8033 practicing paediatric dentists in 2019 [10]. Translated into patient access to care, the supply of full-time paediatric dentists is 14 per 100,000 children. Based on global population of children (estimated to be around 1.97 billion children globally in 2020 [11]), therefore, the expected number of paediatric dentist specialists globally would be around 276,780. Using Cochran’s sample size calculation for cross-sectional design formula (at 95% confidence interval and a margin of error of 5%), a sample size of 384 paediatric dentists was needed for this study. Accounting for 20%, for excluded responses, a total sample size of 460 participants is needed to achieve the objectives of this study.

Data were statistically described in terms of frequencies (number of cases) and percentages while Chi square statistics were used to identify the association between participants baseline characteristic’s (Continent, type of practice and specialty status) and questions pertaining to the use of aesthetic crowns, use of Zirconia crowns, and the frequency of using zirconia crowns). Statistical analysis was conducted using IBM SPSS 28 (Statistical Package for the Social Science; IBM Corp, Armonk, NY, USA).

3. Results

The survey was completed by 557 respondents thus achieving power, of which an undergraduate student response was excluded leaving 556 respondents with 391 (70.3%) females and 165 (29.7%) males. The respondents were from 55 different countries spread across six continents with the highest number of respondents from Asia (n = 289, 52%), followed by Africa (n = 98, 17.6%), Europe (n = 93, 16.7%), North America (n = 48, 8.6%), South America (n = 12, 2.2%), and Australia (n = 6, 1.1%). Ten participants did not report their country of practice.

Close to half of the respondents worked in private practice (49.1 %, n = 273), approximately a quarter (25.2%, n = 140) in dental institutes, 12% in hospital settings (n = 67), 12.4% in Ministries of Health (n = 69) and 1.3% in other sectors (n = 7). The majority of respondents were paediatric dentistry specialists (59%, n = 328), and the rest were university staff members (17.1%, n = 95), 14% paediatric dentistry postgraduate paediatric dental students (n = 78), and 9.9% general practitioners with interest in paediatric dentistry (GPPD) (n = 55).

3.1 Use of aesthetic crowns

The use of aesthetic full coverage restorations was reported by 80% (n = 444) of the respondents. For restoring anterior teeth, participants mainly used either composite strip crowns (94.4%, n = 419) or zirconia crowns (73.6%, n =

327), while those who used aesthetic crowns for restoring posterior teeth mainly used zirconia crowns (68.2%, $n = 303$) (Table 1). Other full types of full coverage restorations such as glass fibre reinforced crowns, polycarbonate crowns, PV-SSCs, and Computer-Aided Design and Manufacturing (CAD-CAM) fabricated crowns were also used by respondents (Table 1).

The use of aesthetic full coverage restorations was significantly affected ($p < 0.05$) by the participants' continent, type of practice and specialty status. The proportion of the participants using aesthetic full coverage restorations were higher among dentists belonging to American continent (93.1%), Dentists practicing at Dental institutes (82.9%), and pediatric dental specialists (86.3%) as well as private practitioners (82.8%) respectively (Tables 2 and 3).

The main barriers to the use of aesthetic full coverage restorations included lack of availability (22%, $n = 42$), lack of training (22%, $n = 41$), and cost (20%, $n = 37$) (Fig. 1). Other less frequently reported reasons for barriers to use such restorations included lack of governmental approval, mainly preferred by the parents rather than children, long GA waiting lists, and treatment time restraints.

3.2 Zirconia crown use

The use of Zirconia crown was significantly affected ($p < 0.05$) by the participants' continent, type of practice and specialty status. The proportion of the participants using Zirconia crowns were higher among dentists belonging to African continent (93.2%), Private practitioners (82.7%), and Faculty members (82.9%) respectively (Tables 2 and 3). Furthermore, the frequency of using zirconia crowns was also significantly affected by type of practice and specialty status ($p < 0.05$). Participants working in private practice (63.1%) and paediatric dentists (56.5%) used zirconia crowns at least once a month (Tables 2 and 3).

Among zirconia crown users, 21% ($n = 69$) performed these crowns only under GA, 24% ($n = 78$) only under local anaesthesia (LA) and/or sedation while the remaining ($n = 178$, 54.4%) performed these crowns under all treatment modalities (GA, LA and/or sedation). Nusmile® PZCs were used by 70% ($n = 254$), of respondents, while other commercial brands, such as Sprig®, were used by 10% of respondents (Fig. 2).

When asked about complications associated with zirconia crown use, participants reported a list of complications ranging from crown loss (30.8%, $n = 100$) to crown discolouration

(12.6%, $n = 41$) (Fig. 3).

When asked about the luting agent used to cement PZCs, the majority of respondents (48.3%, $n = 157$) reported using glass ionomer cement, while 33.8% ($n = 110$) used resin modified glass ionomer cement, 11% ($n = 36$) resin cement and 6.7% ($n = 22$) used a bioactive cement. A large proportion of the respondents reported using the try-in- crown (48.6%, $n = 159$), while 51.1% ($n = 167$) of the respondents reported autoclaving used crowns.

Tooth borne "intra-canal support" was used by 68% ($n = 257$) of respondents. The majority of those using such technique (63.2%, $n = 162$) were paediatric dental specialists, followed by postgraduate paediatric dental students (16.7%, $n = 43$), university staff (15.8%; $n = 41$) and GPPD (4.3%; $n = 11$). The most frequently used intra-canal support systems included glass ionomer (40%, $n = 102$), glass fibre posts (27%, $n = 70$), composite post and core (23%, $n = 59$), polyethylene fibers (5% $n = 13$) and omega loop (5%, $n = 13$).

Twenty percent of the respondents ($n = 113$) reported using zirconia crowns when restoring first permanent molars, while the majority (83%, $n = 464$) reported using prefabricated metal crowns (PMCs), 43% ($n = 238$) reported using composite, 17% ($n = 97$) reported using indirect restoration, while 5% ($n = 32$) reported using adhesive cast gold restorations.

4. Discussion

PZCs were introduced to the discipline of paediatric dentistry in 2010 by Sprig® (formerly EZPedo®). Currently available evidence in the scientific literature suggests that PZCs are an acceptable full coverage restorative material in the primary dentition [9]. Ten years following the introduction of this restorative technique, we sought the opinions of a sample of dentists practicing paediatric dentistry from around the world on the use of these crowns. The study sample size was based upon the child population /paediatric dentists' ratio in 2019–2020 utilising a method previously used by Hussein *et al.* (2020) [12]. The current survey included 417 international paediatric dentists, and 140 respondents with special interest in paediatric dentistry spread across 6 continents and worked across all different clinical dental settings.

The results of this study highlighted the growing use of PZCs in restoring anterior and posterior teeth. This can be explained by the growing evidence in support of zirconia crowns as a successful option in managing anterior and posterior primary teeth. A recent systematic review by Alrashdi and

TABLE 1. Use of different full coverage restorations among respondents.

Crown Use Type	Strip crowns		Zirconia Crowns		Glass fibre reinforced crowns		Polycarbonate crowns		Pre-veneered stainless-steel crowns		CAD CAM fabricated crowns	
	n	%	n	%	n	%	n	%	n	%	n	%
Anterior crowns												
Not Using	25	5.6	117	26.4	322	72.5	358	80.6	323	72.7	396	89.2
Using	419	94.4	327	73.6	122	27.5	86	19.4	121	27.3	48	10.8
Posterior crowns												
Not using			141	31.8	352	79.3	322	72.5	242	54.5	393	88.5
Using			303	68.2	92	20.7	122	27.5	202	45.5	51	11.5

TABLE 2. showing frequency statistics of participants' response for questions related to the use of preformed full aesthetic crowns, use of preformed zirconia crowns and frequency of using zirconia crowns per participants' continent of practice, type of practice and speciality status.

	Use of preformed full aesthetic crowns				Use of preformed zirconia crowns				Frequency of using Zirconia crowns			
	No		Yes		No		Yes		More frequently**		Less frequently***	
	n	%	n	%	n	%	n	%	n	%	n	%
Continent*												
Africa	25	25.5%	73	74.5%	5	6.8%	68	93.2%	30	44.1%	38	55.9%
Asia	46	15.9%	243	84.1%	73	30.7%	165	69.3%	87	51.2%	83	48.8%
Europe	35	37.6%	58	62.4%	31	53.4%	27	46.6%	15	55.6%	12	44.4%
Americas	4	6.9%	54	93.1%	6	11.1%	48	88.9%	30	62.5%	18	37.5%
Type of practice												
Dental Institute	24	17.1%	116	82.9%	34	29.6%	81	70.4%	31	37.8%	51	62.2%
Hospital	13	19.4%	54	80.6%	28	52.8%	25	47.2%	15	57.7%	11	42.3%
MoH	26	37.7%	43	62.3%	17	41.5%	24	58.5%	6	23.1%	20	76.9%
Private practice	47	17.2%	226	82.8%	39	17.3%	186	82.7%	118	63.1%	69	36.9%
Speciality Status												
GPPD	31	56.4%	24	43.6%	12	50.0%	12	50.0%	6	50.0%	6	50.0%
Paediatric Dental Specialists	45	13.7%	283	86.3%	74	26.5%	205	73.5%	118	56.5%	91	43.5%
PG student	17	21.8%	61	78.2%	20	33.3%	40	66.7%	12	29.3%	29	70.7%
University staff members	19	20.0%	76	80.0%	13	17.1%	63	82.9%	34	54.0%	29	46.0%

MoH: Ministry of Public Health, GPPD: General practitioners with interest in paediatric dentistry, PG: Post graduate. * Responses from participants from Australia ($n = 6$) and those who did not report the country where they are practicing ($n = 10$) are not reported under continent as these were excluded from the statistical analysis. ** At least once a month, *** Maximum once or twice a year. % denotes row percentages.

TABLE 3. Results of Chi square statistics assessing the association between participants baseline characteristic's (continent, type of practice and specialty status) and questions pertaining to the use aesthetic crowns, use zirconia crowns, and the frequency of using zirconia crowns). Countries of practice were combined into 4 continents (Asia, Africa, America, Europe).

	Use of preformed full aesthetic crowns	Use of preformed zirconia crowns	Frequency of using Zirconia crowns
Continent			
Chi-square	28.628	43.970	3.987
df	3	3	3
Sig.	<0.001*	<0.001*	0.263
Type of practice			
Chi-square	15.512	33.190	24.834
df	3	3	3
Sig.	0.001*	<0.001*	<0.001*
Specialty status			
Chi-square	53.403	11.439	10.263
df	3	3	3
Sig.	<0.001*	0.010*	0.016*

df: degree of freedom; Sig.: significance.

co-workers [9], recommended the use of zirconia crowns as an alternative to other techniques/materials in restoring primary

teeth in terms of aesthetics, retention, acceptance and gingival health. In addition, recent studies have shown an increase

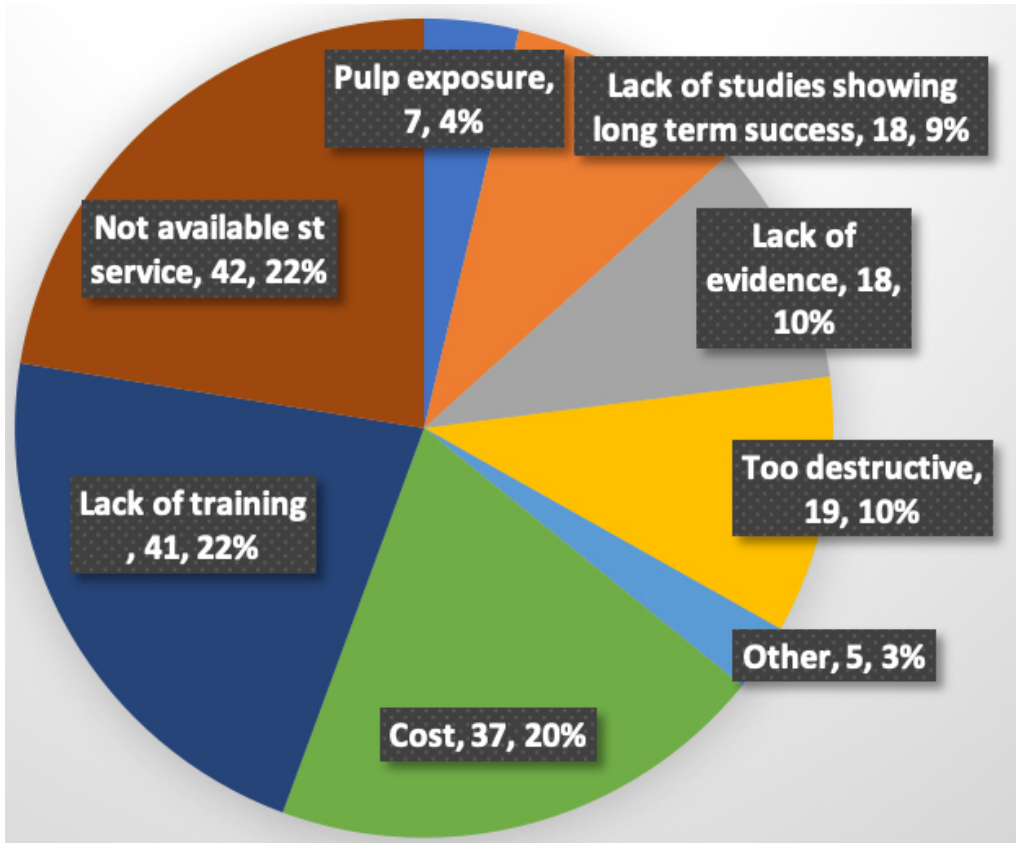


FIGURE 1. Pie chart showing barriers to the use of aesthetic crown restorations.

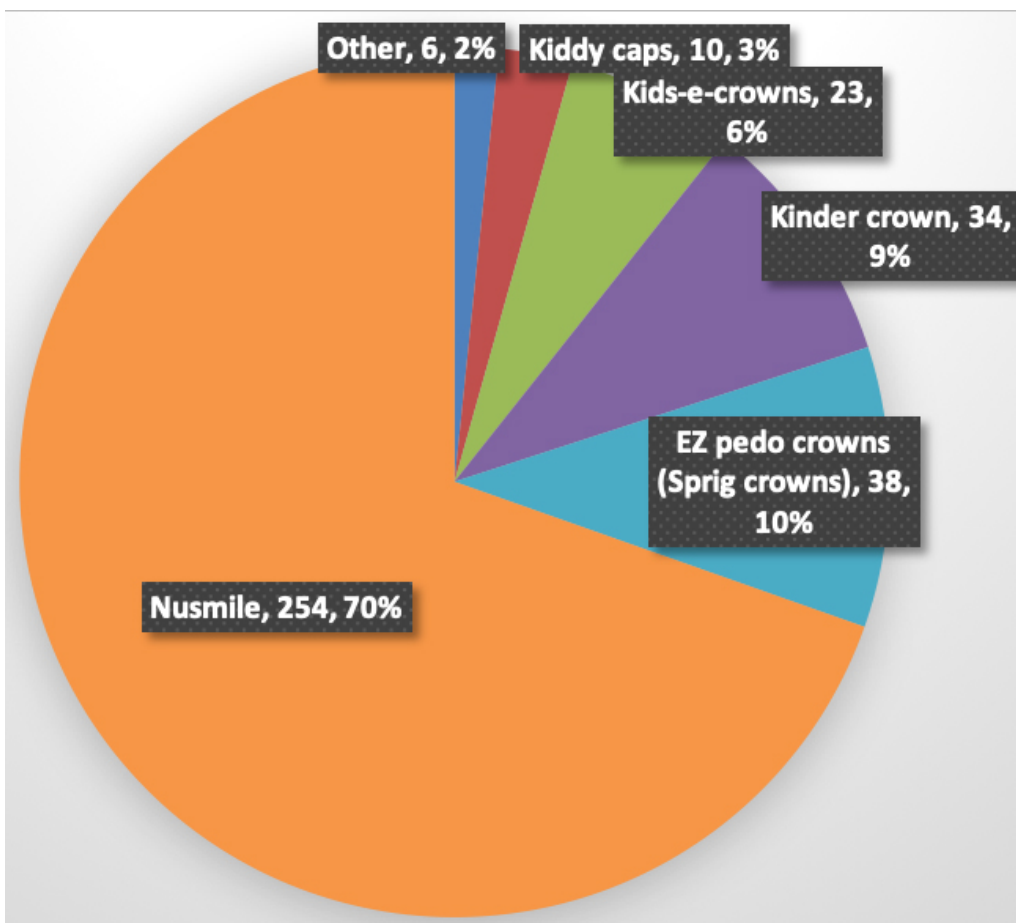


FIGURE 2. Pie chart showing aesthetic white crown commercial brands used. All names are ®.

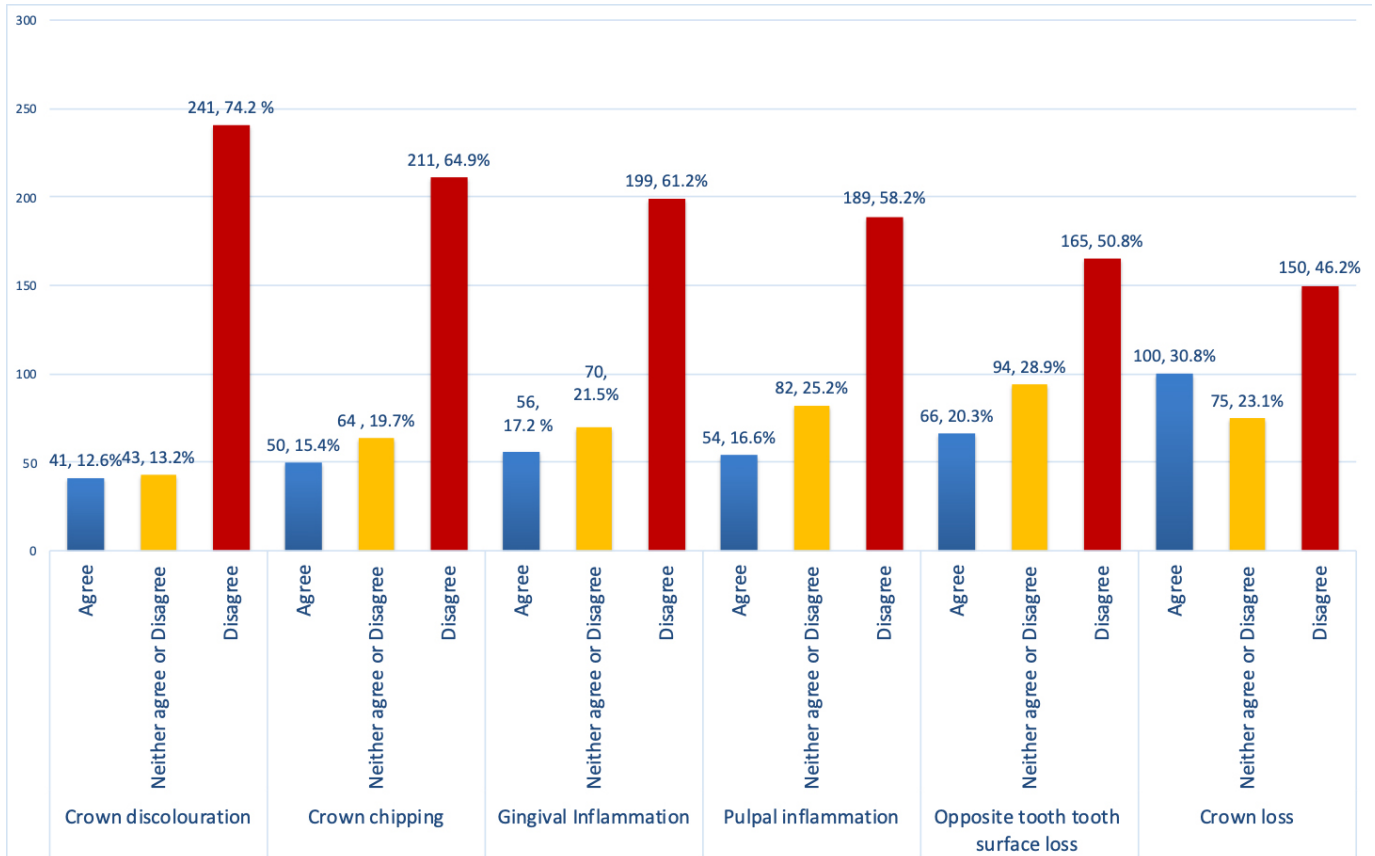


FIGURE 3. Bar chart showing the level of respondent agreement with the association of different complications with zirconia crown use.

in parental satisfaction of PZCs in comparison to other full coverage restorations such as strip crowns and PV-SSCs [13]. While factors such as patient's/parent's interest or access to specialists/private practice might have resulted in higher use of the PZCs among respondents working in Africa and American continents, further in depth assessment is needed in order to assess such differences. The higher uptake of PZCs among paediatric dentists might be associated with their higher skills in managing children or access to more specialized treatment methods such as GA/Sedation where multiple/more extensive multi tooth preparations are possible. The higher use of PZC in a private practice setting could be the result of the increased cost of using such crowns and the sociodemographics of patients/parents seeking more esthetic restorations. Further in depth assessment of the factors affecting practitioner's use of PZCs is needed.

The results of this survey showed that the use of composite strip crowns was by far the most popular full aesthetic restorative option used to restore carious anterior primary teeth. Such results could be attributed to several factors including its high retention rates [14–16], the minimal preparation and training required by dentists in delivering such restorations, and the familiarity of this technique to dentists who are well trained in using composite and prefabricated clear crowns. To date, only two randomised controlled trials have been published in the literature where zirconia crowns had been compared against strip crowns [14, 17] and PV-SSC [14] in restoring carious anterior teeth over a follow up period of 6 [14] and 12

[17] months. Both studies showed superior results of zirconia crowns over strip crowns in terms of gingival health and restoration retention, while more tooth surface loss of opposing teeth was observed with zirconia crown use. The ability of full coverage restorations in reducing recurrent caries in children with early childhood caries, is by far the most important feature of such restorations. Such ability was recently has been shown by Alaki *et al.* (2020) [17] whereby both PZCs and Strip crowns have shown ability to reduce recurrent caries over a period of 12 months. Although not statistically significant, 6.7% of the teeth restored using strip crowns showed evidence of recurrent caries in comparison to none of the PZC.

The results of the current survey showed close numbers of those using PZCs in restoring carious posterior teeth. Studies comparing the use of PMCs to PZCs in restoring carious posterior teeth have shown similar success rates over a period of 12 [18] and 36 months [19] with statistically significant better gingival health, colour satisfaction and children's satisfaction associated with the use of PZCs. Ultimately, the decision of which restoration is utilised is usually dependant on the parents'/children's aesthetic concerns and cost effectiveness of these restorations.

In this study, those not using zirconia crowns had reported the need for training, lack of availability and the high cost of zirconia crowns as the main barriers to using such technique rather than other more technical aspects such as evidence, preparation needs, possibility of pulp exposures or lack of evidence. Such results also indicate more acceptance of such

techniques among the respondents and a reduction in the perceived ideas of the technical limitations of using zirconia crowns.

Other full coverage aesthetic restorations, such as PV-SSCs, glass fibre reinforced crowns, polycarbonate crowns, and CAD-CAM fabricated crowns are being used by respondents albeit to a lesser extent. PV-SSCs were among the first full coverage restorative crowns developed and proposed as a good aesthetic option for primary teeth. However, the partial or total loss of the facial veneer layer under masticatory function, was one of the main drawbacks of this technique [20]. Although PV-SSCs performed similarly well in terms of retention (95%) when compared to PZCs (100%) and strip crowns (85%) in restoring carious anterior teeth, it was associated with 5% partial loss of facial veneer at the metal-resin interface and an increase in gingival bleeding index over a period of 6 months [14].

Polycarbonate crowns are also being used by the respondents in this study despite the reported inability of these crowns to resist strong abrasive forces resulting in crown fractures or dislodgements [21]. No studies comparing these crowns to PZC are available in the literature.

CAD-CAM prefabricated crowns, using material such as zirconia, polymethyl methacrylate and hybrid ceramic, have been proposed as an alternative restorative technique for both anterior and posterior primary teeth, as a result of their reliability in terms of marginal integrity and crown retention [22]. However, the cost effectiveness associated with using such technique might be an issue. A study comparing CAD-CAM to PZCs in restoring anterior and posterior primary teeth showed no differences in terms of gingival health over a period of 6 months. Although recommended by the authors [22], further long term studies are needed. Fiberglass primary crowns, which are fabricated from fiber mesh sheets impeded in resin, were recently introduced. However, a recent randomized controlled study showed such crowns to have low wear resistance, colour deterioration, and poor gingival health with plaque retention [23].

One of the most debatable aspects of using zirconia crowns, is the extensive crown preparation required in comparison to that of PMCs or PV-SSCs [24], which has been claimed to cause pulpal exposure and post preparation pulpal inflammation [9]. A search of the existing literature has found that there is no existing study which evaluates the risks of pulpal exposure following zirconia crown preparations. Interestingly, the majority of the respondents disagreed with the statement that zirconia crown preparation is associated with a high chance of post preparation pulpal inflammation. Such outcome is considered a key barrier to the use of zirconia crowns, and it would be interesting to evaluate the long term pulpal status of teeth restored with zirconia crowns in future studies.

In this study, about 1/3rd of respondents reported crown loss as one of the complications of zirconia crown placement. Recent studies have demonstrated very high retention rates of zirconia crowns (100% over 6 months and 98.3% over 12 months) [14, 17]. This appears to contrast that reported by the respondents in this study. The results of this study showed that almost half of the non-specialists claimed frequent loss of their zirconia crowns placed, while only 29% of specialists

reported this problem. Dislodgment of zirconia crowns is usually related to improper crown size selection, incomplete seating, inadequate cementation, patient occlusion and trauma. It can be postulated that such disagreement could be associated with several factors, such lack of training or experience with zirconia crowns preparation and placement among the respondents in comparison to more trained and calibrated clinicians conducting research studies.

This study showed that glass ionomer cements were the most frequently used luting agent by respondents in this study. Studies comparing different zirconia crown cements are available in the literature whereby glass ionomer [14, 25, 26] and light cured resin cements [17, 25] have been reported. Direct comparison between the two cements showed a significant difference in retention in favour of glass ionomer cements over light cured resin cements [25]. The use of glass ionomer cements was associated with 100% retention after 6 months [14], and 82.4% over 36 months [17]. Despite the lesser attractive properties of glass ionomer cements over other available cements, it has been shown to be the cement preferred by most respondents. The cost effectiveness, ease of use and/or availability of such cement could have contributed to this finding. The superiority of resin based cements over conventional GICs is that it provides both micro mechanical and chemical bonds while the later provides only micro-mechanical retention [27]. Other cements such as light cured resin cements have also been associated with a high retention rate (98.3%) [17] and shown to have less microleakage in comparison to glass ionomer cements [25].

One of the interesting findings of this survey is the high usage of intra-canal support reported by respondents, of which 63% were paediatric dental specialists. The use of intracanal post or retainers in endodontically treated anterior primary teeth, has been shown to improved retention of subsequent coronal restorations providing sufficient function and aesthetics in severely mutilated teeth [28, 29]. Many types of posts or retainers were described in the literature, such as orthodontic wire posts, composite resin posts, polyethylene ribbon posts and glass fibre posts. Further research assessing the long-term success of such intra-canal support in primary teeth is needed in light of such increased use by paediatric dentists worldwide.

Another interesting finding of this survey is the use of zirconia crowns in the management of first permanent molars. These crowns have been recently developed and made commercially available. There is a paucity in the literature on the long term outcomes of these crowns, with only one case report whereby a hypomineralised carious second permanent molar was successfully restored using PZC for a period of 40 months [30]. Further research on the long term success in terms of retention, gingival health, pulp effect and effect on opposing teeth of such crowns is, therefore, needed.

In terms of sterilisation of zirconia crowns, Nusmile® ZR crown manufacturers recommend against using their crowns prior to cementation and provide clinicians with try in crowns, while Sprig® crowns are supplied without such try in crowns. The use of try in crown recommendation is not mainly based on the effect of sterilization on zirconia but also on the unfavourable effect of blood and saliva contamination on crown cementation [31]. According to Nusmile® ZR crown man-

ufacturers, cold sterilization, autoclave or steam sterilization are considered acceptable methods in sterilizing Nusmile® ZR crowns [32]. While a study by Yilmaz and Guler (2008) [33] has shown a significant crazing and contour alterations of the vestibular surface of zirconia crowns with steam autoclaving as shown by scanning electron microscopy, Hogerheyde *et al.* (2021) studies showed no such effect. Further assessment of blood/saliva contamination and sterilisation effect of PZCs is needed.

The authors would like to acknowledge some of the limitations of this survey including the effect of the global coronavirus disease 2019 pandemic and the use of English language in constructing the survey which might have lowered the international response rate of this questionnaire. Although covering 6 continents, a low proportion of respondents were from Australia and the American continents. This is mainly related to the distribution method used whereby the questionnaire was distributed through Asian, African and European paediatric societies. Due to the low numbers of participants practicing in Australia and South America, the statistical analysis was performed so that both North and South American continents were combined while those of Australia were excluded. Distribution of such survey through the international Association of Paediatric Dentistry and the American Academy of Paediatric Dentistry, which were not possible at the time of conducting this survey, would have improved response to this survey. Although, the use of social media platforms and contact lists of regional paediatric dental organisations is useful in engaging with practitioners worldwide, using such methods prevents calculation of an exact response rates. In an attempt to simplify the questionnaire and reduce the number of questions included, some in depth demographic information, such as years of experience, were not collected. Further, in depth, assessment of factors affecting participants choice of using full coverage restorations such as years of practice and country of training is needed.

Within the limitations of this study, this study has shown a wide use of primary tooth full coverage aesthetic restorations among an international sample of practicing dentists. This might be associated with the increased evidence of lower complications and higher success rates associated with such aesthetic restorations. Further in depth assessment of factors affecting participants choice of using full coverage restorations, such as practitioner's years of practice, practitioner's country of training, patients'/parents' preference, patients'/parents' sociodemographic status, and access to governmental treatment is needed.

5. Conclusions

This study highlights a wide international use of full coverage aesthetic restorations of primary teeth among paediatric dental practitioners.

This study also highlights the need for further research and development of available full coverage aesthetic restorations, including prefabricated zirconia crowns, in order to address current controversies surrounding their use.

AVAILABILITY OF DATA AND MATERIALS

Data will not be available.

AUTHOR CONTRIBUTIONS

HN and OES—conceived the idea of the research, HN, OES, RAM and HJT—designed the questionnaire survey, HN, RAM, OES and NS—analysed the data and all authors distributed the questionnaire, and wrote manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The design of this study was approved by the Research Ethics Committee at the Faculty of Oral and Dental Medicine, Future University, Cairo, Egypt (Ref number: (5)/2-2023). This was an opt-in survey where consent was implied through completion of the survey questions.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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