

A Preschool based intervention to reduce Early Childhood Caries in a District of Sri Lanka: A Quasi-experimental Study

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Objective: Early Childhood Caries (ECC) is prevalent among preschool children. The aim was to assess the effectiveness of an intervention to modify family-level determinants of caries (i.e. maternal parenting style, oral health-related self-efficacy and oral health-related knowledge) via preschool teachers, to improve the child level determinants of ECC (dietary sugar consumption, oral hygiene pattern, dental attendance pattern). **Basic research design:** Quasi-experimental study. **Setting:** Preschools in Gampaha District, Sri Lanka. **Participants:** Preschoolers and their mothers/caregivers. **Interventions:** Delivered via preschool teachers to 200 children and their caregivers. **Main outcome measures:** Maternal parenting style, oral health related self-efficacy and oral health related knowledge, parentally reported dietary sugar consumption, oral hygiene pattern, dental attendance pattern and ECC. **Results:** Maternal oral health related knowledge, authoritative parenting, authoritarian parenting and oral health related self-efficacy, maternally reported sugar consumption, sweetened drink consumption, tooth brushing frequency, dental visiting during the past six months and receipt of treatment better in the intervention group than the control group post-intervention. **Conclusions:** The intervention shows potential in modifying family level determinants of ECC.

Keywords: dental caries, determinants, behaviours

Introduction

Early Childhood Caries (ECC) is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child under the age of six (American Academy of Pediatric Dentistry, 2008). ECC is highly prevalent among preschool children worldwide, with a prevalence varying between 17% and 63%, in one to five-year-old children globally (Tinanoff *et al.*, 2019). It is often left untreated among children below three years. The prevalence of ECC among preschoolers in different districts of Sri Lanka ranges from approximately 40% to 78% (Baminy, 2018; Malmessa, 2017). The latest National Oral Health Survey (NOHS) 2015/2016 in Sri Lanka reported that the prevalence of dental caries in the primary teeth of five-year-old children was 63.1%, with an average of three affected teeth. Approximately 96.2% of five-year-old children with dental caries have untreated teeth (Ministry of Healthcare and Nutrition, 2018).

Although ECC is primarily caused by dietary sugars, Fisher-Owen *et al.*'s (2007) conceptual framework describes how the determinants of caries act on three levels: child, family, and community. Community-level determinants influence family level determinants, while family level determinants influence child-level causes. Many aetiological factors are well known and may be modifiable because they are behaviour-related. Child-level determinants include dietary sugar consumption, fluoride-use and dental attendance (Kirthiga *et al.*, 2019). Although routine health education sessions have been carried out

by primary health care workers targeting these proximal determinants over the decades in Sri Lanka, they have not reduced the country's ECC burden.

Therefore, it is important to consider family level determinants to improve these child-level determinants, as the family is the primary and initial source of these behaviours. Several systematic reviews have emphasised the need to study parental-or family level determinants in developing nations in the development of ECC (Hooley *et al.*, 2012; Rai and Tiwari, 2018). A cross-sectional study among three to four year old preschoolers identified child-and family level determinants of ECC (Gunasinghe *et al.*, 2023) as dietary sugar consumption, oral hygiene pattern, and dental attendance pattern at the child level, and maternal oral health-related knowledge, parenting style, and oral health-related self-efficacy at the family level. Perceived self-efficacy is defined as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (Bandura, 1994). Baumrind (1971) outlined three primary parenting styles: authoritative, authoritarian, and permissive. Authoritative parents employ positive discipline and consider their children's feelings. Authoritarian parents enforce strict rules with little regard for the child's input, often leading to negative developmental outcomes such as reduced resilience and social competence, and increased aggression. Permissive parents are lenient, avoiding discipline, which can result in poor social skills and externalizing and internalizing problem behaviours (Kuppens and Ceulemans, 2019).

Preschool may be a useful venue for oral health interventions as children spend a lot of time in preschools exposed to the outer social environment, which influences the development of new behaviours and habits (World Health Organisation, 2019). Preschool teachers have also been identified as a good resource for oral health promotion under the concept of health-promoting preschool in Sri Lanka.

Therefore, the aim of this study was to assess the effectiveness of an intervention to improve identified family level determinants: 1) to modify the parenting style of the mothers in relation to the oral health behaviours of the child, 2) to improve maternal oral health-related self-efficacy, and 3) to enhance the oral health-related knowledge of the mothers via preschool teachers to improve the identified child-level determinants (dietary sugar consumption, oral hygiene patterns, and dental attendance patterns) to reduce ECC.

Methods

This quasi-experimental study was conducted from June 2020 to April 2021 during the COVID-19 pandemic in Sri Lanka. Participants were three-to four-year-old preschool children who were permanent residents of the area (Study population 1) and their mothers (study population 2).

The sample size was calculated using Pocock (1983). The intervention's success was defined as a 20% decrease in children consuming sweets more than twice a day, with a baseline frequency of 30%. The effect size of this study was based on a study conducted by Nanayakkara (2011). Preschools were selected from two Divisional Secretariat (DS) of the Gampaha District. Each preschool was considered as a cluster, and the cluster size was set to 20. The rate of homogeneity was set to 0.1. The calculated design effect was 2.9. Two hundred preschool children and mothers were assigned to the intervention

and control groups, respectively, with ten clusters in each arm. Gampaha District has 13 DS divisions. In multi-stage cluster-sampling, the divisions were matched according to socio-economic parameters with one division matched to several others where necessary. A matched pair was selected at random. From this pair, one division was taken as the intervention and the other as the control by drawing lots. Subsequently, ten preschools were selected at random from each division. A list of preschools was used as the sampling frame. Twenty preschool children were selected at random from each preschool in the intervention and control groups (Figure 1). In each case randomization used computer generated random numbers. Information sheets and consent forms for mothers were sent to preschool teachers before participant recruitment.

The intervention package was designed to be delivered via teachers. Key informant interviews with relevant stakeholders (preschool officers, preschool teachers, primary healthcare workers, and experts in psychology and community dentistry) and the previous literature were considered in its design. The intervention was developed under the guidance of a consultant in Community Dentistry and a psychologist to modify the maternal parenting style in relation to their child's oral health behaviours, enhance maternal oral health-related self-efficacy, and improve their oral health-related knowledge and attitudes. A training program for preschool teachers in the intervention arm provided knowledge and skills on how to modifying maternal parenting skills and oral health-related self-efficacy, and to improve their knowledge to influence dietary sugar consumption, oral hygiene, and dental attendance patterns of preschool children to reduce ECC. The program consisted of lectures and discussions with experts. Next, the trained teachers conducted health education sessions and delivered intervention materials to the mothers to modify their targeted behaviours (Table 1).

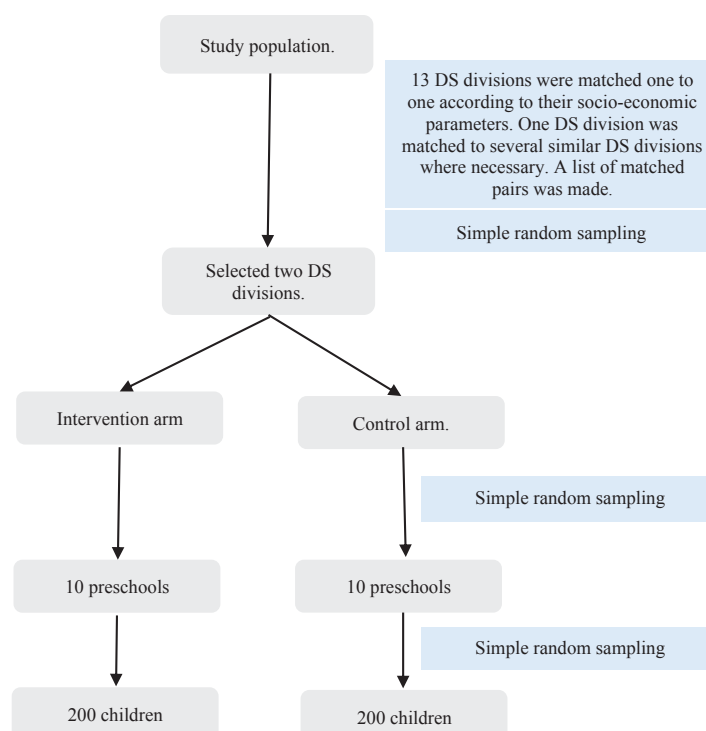


Figure 1: Selection of the sample.

Table 1. The content of the intervention package.

Target group	Method	Content
Preschool teacher	Training programme	Lecture 1 - an overview of parenting and how to improve good parenting related to oral health by an Early Childhood Development officer. Lecture 2 - an overview of knowledge on maternal self-efficacy and how to improve oral health-related maternal self-efficacy to improve child oral health behaviours by a psychologist Lecture 3 - knowledge on oral health behaviours and oral health of preschool children by PI.
Mothers/caregivers	Health education sessions	Content 1. Oral health of preschoolers and ECC. 2. How to improve good parenting, maternal self-efficacy related to oral health to improve oral health behaviours of the child. 3. Tooth brushing demonstration. Procedure First HE session by PI to train preschool teachers on HE. Proceeding HE sessions (group or individual) by preschool teachers. At the HE session, one mother who was involved in practising good oral health behaviours of her child was allowed to talk and motivate other parents.
	Oral health record (OHR) for the preschool children prepared by PI	Content OHR was a clinical record which included questions on dietary sugar consumption, oral hygiene, and dental attendance pattern of the child, parenting style and maternal oral health-related related, self-efficacy and dental status in terms of ECC. Procedure The preschool teacher delivered the OHR to each parent and asked them to fill it out and hand it over to her. The records were kept at the preschool. The teacher reminded the next visits to the clinics. Aim To be used by dental surgeons and School Dental therapists for individual treatment planning considering the determinants. To send the children to a clinic by the preschool teacher, to improve the dental attendance pattern of the child, to get an idea of every child's oral health, to give personalized messages and review progress by the teacher.
	A booklet	Information on oral health of preschoolers, ECC and how to practice good parenting and improve self-efficacy related to the oral health of preschoolers.
	Motivation materials	Toothbrushing calendar for preschool children. Weekly food diary for the preschool children. Prepared by preschool teachers under the supervision of PI to continuously motivate parents and children on targeted behaviours.

The intervention period was six months. The intervention commenced before the 2nd wave of the COVID-19 pandemic started when the preschools were open in Sri Lanka and continued during and after that wave. Although the preschools were closed for some months, the teachers sent academic work to the mothers. Therefore, preschool teachers could continue the intervention by motivating and monitoring the behaviours of mothers and children individually, as they met parents once or twice a week to send academic work. Whilst the preschools in the control arm did not receive the intervention they were not discouraged from using any oral health services or other oral health related activities.

The primary outcomes were the maternal parenting style (authoritative, authoritarian, and permissive), oral health-related self-efficacy and oral health-related knowledge. The secondary outcomes were maternally reported dietary sugar consumption, oral hygiene pattern, and dental attendance of the preschool children and ECC in terms of decayed, missing, and filled teeth. Dietary sugar consumption included consumption of biscuits/buns/cakes/toffees/chocolates/ice creams/any sweet items and sweetened drinks (sweet flavoured milk/fruit juices/carbonated drinks). Oral hygiene patterns included frequency of toothbrushing, type of toothpaste used, and brushing process (satisfactory or not). Dental attendance considered whether the child had ever visited a dental clinic.

A self-administered questionnaire enquired about sociodemographic data of the participants and maternal oral health-related knowledge, parenting style, and maternal oral health-related self-efficacy to measure the primary outcomes (Gunasinghe *et al.*, 2023). The questionnaires were validated for judgmental validity, were pre-tested and assessed for test-retest reliability. A structured interview collected data on the child's dietary sugar, oral hygiene and dental attendance as secondary outcomes. A locally developed tool to measure parenting style (authoritative, authoritarian, and permissive parenting styles) was used (Udayamalee, 2013) and an international tool (Kakudate *et al.*, 2010) was validated using the Modified Delphi technique to measure maternal oral health-related self-efficacy in the local context. The data collection team included the principal investigator (PI), an undergraduate psychology interviewer, a data recorder, and an assistant. The interviewer was blinded to the intervention. Inter-interviewer reliability between the PI and interviewer was assessed using the kappa coefficient (0.89).

The PI was trained and calibrated by a consultant in Community Dentistry and clinically examined the children according to the WHO Oral Health Surveys Basic Methods (2013). The data collection team was trained in COVID-19 precautionary measures and the interviews and oral examinations were conducted in the preschools

where ample natural ventilation was ensured. Children or mothers who did not attend on the day of data collection were considered as non-respondents.

Data were compared between the intervention group (IG) and control group (CG) before and after the intervention. Means of oral health-related knowledge of the mother, parenting style (authoritative, authoritarian, permissive), and maternal oral health-related self-efficacy between the IG and CG were compared using the Mann Whitney U test. The dietary sugar consumption, oral hygiene pattern, dental attendance, and dmft scores of preschoolers between the IG and CG were compared using the chi-square test. Data were analysed using the Statistical Package for Social Sciences (SPSS) 23rd version.

Permission to conduct the study was obtained from the Provincial Director of Health Services, Western Province; the Regional Director of Health Services, Gampaha; the Director of Preschool Unit Department of Education, Western Province; and the District Secretariat, Gampaha in Sri Lanka. Ethical clearance was obtained from the Ethics Review Committee of the Faculty of Medicine at the University of Colombo (EC-19-061).

Results

The response rate for the IG at the pre-intervention stage was 93.5% (n=187) and that for the CG was 95% (n=190). Four children in the IG and five children in the CG could not be assessed in the post-intervention stage, as they were under quarantine and were excluded from the post-intervention analysis. Demographic factors were similar in the IG and CG (Table 2).

Values for the primary and secondary outcome variables were similar in both groups at baseline (Tables 3 and 4).

Post-intervention there were differences in the oral health-related knowledge of mothers, authoritative parenting, authoritarian parenting and maternal oral health-related self-efficacy (Table 3).

Post intervention the mothers reported that the intervention group children were less likely to have sweets or sweetened drinks everyday or more often, and were more likely to use a fluoride toothpaste, to have visited a dentist and to have received dental fillings than the control group (Table 4).

Discussion

This study aimed to evaluate the effectiveness of an intervention to improve the selected family level determinants of preschool children via their teachers to improve child-level determinants to reduce ECC. After the intervention mothers reported enhanced family level factors associated with ECC, such as parenting style, maternal oral health knowledge of mothers and oral health-related self-efficacy. The child-level factors of ECC, dietary sugar consumption, oral hygiene pattern, dental attendance, and treatment received for ECC (filled teeth), were better in the intervention group compared to the control group.

Health education sessions conducted by preschool teachers with parents considered oral health, ECC, and parenting in relation to oral health and maternal oral health-related self-efficacy. The intervention group and individual health

Table 2. Demographic factors of the intervention group and control group at baseline.

<i>Sociodemographic factors</i>	<i>IG (n=187) %</i>	<i>CG (n=190) %</i>
Gender		
Girls	49.2	51.6
Boys	50.8	48.4
Ethnicity		
Sinhala	97.9	97.4
Tamil	2.1	1.1
Muslim	0.0	1.6
Burgher	0.0	0.0
Mother's education	n = 187	n = 190
No schooling	0.0	1.1
Grade 1 to 5	1.6	0.0
Grade 6 to 10	5.3	5.3
Up to O/L ¹	46.0	48.9
Up to A/L ²	34.8	27.9
Diploma/vocational	7.0	7.9
Degree	5.3	8.9
Father's education	n = 185	n = 190
No schooling	0.0	0.0
Grade 1 to 5	1.1	0.5
Grade 6 to 10	7.0	3.7
Up to O/L1	56.8	53.2
Up to A/L2	24.9	32.6
Diploma/vocational	4.3	6.3
Degree	5.9	3.7
Mothers' occupational status	n = 187	n = 190
Employed	41.2	44.7
Unemployed	58.8	55.3
Father's occupational status	n = 187	n = 190
Employed	100.0	99.5
Unemployed	0.0	0.5
Family Income	n = 187	n = 189
25,000 Rs	28.3	32.8
25,000 Rs-50,000 RS	47.1	40.2
>50,000Rs	24.6	27.0

¹ =G.C.E Ordinary Level examination. ²=G.C.E Advanced level examination. IG=Intervention Group. CG=Control Group.

education sessions may have played a role in helping mothers modify oral health practices for their children at home. The booklet provided during the intervention may have also helped mothers become more authoritative in their parenting styles while reducing permissive and authoritarian tendencies. This may have led to an improvement in the dietary sugar consumption, oral hygiene, and dental attendance behaviour of their children. Maternal self-efficacy is an important factor in improving children's oral health behaviours, and Bandura (1994) explained different ways to enhance self-efficacy. Mothers who received health education sessions reported greater self-efficacy, which is the knowledge and awareness of the concept and how it affects oral health behaviours. In one of the health education sessions, one mother of every preschool was allowed to explain how she maintained the healthy behaviours of her child for everyone. This improves the vicarious experience of self-efficacy. Therefore, improved maternal oral health-related self-efficacy might have helped improve child-level factors.

Table 3. Family level determinants of ECC post-intervention.

Variable	Baseline		Post Intervention	
	Intervention Mean (SD)	Control Mean (SD)	Intervention Mean (SD)	Control Mean (SD)
Oral health knowledge	5.66 (1.92)	5.71 (1.85)	7.78 (1.73)	6.04* (1.22)
Authoritative Parenting	27.97 (3.75)	27.41 (3.81)	29.51 (3.10)	27.04* (5.48)
Authoritarian Parenting	23.75 (4.61)	23.16 (4.67)	22.95 (4.92)	22.59* (5.37)
Permissive Parenting	14.37 (3.71)	13.54 (3.52)	12.58 (2.85)	13.21 (4.44)
Maternal Oral health related Self Efficacy	17.81 (4.09)	18.39 (3.12)	21.57 (2.82)	18.68* (3.40)

* Differences between groups post-intervention, $p < 0.05$, Mann Whitney U test

Table 4. Child level determinants of ECC among intervention and control group at baseline and post- intervention.

Variable	Baseline		Post Intervention	
	Intervention (n=183) (%)	Control (n=185) (%)	Intervention (n=183) (%)	Control (n=185) (%)
Sweet consumption				
Several times a day/everyday	72.7	75.3	51.4	70.8*
Several times a week or less	27.3	24.7	48.6	29.2
Sweetened drinks consumption				
Several times a day/everyday	6.4	11.6	2.2	9.2*
Several times a week or less	93.6	88.4	97.8	90.8
Frequency of toothbrushing				
Once per day	45.5	43.2	14.8	44.9*
Twice per day/more	54.5	56.8	85.2	55.1
Type of toothpaste used				
Fluoridated	63.1	70.5	85.2	74.6*
Non fluoridated	36.9	29.5	14.8	25.4
Brushing process				
Satisfactory	62.6	64.2	89.6	61.1*
Not satisfactory	37.4	35.8	10.4	38.9
	Ever visited a dental clinic		Visited during last 6 months	
Yes	34.2	40.5	37.7	27.6*
No	65.8	59.5	62.3	72.4
Dental caries status				
Decayed teeth present	54.5	55.8	50.3	58.4
Decayed teeth absent	45.5	44.2	49.7	41.6
Missing due to ECC	0.0	0.0	0	0
No missing due to ECC	100.0	100.0	183	185
Filled due to ECC	1.1	2.6	10.4	4.3
No filled due to ECC	98.9	97.4	89.6	95.7

* Differences between groups post-intervention, $p < 0.05$, Chi sq.

Further, the use of oral health records and continuous motivation by the motivation materials given by teachers might have supported parenting skills and self-efficacy to improve the child-level factors. Preschool teachers reminded needy children to attend dental clinics for treatment and routine checkups. However, dental treatments were restricted only to emergency management early in the second wave of the COVID-19 pandemic. Furthermore, preschool teachers were well motivated and capable of carrying out the intervention. They were also capable of interacting with their parents. The parents complied with the teachers. Therefore, it was feasible to utilise preschool teachers to improve the health of children of this age group.

A quasi-experimental study in preschools in Iran reported that a similar intervention enhanced oral health-related knowledge, attitudes, and oral health behaviours of parents (Shirzad *et al.*, 2016). Likewise, a similar intervention study in China, reported increased twice-daily tooth brushing and tooth brushing before going to bed and parental oral health-related knowledge and attitudes (Rong *et al.*, 2003). A systematic review also showed that family level factors, such as parenting interventions, improved the health behaviours of children in early childhood (Jeong *et al.*, 2021). Other studies have conducted interventions using similar methods that enhanced mothers' self-efficacy (Huebner and Milgrom, 2015; Shirzad *et al.*, 2016). One

intervention study showed that self-efficacy plays a moderating role in the initiation of oral health behaviours (Zhou *et al.*, 2015). The evidence generated here, on ECC and its determinants can be used in regional-level program planning and oral health service planning for policymakers targeting the determinants of ECC.

This study has several strengths. The probability sampling used at every stage of the study, helped to reduce selection bias. Interviewer bias was minimised as the interviewer was blinded to the intervention and the interviews took place before the oral examination. Detection bias was minimised as the oral examination was not performed by the interviewer.

The study had several limitations. As questionnaires were used to collect data on the determinants of ECC, recall bias of the mothers may have been introduced. Furthermore, as the outcome measures were self-reported, participants might have provided socially acceptable responses, especially as they were primed by the data. Response bias may have also occurred as a result of using self-reported data. The high level of support from the teachers to the mothers may also have undermined self-efficacy. Future studies should provide some kind of close parental support in control groups to determine which aspects of the intervention may be effective. The generalisability of the findings to other districts cannot be assured. Although matching of the DS divisions with similar socio-economic backgrounds was carried out to minimise the underlying variability of the confounding factors between the two groups, the quasi-experimental study design may have introduced confounding. As this intervention was conducted during the COVID-19 pandemic in Sri Lanka, group-wise HE sessions had to be limited due to precautions. Dental utilisation in the children was also affected. Several participants in both groups, could not be assessed post-intervention, as they were quarantined during the data collection period.

In conclusion, mothers who received an intervention developed targeting parenting style, maternal oral health-related self-efficacy, and oral health-related knowledge reported improved child-level determinants of ECC including sweet consumption, oral hygiene, and dental attendance.

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