ORIGINAL RESEARCH

Cariogram-based Comparison of Caries Risk Profile in Preschoolers Before and After Giving Parent-oriented Educational Mobile Messages: A Randomized Controlled Trial

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Abstract

Background: Mobile health (mHealth) holds immense promise in revolutionizing personalized approaches to disease prevention. Parental involvement plays an important role in shaping children's oral health behaviors.

Aim: To assess and compare the effectiveness of parent-oriented educational mobile messages and conventional oral health education (OHE) in the caries risk profile among preschoolers using Cariogram.

Materials and methods: A double-arm, parallel-group randomized controlled trial was conducted with 100 mother–child pairs from four preschools. The study recruited mothers with smartphones, while children who were ill and without dental caries were excluded. A computer-generated table of random numbers was employed to randomize participants to the mHealth group ($n = 50$) and conventional OHE group ($n = 50$). The intervention group received educational messages *via* WhatsApp every 2 weeks for 4 months, alongside conventional OHE, and the control group ($n = 50$) received only OHE. The outcome assessor remained blinded throughout the study period. Cariogram was assessed at baseline and after 4 months.

Results: Among the 100 mother–child pairs who enrolled in the study, 84 completed it. The mHealth group showed a significant increase in the chance to avoid new cavities and a decrease in high-risk participants ($p < 0.001$). Additionally, the intervention group exhibited reduced *Lactobacillus* count, snack frequency, plaque amount, and increased fluoride exposure compared to baseline ($p < 0.001$). Intergroup comparisons revealed significant differences in most caries risk factors, except salivary flow rate, *Streptococcus mutans* count, decayed, missing and filled teeth (DMFT) scores, and buffering capacity.

Conclusion: This study demonstrated the effectiveness of parent-oriented mHealth education in reducing caries risk among preschoolers when compared to conventional OHE.

Clinical significance: This study provides evidence that supports the creation of digital strategies for early childhood caries prevention programs. These strategies empower individuals to take charge of their dental care, particularly laypersons, enhancing self-management.

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Keywords: Caries risk assessment, Cariogram, Dental caries, mHealth, Oral health education, Randomized controlled trial.

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Introduction

Dental caries remains a neglected topic, despite the World Health Organization's (WHO) acknowledgment of its status as a major global health issue, affecting 60–90% of children and a significant portion of adults worldwide.[1] The scenario in India mirrors that of both developed and developing nations alike. According to a comprehensive review by Devan et al., the prevalence of early childhood caries in India is 47%.[2]

Addressing the multifaceted chronic nature of dental caries necessitates a comprehensive and multifocal approach, commencing with the evaluation of caries risk.[3] Among the various risk assessment tools available, the Cariogram stands out due to its substantial evidence base, demonstrating moderate accuracy, particularly in children and young adults.[4] The Cariogram illustrates a person's possibility of preventing future cavities in the future in the form of a graphical picture. It also depicts how various etiological factors affect the caries risk.[4]

Mobile health (mHealth) holds immense promise in revolutionizing personalized approaches to disease prevention.[5] Among the plethora of mobile applications, WhatsApp Messenger stands out as one of the most popular worldwide, boasting over 2 billion monthly users.[6] Studies employing mHealth in dentistry are relatively few, primarily focusing on orthodontic patients to

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enhance motivation and oral self-care knowledge.[7,8] However, there is a limited number of clinical trials evaluating specific interventions for managing dental caries in children and addressing associated risk factors.[9] This study seeks to bridge this gap in knowledge. Since families play a crucial role in developing a child's behavior,[10] by engaging parents in oral health care strategies, there lies a collective hope of realizing a future where preschool children are free from oral diseases.

This study aims to evaluate the impact of mHealth-based parent-oriented educational mobile message intervention on the caries risk profile of preschoolers using Cariogram. The research hypothesis is that there is a difference in the effectiveness of parent-oriented educational mobile messaging and conventional oral health education (OHE) on the caries risk profile of preschoolers assessed using Cariogram after a 4-month follow-up.

Materials and Methods

Study Design and Setting

This was double-arm, parallel group randomized controlled trial that took place among 3–6-year-old preschool children along with their mothers from four private preschools in Belagavi, India. It was conducted from March to September 2023. Clinical trial registration was done prospectively with the number CTRI/2023/03/050519.

Ethical Considerations

The study obtained clearance from the Institutional Research and Ethics Committee with reference number 1578 (dated 30/03/2024) and followed the ethical principles established in the Declaration of Helsinki (revised 2000). The study adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Study Participants and Sampling

Children aged 3–6 years, along with mothers who had WhatsApp installed on their phones or were willing to install it for the study, and mothers who could read and understand English language well were included in the study. Conversely, children who were severely ill or had any systemic disease, those without any dental caries, mothers who did not use smartphones, and mothers who declined to provide consent were not considered for inclusion.

The sample size was done according to a previous study by Nishi et al.[11] The GPower program (G*Power version 3.1.9.4 statistical software) was used to calculate a target size of 82, with 41 participants in each group, at a power of 0.85 and an alpha error of 0.05. Since the study involved follow-up, 20% dropout rate was considered. Therefore, the final sample size was 100.

Convenience sampling was employed for this study. Out of the many preschools that were invited to take part in the study, only four granted permissions. A total of 214 mother and child pairs were assessed for eligibility from four preschools. Out of this, 120 met the inclusion criteria.

Computer-generated table of random numbers was employed to randomize participants into mHealth group (n = 50) and OHE group (n = 50). Participant enrollment and random allocation to either of the groups were performed anonymously by an independent third person not associated with the research to minimize bias. Due to the nature of the intervention, neither the principal investigator nor the participants were blinded. However, the outcome assessment and statistical analyses were carried out in a blinded manner.

Data Collection Tool and Technique

A self-designed questionnaire was prepared and subsequently reviewed by experts. The questionnaire comprised a total of 25 closed-ended items covering sociodemographic data, dietary habits, fluoride programs, items for recording clinical examination, and physicochemical and microbiological parameters of saliva. The 25th item entailed the interpretation of the Cariogram, which was derived after analyzing and inputting all these parameters into Cariogram software.

The outcome assessor was trained to perform the clinical examination in the Department of Public Health Industry under the supervision of a professor. Clinical examination was done to assess the dental plaque using visible plaque index (VPI)[12] and dental caries decayed, missing and filled teeth (DMFT) index for primary teeth.[13] Intraexaminer reliabilities were found to be 0.82 and 0.86 according to kappa statistics for plaque and DMFT indices, respectively, indicating strong agreement. Two assistants underwent training to guarantee accurate documentation of the readings.

Phases of the Study

Preparatory Phase

Pilot study was done on 10 mothers and their children to know the format to record pertinent variables and the time required for the examination. The standardization of saliva collection was done during the pilot study. Among the various methods, spitting method where saliva is pooled in the floor of the mouth was found to be feasible in this study.

The questionnaire was distributed to the 10 mothers during the pilot study. The format was easy to understand and took about 15 minutes to complete. Reliability checks using Cronbach's alpha demonstrated good internal consistency (0.84). Validity assessment using content validity (0.78) was also positive.

Baseline assessment: The questionnaire along with informed consent form was distributed to the 100 mothers on four different days in the four schools. The method of filling the questionnaire and 3-day diet diary were explained and they were asked to return the filled questionnaire after 15 minutes. Following this, clinical examination and saliva collection were done. Saliva was collected 2 days in a week to coincide with the incubation period for microbial analysis of saliva.

The Cariogram recommends using either unstimulated or stimulated saliva.[4] Unstimulated saliva collection was chosen in the present study due to participant age and potential choking risks from stimulated saliva collection methods. Saliva collection was done after the clinical examination between 10:00 and 11:30 am during school hours to align with the circadian rhythm. Participants were advised to avoid having any food or drinks except water for 1 hour before saliva collection. Salivary flow rate and buffering capacity were recorded followed by microbial analysis. A total of 0.5 mL of saliva was transferred to a 2 mL Eppendorf tube containing 0.5 mL thioglycolate transport medium using a disposable syringe. The saliva samples were sent to a lab to identify the presence of *Lactobacillus* and *Streptococcus mutans* bacteria.

Once the incubation was complete, colony characteristics were studied and bacterial colonies were examined based on their appearance (shape, size, and color). Specialized software was used to count the number of these colonies, expressed as colony-forming units (CFUs) per milliliter (CFUs/mL) of saliva.

All caries-related factors were scored and entered in the Cariogram program, and the chance of avoiding caries was estimated

Table 1: Details of factors along with codes used in Cariogram

S. No.	*Factor*	*Information collected*	*Cariogram scores*
1	Caries experience	Past caries experience obtained through WHO dentition status for primary teeth (DMFT)	0: DMFT 0 1: DMFT 1 2: DMFT 2 3: DMFT > 3
2	Related disease	General disease or conditions associated with dental caries Data were collected through the questionnaire	0: No disease, healthy 1: A general disease, which can indirectly influence the caries process to a mild degree 2: A general disease, which can indirectly influence the caries process to a high degree
3	Diet contents	The *Lactobacillus* count was used as a measure of cariogenic diet	0: $<10^3$ CFU/mL 1: 10^4 CFU/mL 2: 10^5 CFU/mL 3: $>10^6$ CFU/mL
4	Diet frequency	Estimation of number of meals and snacks per day Data were obtained from the average of 3-day diet diary	0: 3 meals/day 1: 4–5 meals/day 2: 6–7 meals per day 3: >7 meals per day
5	Plaque amount	VPI was used to assess dental plaque	0: VPI < 5% 1: VPI 5–20% 2: VPI 21–50% 3: VPI > 50%
6	*S. mutans*	Salivary *S. mutans* was assessed using laboratory test and expressed as CFU/mL of saliva	0: Negligible 1: $<10^4$ CFU/mL 2: 10^4–10^5 CFU/mL 3: $>10^5$ CFU/mL
7	Fluoride program	Estimation to what extent fluoride is available in the oral cavity Obtained through interview	0: Maximum fluoride program 1: Fluoride supplements 2: Only fluoride toothpaste 3: No fluoride
8	Saliva secretion	Unstimulated whole saliva was assessed and expressed as milliliter per minute	0: >0.25 mL/min 1: 0.1–0.25 mL/min 2: <0.1 mL/min
9	Saliva buffering capacity	Estimation of capacity of saliva to buffer acids Done by adding saliva in 0.005 M HCl and checking through pH indicator strips	0: pH > 6.0 1: pH 4.5–5.5 3: pH < 4.0

for each participant. The details of factors along with codes have been briefed in Table 1. In this study, all participants received score 1 for the clinical judgment factor in the Cariogram, indicating that risk is assessed based on other entered values. Additionally, the country/area was configured to standard, as this setting is appropriate for countries without water fluoridation, such as India.

Participants were categorized into three caries risk levels according to the percentage shown by Cariogram as low risk (61–100% chance to avoid caries), moderate risk (41–60% chance), and high risk (0–40% chance).

Intervention Phase

All mothers in the study were given conventional OHE regardless of their assigned groups. This was delivered through the use of models and posters, covering topics such as the concept and causes of dental caries, its consequences, and the significance of diet and other factors. The conventional education session lasted for 20 minutes in all four schools. The intervention group received educational mobile messages through WhatsApp every 2 weeks over a 4-month period. They were directed to enable the "read receipts" option on WhatsApp to confirm their active participation. All messages were framed in simple and understandable English drawing upon the principles of the health belief model and insights obtained from existing literature.[14–16] These messages aimed to enhance maternal awareness regarding the risk factors, consequences, and preventive aspects of dental caries. Each message, spanning 75–150 words, was enriched with emoticons and visual aids such as pictures and videos to facilitate better understanding. In contrast, the control group received only the conventional OHE. Both the intervention and conventional education were administered by the principal investigator.

Postintervention assessment: All the parameters were reassessed after 4 months. Caries risk was estimated again through Cariogram. The individualized caries risk summary sheet obtained through Cariogram was given to all mothers at the end of the intervention. Moreover, concession cards were provided to all the participants for comprehensive dental treatment.

The CONSORT flowchart outlining the study design is depicted in Figure 1.

Statistical Analysis

Data were processed using the IBM Corp. Released 2012. IBM SPSS® Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp. Descriptive statistics was applied for sociodemographic data of all participants. All quantitative data were subjected to the normality (Shapiro–Wilk) test and it did not follow normal distribution

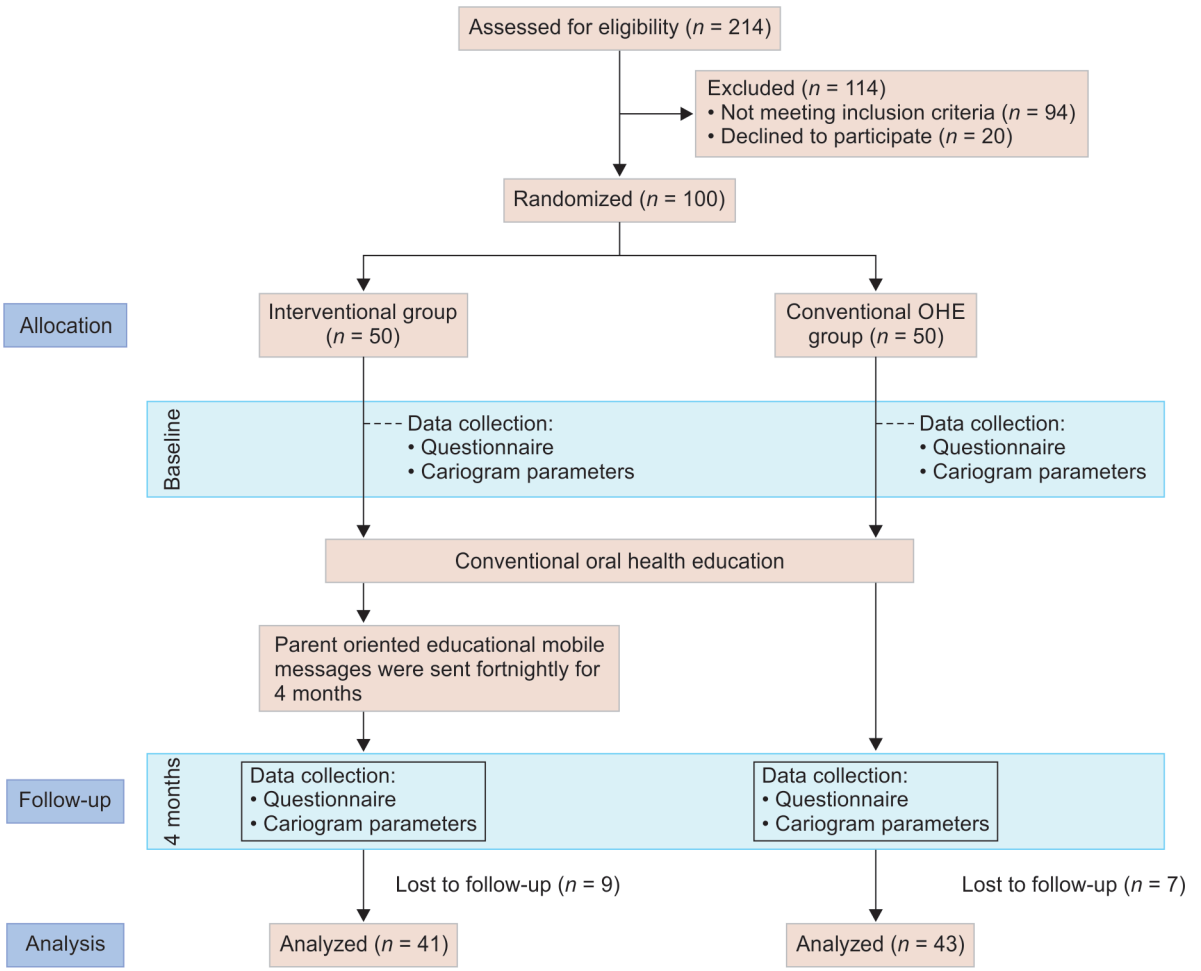

Fig. 1: Consolidated standards of reporting trials (CONSORT) diagram

(p = 0.00). Therefore, nonparametric tests were done. Wilcoxon signed-rank test and Mann–Whitney *U* test were employed for intragroup and intergroup comparisons. Dropout analysis was also carried out to confirm any bias from attrition.

Results

Among the 100 mother–child pairs who enrolled in the study, 84 completed it. In the intervention group, a total of nine participants dropped out. In contrast, the control group experienced a total of seven dropouts.

Demographic Details of the Participants

Table 2 demonstrates the demographic details of the participants. A total of 100 preschool children and their mothers were assessed at baseline. No significant differences were observed in the sociodemographic parameters between the groups.

Caries Risk Profile of the Participants

Table 3 illustrates the distribution of participants based on caries risk. The number of participants in low caries risk increased from baseline to postintervention in the mHealth group. In contrast, the number of participants in the high caries risk reduced between the two intervals. There was a significant association between risk categories and the study groups postintervention (p = 0.000).

Distribution of the Cariogram Sectors among Participants

Table 4 depicts the percentage chance of avoiding new cavities in both groups at baseline and postintervention. Initially, the OHE and mHealth groups exhibited mean percentages of 34.54 ± 19.36 and 36.98 ± 19.35, respectively, at baseline (p = 0.847). The mean percentages increased significantly in the mHealth group (57.29 ± 12.94) compared to OHE group (36.65 ± 19.44) after the intervention (p < 0.001).

Table 4 also shows the weight of various Cariogram sectors among the participants in both groups. The diet sector exhibited similar mean percentages at baseline with 15.50 ± 6.50 and 15.22 ± 5.72 in the OHE and mHealth groups, respectively (p = 0.921). However, after the intervention, there was a significant decrease in the mHealth group (9.314 ± 3.36) compared to the OHE group (15.27 ± 6.30) (p < 0.001). Similar findings were seen in the rest of the three sectors. However, it is important to note that there was no significant difference in the two groups at baseline or postintervention regarding the circumstance sector.

Distribution of the Various Cariogram Parameters among the Two Groups

Baseline VPI scores (mean percentages) were 17.98 ± 13.07 for the OHE group and 17.48 ± 14.98 for the mHealth group (p = 0.692). Postintervention, VPI significantly decreased in the mHealth group

Table 2: Demographic data of the study participants

Variable	*Category*	*OHE group (n = 50) n (%)*	*mHealth group (n = 50) n (%)*	*Statistical value*	*p-value*[a]
Gender	Male	28 (56%)	23 (46%)	1.00	0.317
	Female	22 (44%)	27 (54%)		
Socioeconomic status	Upper	10 (20%)	9 (18%)	0.065	0.799
	Upper middle	40 (80%)	41 (82%)		
Number of siblings	Single child	16 (32%)	17 (34%)	0.045	0.832
	More than one child	34 (68%)	33 (66%)		
Staple diet	Wheat	13 (26%)	18 (36%)	1.251	0.870
	Rice	19 (38%)	17 (34%)		
	Maize	2 (4%)	2 (4%)		
	Jowar	1(2%)	1 (2%)		
	Wheat + Rice	15 (30%)	12 (24%)		
Diet type	Vegetarian	15 (30%)	10 (20%)	1.333	0.248
	Mixed	35 (70%)	40 (80%)		
Material for oral hygiene	Toothbrush	50 (100%)	50 (100%)	0.00	1.00
	Finger	0	0		
	Others	0	0		
Method of oral hygiene	Toothpaste	50 (100%)	50 (100%)	0.00	1.00
	Toothpowder	0	0		
	Others	0	0		
Area	Urban	37 (74%)	39 (78%)	0.219	0.640
	Periurban	13 (26%)	11 (22%)		
Age (mean ± SD)		4.52 ± 0.974	4.70 ± 0.839	0.944	0.345[b]

SD, standard deviation; All values except age (mean ± SD) are expressed as frequency and percentages (in parentheses). The statistical test used: [a]Chi-square test; [b]Mann–Whitney *U* test for age

Table 3: Distribution of caries risk using Cariogram in the intervention and control group at baseline and postintervention

Time point	*Caries risk*	*OHE group*	*mHealth group*	*Chi-square*	*p-value*[a]
Baseline	Low risk	6 (12%)	6 (12.0%)	0.786	0.675
	Moderate risk	14 (28%)	18 (36%)		
	High risk	30 (60%)	26 (52%)		
Postintervention	Low risk	7 (16.3%)	18 (43.9%)	23.13	<0.001*
	Moderate risk	12 (27.9%)	20 (48.8%)		
	High risk	24 (55.8%)	3 (7.3%)		

All values are expressed as frequency and percentages (in parentheses). The statistical test used: [a]Chi-square test. Level of significance: *$p < 0.001$ is considered highly statistically significant

(5.08 ± 7.65) compared to the OHE group (16.46 ± 12.68, $p = 0.000$). Baseline DMFT means were 2.06 ± 0.99 for the OHE group and 2.30 ± 1.26 for the mHealth group ($p = 1.06$). Postintervention, the OHE group's DMFT increased to 2.32 ± 1.32 ($p = 0.001$), while the mHealth group's remained stable (2.30 ± 1.26, $p = 0.317$). Salivary flow rates did not show any significant difference in the mHealth and OHE groups from baseline to postintervention (OHE: baseline 0.246 ± 0.07, postintervention 0.248 ± 0.08, $p = 0.820$; mHealth: baseline 0.23 ± 0.10, postintervention 0.25 ± 0.09, $p = 0.08$). Similarly, salivary buffering capacity showed no significant difference in the two groups (OHE: baseline 5.72 ± 0.84, postintervention 5.73 ± 0.87, $p = 1.00$; mHealth: baseline 5.73 ± 0.75, postintervention 5.70 ± 0.73, $p = 0.792$).

The mean salivary *S. mutans* CFU/mL (represented in log10) at baseline or postintervention showed no significant difference between OHE (baseline: 5.88 ± 0.43; postintervention: 5.84 ± 0.45) and mHealth groups (baseline: 5.90 ± 0.42; postintervention: 5.87 ± 0.38), with *p*-values of 0.338 and 0.651, respectively. The mean salivary *Lactobacillus* CFU/mL (represented in log10) significantly differed postintervention between OHE (baseline: 6.29 ± 0.45; postintervention: 6.27 ± 0.43) and mHealth groups (baseline: 6.35 ± 0.491; postintervention: 5.95 ± 0.35) ($p = 0.000$). Dropout analysis revealed no significant differences between completers and dropouts, suggesting minimal bias from attrition.

Discussion

A mother's influence profoundly impacts a child's development and well-being, playing a pivotal role in instilling healthy behaviors from an early age.[17] The present study assessed and compared the effectiveness of parent-oriented educational mobile messages and conventional OHE in reducing the caries risk in preschoolers. It was found that educational mobile messages delivered *via* WhatsApp to mothers significantly reduced the caries risk in their children compared to a one-time session of conventional OHE, as measured by Cariogram.

Table 4: Comparison of Cariogram parameters mean percentages in the intervention and control group at baseline and postintervention

Cariogram parameter	*Time interval*	*OHE group Mean ± SD (median)*	*mHealth group Mean ± SD (median)*	*z-value*	*p-value*[b]
Actual chance of avoiding new cavities	Baseline	34.54 ± 19.36 (31.5)	36.98 ± 19.35 (38)	0.192	0.847
	Postintervention	36.65 ± 19.44 (34)	57.29 ± 12.94 (57)	4.709	<0.001**
	z-value	1.029	5.375		
	p-value[a]	0.303	<0.001**		
Diet	Baseline	15.50 ± 6.50 (14)	15.22 ± 5.72 (15.5)	0.099	0.921
	Postintervention	15.27 ± 6.30 (14)	9.314 ± 3.36 (9)	4.671	<0.001**
	z-value	1.648	4.553		
	p-value[a]	0.099	<0.001**		
Bacteria	Baseline	16.82 ± 5.07 (16)	16.2 ± 5.09 (16)	0.148	0.882
	Postintervention	16.09 ± 5.06 (14)	11.65 ± 3.41 (10)	4.282	<0.001**
	z-value	1.009	4.555		
	p-value[a]	0.313	<0.001**		
Susceptibility	Baseline	27.04 ± 19.20 (18.5)	25.36 ± 19.19 (16)	0.175	0.861
	Postintervention	25.55 ± 18.31 (19)	15.24 ± 9.94 (13)	2.978	0.003*
	z-value	0.087	4.921		
	p-value[a]	0.930	<0.001**		
Circumstance	Baseline	6.20 ± 2.89 (6)	6.26 ± 2.67 (6)	0.691	0.490
	Postintervention	6.46 ± 3.08 (6)	6.21 ± 2.46 (6)	0.232	0.817
	z-value	1.035	2.088		
	p-value[a]	0.300	0.037*		

SD, standard deviation; All values are expressed as mean ± SD. [a]Wilcoxon signed-rank test and [b]Mann–Whitney *U* test. Level of significance: *$p < 0.05$ is considered statistically significant and **$p \leq 0.001$ is considered highly statistically significant

Preschoolers aged 3–6 years and their mothers were chosen for this study as this age-group represents early childhood, a critical period for establishing health habits that influence future oral health.[18] Research suggests that behaviors learned and practiced during this period are more likely to persist.[18] The design of the nine educational mobile messages sent to the mothers was according to the principles of the Health Belief Model and the WHO's implementation manual for tackling early childhood caries.[19] Additionally, the messages leveraged the power of reinforcement, which research suggests leads to behavioral change and ultimately, a commitment to new practices.[20]

The Cariogram has demonstrated superior long-term validity compared to other caries risk assessment methods such as caries management by risk assessment (CAMBRA) and caries risk assessment (CRAF).[21] Furthermore, it is the only risk assessment tool validated in diverse populations.[22] While previous studies reported limitations in the Cariogram's accuracy for preschoolers, these studies employed a modified version excluding salivary parameters, which may have affected the results.[23,24] The present study utilized the complete Cariogram alongside adjustments tailored to young children, potentially contributing to its effectiveness in preschool caries risk assessment.

In the present study, the intervention group demonstrated a significant increase in the chance to avoid new cavities, indicating a decrease in overall caries risk. Following the intervention, the number of high-risk participants decreased, while the number of low-risk participants increased. The control group, however, did not exhibit significant changes in risk category distribution. The findings align with research by Doost-Hoseini et al., who observed a similar reduction in the high-risk group among orthodontic patients following preventive interventions.[25]

The Cariogram not only depicts overall caries risk but also reveals the influence of various factors on the chance to avoid new cavities.[4] In this study, the intervention group displayed significant reduction in the mean percentages of all four Cariogram sectors, namely diet, bacteria, susceptibility, and circumstances following the intervention.

The Cariogram's "diet" sector considers both dietary content, measured by *Lactobacillus* count, and dietary frequency assessed through a 3-day diet record. Karjalainen et al. demonstrated significant association between high sugar intake at 3 years of age and increased caries risk, along with elevated *S. mutans* count.[26] Notably, a 7-day text message intervention aimed at mothers resulted in a decrease in sugary snacks and soda consumption in their children compared to the control group.[27] Similarly, a systematic review indicated that interventions combining easy access to sugar-free beverage alternatives with health education significantly reduced sugary drink consumption in children aged 8–18 years.[28] The present study observed similar results, with a significant reduction in daily snacks among children in the intervention group. Additionally, the *Lactobacillus* count in the intervention group decreased significantly postintervention, aligning with findings by Kumar et al.[29] A high *Lactobacillus* count indicates high carbohydrate consumption, which, in turn, leads to high caries risk.

The Cariogram's "bacteria" sector reflects both plaque amount and *S. mutans* count. Dental plaque levels were assessed using the VPI, a common index employed in similar studies among preschool children.[16,30] Dental plaque is a well-established factor contributing to both caries and periodontal disease.[4] In line with previous research on mobile health interventions improving oral hygiene,[31] the intervention group in this study demonstrated a significant decrease in visible plaque scores.

The presence of *S. mutans* in plaque or saliva even in young children without cavities is a strong indicator of an increased risk for developing dental caries in the future.[32] This highlights the importance of considering *S. mutans* levels in caries risk assessment. In the present study, while both groups saw a decrease in *S. mutans* levels, the intervention group experienced a much more substantial reduction. These findings align with the study by Seow et al., where educational interventions combined with proper toothbrushing demonstrations for mothers resulted in reduced *S. mutans* levels in their children.[33]

The Cariogram's "susceptibility" sector incorporates three factors: fluoride exposure, saliva secretion, and saliva buffering capacity. Fluoride is a well-recognized protective factor against caries, contributing significantly to the decline in caries prevalence observed in Western countries.[34] In this study, none of the participants received fluoride supplements, and fluoridated toothpaste was the sole source of fluoride exposure. The usage of fluoride toothpaste was confirmed by requesting participants to disclose the brand name used. The intervention group demonstrated a significant increase in fluoride toothpaste usage compared to baseline. This finding aligns with an OHE program in Thailand targeted at mothers and children, which resulted in improved use of fluoride toothpaste after the intervention.[35]

This study found no significant changes in salivary flow rate or buffering capacity between the two groups, either before or after the intervention. This aligns with previous research, suggesting a weak correlation between caries incidence and salivary flow rate or buffering capacity in young children.[36] Furthermore, children with dental caries often do not exhibit clinical signs of reduced salivary secretions, and when present, these reductions are typically associated with systemic diseases.[33] Therefore, while salivary factors are incorporated into the Cariogram for completeness, they may not be as influential for caries risk assessment in young children compared to other factors.

The Cariogram's "circumstances" sector considers both past caries experience and the presence of related diseases. Caries experience is recognized as a significant predictor of future caries risk.[37] The mean DMFT scores for the control and intervention groups at baseline were 2.06 ± 0.99 and 2.30 ± 1.26, respectively, which fall within the range documented by Janakiram et al. in their review of caries prevalence among children in India.[38]

While improvements in toothbrushing frequency are generally linked to reduced caries incidence,[39] the present study did not observe much changes in the mean DMFT scores between the groups following the intervention. However, the control group exhibits a slight increase in mean DMFT from baseline to postintervention. This difference in DMFT scores may be attributable to several factors. First, caries lesions tend to progress more rapidly in primary teeth compared to permanent teeth.[40] Second, factors such as plaque buildup, frequent snacking, and inadequate oral hygiene practices likely contributed to a more pronounced increase in caries within the control group.

Limitation and Future Recommendations

This study encountered a few limitations. First, a dropout rate of 16 mother–child pairs could potentially affect how well the findings apply to a broader population. While an intention-to-treat analysis did not reveal a significant impact, future studies might benefit from a larger sample size and improved strategies to retain participants. Second, the intervention focused solely on mothers, and children did not receive a direct educational component. As an alternative option, future research can incorporate cartoons or games regarding oral health in addition to parent-oriented educational messages. Further research can explore the potential of adapting the intervention for rural settings with potentially lower baseline digital access. Additionally, government initiatives promoting digital literacy programs can bridge the digital divide and empower a larger population of parents to utilize mHealth tools for their children's well-being.

Conclusion

The current study showed that parent-oriented educational messages delivered *via* WhatsApp were effective in reducing the caries risk in preschool children. The mHealth-based group displayed a decrease in Cariogram scores and a shift toward lower caries risk categories compared to the group that received conventional OHE alone.

Clinical Significance

This study provides evidence that supports the creation of digital strategies for early childhood caries prevention programs. The success of this mHealth intervention opens doors for future exploration in improving children's oral health on a wider scale. By harnessing the power of mHealth and ensuring equitable access to knowledge, we can empower parents and pave the way for a future generation free from oral diseases.

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