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Original Article

The effectiveness of a caries preventive program in mothers and infants — An 18-month follow-up study

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Abstract *Background/purpose:* MS and LB, the primary bacteria groups responsible for dental caries, and high levels of these bacteria in the mother promote transmission from mother to infant. The aim of this study was prevention of maternal MS and LB transmission on infants by using different preventive strategies and inhibition of early childhood caries progression.
Materials and methods: This study was conducted with 50 mother-child pairs who were randomly allocated into either a study group or a control group (n = 25 each). Mothers in the study group were enrolled in a detailed preventive program that included elimination of dental caries with restorative and antibacterial procedures, whereas those in the control group received only a single episode of oral-health education.
Results: After 18 months, significant MS and LB inhibition was observed in the study group ($p < 0.0001$). In addition, caries prevalence in the infants in the study and control groups was 0% and 20% respectively, and the difference between the two groups was statistically significant ($p = 0.020$).
Conclusion: These results indicate that primary preventive intervention and oral-health instruction can significantly inhibit the MS and LB levels of mothers and prevent caries in their children during the early years of life.

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Introduction

Dental caries continues to represent a major public health problem, especially among young children,[1,2] affecting up to 50% of pre-school children and 60%—90% of school-age children in developed countries.[3,4] Early childhood caries (ECC) is one of the most common childhood diseases and is well-established in the literature as an infectious, transmissible disease strongly associated with the bacteria Mutans Streptococci (MS) as a causal agent.[5,6] Studies have shown that MS is frequently transferred to children from their primary caregivers and that reducing salivary MS levels in the mouth of the mother leads to a reduction in MS colonization and/or caries activity in the oral cavity of her child.[5,7] Infants between 1.5 and 3 years of age can be infected by their mothers or caregivers through bacteria transmission, with mothers considered to be the primary source of cariogenic bacteria.[8]

Developed countries have employed different strategies for preventing ECC. Of these, the primary strategy involves inhibiting the spread of the dominant bacteria in the community. Mother-child caries prevention programs are considered a very modern approach to inhibiting bacterial transmission to infants and preventing primary tooth caries, especially among low socio-economic-status communities and in areas with limited access to dentists. Critical steps include increasing awareness, improving oral hygiene status and treating primary lesions to reduce maternal MS and lactobacilli (LB) levels. Programs aimed at reducing ECC should include one-on-one education of mothers,[9] and studies based on such programs have reported that addressing the oral-health status and dietary habits of mothers provides a simple, long-term, and very important method for preventing caries in infants.[9—11] Oral-health education programs, preventive measures and dietary recommendations have been shown to inhibit bacterial transmission from mothers to infants during the window of infectivity, i.e. the period between 19 and 31 months. By delaying MS transmission to infants during this period, it should be possible to lower the incidence of caries in infants, even without any supplementary protective program at a later date.[6,12]

Therefore, the present study was conducted to determine the effect of various preventive strategies on mother-infant MS and LB transmission and the inhibition of early childhood caries. The null hypothesis was that different preventive strategies would not effect maternal-child oral bacterial transmission or inhibit ECC development.

Materials and methods

Participant selection

The study was approved by the Ethical Committee for Clinical Research of the .... University, ... (approval number:13/03). This study was carried out at 3 different Family Practice Centers (FPC) in ..., ... Selected FPCs were located in similar neighborhoods in terms of population density and birth rates, and selected patients came from similar socio-economic backgrounds. The patient selection criteria were mother-infant pairs with no systemic disorders, using no analgesic or anti-inflammatory medication, and first-time-mothers with 6-month-old or younger babies. Power analysis conducted using the SPSS software program indicaed a minimum of 24 mother-infant pairs per group were required to achieve a sensitivity level of 5% within an 80% confidence interval of 67 mother-child pairs attending 3 FPCs on different days, 53 were found to meet the criteria and were included in the study. The purpose of the study and the clinical procedures were explained, after which written consent was obtained.

Mother-infant pairs were randomly allocated to either a study group ($n = 26$) that was enroled in a detailed preventive program that included restorative and antibacterial treatment for the elimination of dental caries or a control group ($n = 27$) that received only a single session of oral-health education.

A program of preventive treatment (Table 1) was applied by 2 calibrated researchers aided by dental hygiene students. Once the mothers' treatment requirements were determined, oral-hygiene training was provided and included both demonstrations and dietary recommendations. Demonstrations comprised instructions for proper brushing (twice a day) and dental-floss use (at least once a day) for mothers and oral-hygiene procedures (including brush and gauze use) for infants. Dietary recommendations included restriction of sugar consumption for mothers as well as bottle/breast-feeding recommendations for infants. In addition, a chlorhexidine varnish containing 1% thymol (Cervitec Plus; Ivoclar Vivadent, Liechtenstein) was applied every 3 months at the FPC, after which mothers were provided with 0.2% chlorhexidine mouthwash (Klorhex; Drogsan, Turkey) that they were instructed to use for the next two weeks.

Sample collection

Oral examinations were conducted by two calibrated researchers in the FPC examination rooms. Examinations were conducted according to World Health Organization inspection criteria under white light and with the help of a dental mirror and explorer.[13]

Salivary samples were collected from mothers in both groups at baseline and at 6, 12 and 18 months. Saliva was stimulated with paraffin wax. After collection, salivary MS and LB levels were measured, and CRT concentrations were determined using detection kits (CRT bacteria test; Ivoclar Vivadent, Liechtenstein) according to the manufacturer's instructions, with scores recorded as either "1" (low bacteria concentration of less than 10^5 CFU/ml) or "2" (high bacteria concentration of greater than 10^5 CFU/ml).

Caries monitoring for the infants was also performed by the researchers according to Harris[9] in the knee-to-knee position at six-month intervals. In cases where a caries lesion was identified, 5% sodium-fluoride varnish (Dura-Shield; Sultan, USA) was applied to the lesion by a dental hygiene student, and the mother was referred to the Department of Pediatric Dentistry.

Statistical analysis

Statistical analysis was performed using the SPSS software program (SPSS 15.0; SPSS Inc, USA). Data was analysed using

Table 1 Preventive program flow chart.

	Study (n = 25) Dental treatment and preventive application	Control (n = 25) Only screen
First meeting	- Interview with mothers about the study - General information disclosure - Signing of consent forms - Detailed information about hygiene education - Detailed information about the present study - Oral examinations of mothers - Determination of treatment needs - Collection of saliva samples of mothers - Detection of MS and LB from saliva (CRT bacteria)	- Interview with mothers about the study - General information disclosure - Signing of consent forms - Detailed information about hygiene education - Detailed information about the present study - Oral examinations of mothers - Determination of treatment needs - Collection of saliva samples of mothers - Detection of MS and LB from saliva (CRT bacteria)
2nd meeting 3. month	- Performing the necessary dental treatment procedures for the mothers (with special appointments) - Preventive measures for the mothers (Chx varnish and antibacterial applications), Oral hygiene and diet recommendations	- Directing the mothers to dental clinics for dental treatments
3rd meeting 6. month	- First oral examination of infants - Collection of saliva samples of mothers, Detection of MS and LB from saliva - Preventive measures for the mothers (Chx varnish and antibacterial applications), Oral hygiene and diet recommendations	- First oral examination of infants - Collection of saliva samples of mothers, Detection of MS and LB from saliva
4th meeting 12. month	- Second oral examination of infants - Collection of saliva samples of mothers, Detection of MS and LB from saliva - Preventive measures for the mothers (Chx varnish and antibacterial applications), Oral hygiene and diet recommendations	- Second oral examination of infants - Collection of saliva samples of mothers, Detection of MS and LB from saliva
5th meeting 18. month	- Third oral examination of infants - Collection of saliva samples of mothers, Detection of MS and LB from saliva	- Third oral examination of infants - Collection of saliva samples of mothers, Detection of MS and LB from saliva

MS: Mutans streptococci, LB: Lactobacilli, Chx: Chlorhexidine.

Mann–Whitney U and Independent-Samples T tests with the level of significance set at $p < 0.05$.

Results

The study was initiated with 53 mother-infant pairs; however, 1 pair from the study group and 2 from the control group dropped out for various reasons (e.g. pregnancy, moving to another city, unavailability for control appointments). Therefore, the study was finalized with a total of 50 mother-infant pairs (n = 25 for each group).

Mean age of the mother-infant pairs and DMFT values are presented in Table 2. There were no significant differences in DMFT values ($p = 0.118$), mean age of mothers ($p = 0.688$), or mean age of infants ($p = 0.727$) between the groups.

MS and LB scores of the mothers are given in Tables 3 and 4, respectively. No significant differences were observed between the salivary MS and LB levels of mothers in the study and control groups at baseline ($p > 0.05$); however, significant differences in both MS ($p = 0.049$) and LB ($p = 0.005$) levels were observed between the two groups after 18 months. Whereas MS and LB levels decreased significantly between each measurement time-point in the study group ($p < 0001$), no significant changes were observed in the MS and LB scores of the control group ($p > 0.05$).

Mean age, dmft value and caries prevalence of infants by group are presented in Table 5. No caries lesions were detected in the study group at 6, 12, or 18 months, whereas the prevalence of dental caries in the control group was 4% (n = 1) at 12 months and 20% (n = 5) at 18 months. The increase in caries lesions among the infants in the control

Table 2 Mean ages, DMFT values and results of statistical analysis, by group.

	Study (n = 25)	Control (n = 25)	*p*-value
Age of mothers	26.6 ± 4.75	25.2 ± 4.33	0.688[a]
Age of infants (month)	4.04 ± 1.86	3.88 ± 2.11	0.727[b]
DMFT values of mothers	6.52 ± 3.11	5.16 ± 2.58	0.118[b]

*significant differences ($p < 0.05$).
DMFT: decay-missing-filled teeth.
[a] Independent-Samples *T* Test.
[b] Mann Whitney *U* test.

Table 3 MS scores of mothers, by measurement time-point and by group.

Groups		1st		2nd		3rd		4th	
		1	2	1	2	1	2	1	2
Study	n = 25	5	20	7	18	11	14	17	8
	100%	20	80	28	72	44	56	68	32
Control	n = 25	11	14	11	14	11	14	10	15
	100%	44	56	44	56	44	56	40	60
p-value		0.072		0.243		1		**0.049***	

Score 1: low level (less than 10^5 CFU/ml), score 2: high level (greater than 10^5 CFU/ml).
*A p value of <0.05 according to Mann Whitney *U* test was considered statistically significant.

Table 4 LB scores of mothers, by measurement time-point and by group.

Groups		1st		2nd		3rd		4th	
		1	2	1	2	1	2	1	2
Study	n = 25	3	22	14	11	14	11	19	6
	100%	12	88	56	44	56	44	76	24
Control	n = 25	7	18	11	14	10	15	9	16
	100%	28	72	44	56	40	60	36	64
p-value		0.162		0.401		0.262		**0.005***	

Score 1: low level (less than 10^5 CFU/ml), score 2: high level (greater than 10^5 CFU/ml).
*A p value of <0.05 according to Mann Whitney *U* test was considered statistically significant.

group between 6 months and 18 months was statistically significant (p = 0.007).

The dmft values of the study and control groups did not vary significantly at 6 months or 12 months (p˃0.05); however, at 18 months, dmft scores were significantly higher in the control group as compared to the study group (p = 0.020).

Discussion

MS and LB, the primary bacteria groups responsible for dental caries, are said to be transmitted from mothers to their children, and high levels of these bacteria in the mother promote transmission from mother to infant.[2] These bacteria are able to colonize the surface of teeth, and, in the presence of a sugar substrate, cause a marked reduction in oral pH, thereby inducing demineralization of dental hard tissue.[9] Preventive intervention in mothers has been suggested as a means of inhibiting the transmission of MS and LB to infants and ultimately of reducing middle- and long-term caries prevalence in the community.[14,15] This study used various strategies to prevent maternal transmission of MS and LB to infants and inhibit the progression of early childhood caries.

Previous studies have indicated that when preventive measures are taken before a certain age, MS transmission to infants can be inhibited or delayed, and future caries can be prevented. However, there is no strict definition of what should be included in a preventive program, and different approaches to the issue are mentioned in the literature. Kohler and Andreen[15] conducted a preventive program consisting of oral hygiene instruction, dietary advice, professional teeth cleaning, treatment of caries lesions, and chlorhexidine and fluoride application. In a study by Soderling et al.[12] in pregnant women with high levels of MS received either xylitol, fluoride, or chlorhexidine treatment; based on children's MS counts at 3- and 6-year examinations, a xylitol-associated reduction in the probability of mother-child transmission of MS was identified. In another study, Tenovou et al.[16] evaluated the effect of chlorhexidine (1%) and sodium fluoride (0.2%) gel treatments twice a year for 3 years in child—mother pairs divided into three groups based on maternal saliva MS levels. According to their results, both MS colonization and incidence of caries were highest among the pairs that received no gel treatment. In line with similar studies in the literature,[8,15,17] our study included such steps as providing information about preventive measures, giving advice on oral health and dietary habits, treating carious lesions and periodontal disease, and applying antibacterial agents.

MS transmission within a family can occur vertically from parents and caregivers as well as horizontally between siblings. Caufield et al.[5] reported that MS colonization can occur after tooth eruption in newborns at 19—31 months, whereas Navia[18] reported the most vulnerable period in terms MS infection to be the first 14 months of life because this period is characterized by the eruption of primary

Table 5 Mean age, dmft value and caries prevalence of infants, by group.

		Study	Control	*p*-value
1st exam.	Caries prevalence	%0 (n = 0)	%4 (n = 1)	
	dmft value	0 ± 0	0.08 ± 0.4	0.317
	Mean age (month)	10.04 ± 1.86	9.88 ± 2.11	
2nd exam.	Caries prevalence	%0 (n = 0)	%4 (n = 1)	
	dmft value	0 ± 0	0,08 ± 0,4	0.317
	Mean age (month)	16.04 ± 1.86	15.88 ± 2.11	
3rd exam.	Caries prevalence	%0 (n = 0)	%20 (n = 5)	
	dmft value	0 ± 0	0.52 ± 1.19	**0.020***
	Mean age (month)	22.04 ± 1.86	21.88 ± 2.11	

dmft: decay-missing-filled teeth.
*A p value of <0.05 according to Mann Whitney *U* test was considered statistically significant.

teeth, an inadequate immune system, and an absence of oral hygiene and fluoride prophylaxis. Considering these information in the literature,[19,20] mothers who have only one child from 0 to 6 months of age were selected for the present study.

The literature includes various studies aiming to identify children at risk for dental caries so that parents can receive oral-health counseling from their primary health-care providers. Novak and Casamassimo[21] reported that preventive treatment implemented by family physicians can provide parents with useful oral-health education and increase the number of non-carious individuals in the community. Pierce et al.[22] reported that after 2 h of training in infant oral health, pediatric primary-care providers achieved an adequate level of accuracy in identifying children who required professional dental care, including children with cavitated carious lesions. Kagihara et al.[23] emphasized that preventive programs in which guidance is provided by primary health-care providers are highly effective in preventing ECC. In this respect, conducting the present study at Family Practice Centres is consistent with the literature and proved to be a useful method for increasing awareness among family physicians and other health-care providers.

The results of the present study showed statistically significant reductions in maternal MS and LB levels over time ($p < 0.0001$), whereas no significant differences were observed in the control group ($p > 0.05$). These findings indicate that treatment of carious lesions and periodontal disease as well as the application of chlorhexidine as an antibacterial agent, together with oral-hygiene education and dietary recommendations, can play a key role in reducing MS and LB levels.

Chlorhexidine is an antibacterial agent frequently used in mother-child studies.[7,19] Both oral-hygiene education and periodic application of chlorhexidine varnish and mouthwash as a prophylactic for mothers have been reported to be effective methods for preventing ECC in high-risk groups.[20] In a study by Dasanayake et al.[19] that evaluated the effect of a 10% chlorhexidine varnish on mother-child transmission of MS, MS levels in the study group were found to be significantly lower ($p < 0.05$) than those in the control group after 12 months. Similarly, in the present study, chlorhexidine varnish and mouthwash application among mothers in the study group resulted in a significant reduction in MS levels ($p < 0.0001$).

In line with previous reports in the literature,[14,16] this study also found statistically significant differences in caries prevalence among infants in the study group as compared to the control group ($p = 0.020$), with caries rates of 0% and 20%, respectively, for the study and control groups. This may be attributed to the 6-monthly training and dietary recommendations provided for mothers in the study group as well as the significant reductions in MS observed in mothers in this group as compared to the control group, indicating an inhibition of vertical transmission between mother and child. In addition to caries inhibition, this study also found a significant difference ($p = 0.02$) between the dmft values of infants in the study group ("0") and the control group ("0.52"). which is in line with numerous studies in the literature.[7,11,12,15,16,24]

The present study shows unequivocably that caries preventive programs initiated shortly after pregnancy have a positive impact on mothers and their babies. The study also indicates that primary prevention programs play an important role in the prevention of ECC and MS transmission, and it highlights the opportunity that the systematic use of family practice centers can provide in terms of ECC prevention, especially in areas with limited access to dental services and among families of low socio-economic status.

In conclusion, primary preventive interventions and oral-health instructions have a significant effect on the MS and LB levels of mothers. High levels of these bacteria in the mother promote transmission from mother to infant. Therefore, prophylactic measures should be taken in mothers to prevent ECC.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

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