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**Early Childhood Caries  
and a Community Trial of its Prevention in Tehran, Iran**

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**Academic dissertation**

To be presented with the permission of the Faculty of Medicine of the University of Helsinki, for public discussion in the main auditorium of the Institute of Dentistry, Mannerheimintie 172, Helsinki, on 17 May, 2008 at 12 noon.

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*“In the name of him who created and sustains the world*

*The two worlds are as a drop of water in the ocean of his knowledge”*

*Sa’adi Shirazi (1213-1293 A.D)*

***To the children all over the world***



## ABSTRACT

Mohebbi SZ. Early Childhood Caries and a Community Trial of its Prevention in Tehran, Iran. Department of Oral Public Health, Institute of Dentistry, University of Helsinki, Finland, 2008. 92 pp. ISBN 978-952-10-4679-7.

The present study assessed the prevalence of and risk factors for Early Childhood Caries (ECC) in children 12- to 36- month-old and evaluated the impacts of an educational intervention on ECC prevention in the 12- to 15-month-old cohort.

The target population included 12- to 36-month-olds ( $n = 504$ ) and their mothers attending the vaccination offices of 18 randomly selected public health centers of Tehran city. The mother was first interviewed by a structured questionnaire covering background factors, feeding habits, daytime sugar intake, mother's and child's oral cleaning habits, and mother's perception toward her ability to maintain the child's oral hygiene; then the child's clinical dental examination was carried out covering caries experience and dental plaque status.

In addition, the 12- to 15-month-olds ( $n = 242$ ) were assigned to a six-month interventional study. The 18 health centers were randomly allocated into two groups for intervention and one for control. The mothers in the intervention groups received education on caries prevention from the vaccination staff with extra motivation as reminder phone calls in one of the intervention groups. The outcome was measured as differences in increments of enamel and dentinal caries and as mothers' perceptions about the usefulness of intervention.

The results showed that the prevalence of ECC was rather high (3%-26%) in the three age groups, and almost all dmft was due to untreated caries. The majority of the children showed visible plaque on central upper incisors. Oral cleaning on a daily basis was reported for just 68% of mothers and 39% of children. The frequency of oral cleaning and good oral hygiene of the child were directly proportional to the mother's own toothbrushing frequency. Of the children, 98% were solely or partly breastfed. ECC was more likely to occur among those for whom the burden of milk-bottle feeding at night existed ( $OR = 4.9$ ), while breastfeeding *per se*, its duration, and its nighttime burden were not related to ECC. The indicator of daytime sugar intake also did not show a clear relationship with ECC. The educational intervention applying a pamphlet with some extra motivation and implemented by non-dental staff of public health centers appeared to be successful in preventing caries increments and mothers

reported more positive self-perceived behavioral changes in this group than those in the group with a pamphlet only.

To improve oral health status among the young children in countries with a developing oral health system, community-based oral health educational programs should be established by involving non-dental staff of health settings who are more frequently in contact with these children. Parents should be encouraged to realize that they play the dominant role in the oral health care of their children. Parents' own oral health behaviors should be emphasized in dental and general health settings.

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## LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following articles referred to in the text by their Roman numerals.

- I. Mohebbi SZ, Virtanen JI, Vahid-Golpayegani M, Vehkalahti MM. Early childhood caries and dental plaque among 1- to 3-year-olds in Tehran, Iran. *Journal of Indian Society for Pedodontics and Preventive Dentistry* 2006;24:177-181.
- II. Mohebbi SZ, Virtanen JI, Vahid-Golpayegani M, Vehkalahti MM. Feeding habits as determinants of early childhood caries in a population where prolonged breastfeeding is a norm. *Community Dentistry and Oral Epidemiology* 2007;doi:10.1111/j.1600-0528.2007.00408.x. (Early online version).
- III. Mohebbi SZ, Virtanen JI, Murtomaa H, Vahid-Golpayegani M, Vehkalahti MM. Mothers as facilitators of oral hygiene in early childhood. *International Journal of Paediatric Dentistry* 2008;18:48-55.
- IV. Mohebbi SZ, Virtanen JI, Vahid-Golpayegani M, Vehkalahti MM. Effectiveness of Educational Intervention on Early Childhood Caries: A Cluster Randomized Trial. 2007 (Submitted manuscript).

## **ABBREVIATIONS**

AAPD	American Association of Pediatric Dentistry
ADA	American Dental Association
ARR	Absolute risk reduction
CDC	Center for Disease Control (USA)
CI	Confidence interval
dmft	Decayed, missing and filled primary teeth
dt	Decayed primary teeth
de	Upper central incisors with enamel caries
ECC	Early Childhood Caries
EMRO	Eastern Mediterranean Regional Office
ft	Filled primary teeth
HBM	Health Belief Model
mt	Missing primary teeth
MS	Mutans streptococci
NNT	Number needed to treat
OR	Odds ratio
PPM	Parts per million
SD	Standard deviation
SES	Socio-economic status
USD	United States Dollar
WHO	World Health Organization



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## 1. INTRODUCTION

Dental caries afflicts humans of all ages and in all regions of the world (World Health Organization, WHO, 2003a). It is a disease that may never be eradicated because of the complex interplay of social, behavioral, cultural, dietary and biological risk factors that are associated with its initiation and progression (Ismail et al., 1997). Traditional treatment of oral disease is extremely costly, making it the fourth most expensive disease to treat in most industrialized countries (WHO, 2003a). In many low-income countries, if treatment were available, the cost of dental caries alone in children would exceed the total health care budget for the children.

Caries in infants and young children has long been recognized as a clinical syndrome which was described as early as the first decades of the last century. Belterami (1952) described the early caries in children in 1930s as “Les dents noire de tout-petits” which means, “black teeth of the very young.” Fass (1962) is perhaps the best known in this regard as for using the term “nursing bottle mouth.” Since 1962, a variety of other terms have been used to identify the caries in young children including the terms baby bottle tooth decay, nursing bottle syndrome, bottle mouth caries, nursing caries, rampant caries, nursing bottle mouth, milk bottle syndrome, breast milk tooth decay and facio-lingual pattern of decay (Milnes, 1996). Among all the expressions used to address caries in young children, the role of the baby bottle as an etiologic factor in progression of caries is perceived.

Prolonged use of a baby bottle, especially use of the bottle at bedtime, is believed to be associated with increased risk for caries, but use of the baby bottle might not be the only factor in caries development in early childhood. Carious lesions are produced from the interaction of cariogenic microorganisms, fermentable carbohydrates, and teeth. Given the proper time, these factors induce incipient carious lesions that continue to progress. Frequent consumption of liquids containing sugar can increase the risk for caries due to prolonged contact between sugars in the consumed liquid and cariogenic bacteria on the susceptible teeth (American Association of Pediatric Dentistry, AAPD, 2007). As a result, the Center for Disease Control (CDC) recommended the term early childhood caries or ECC to be used to describe any form of caries in infants and preschool children to better reflect the multi-factorial etiologic process related to ECC development (Reisine and Douglass, 1998). This

new name for the old problem reflects an evolving understanding about the underlying etiologic factors of caries in young children. The new term may induce a greater awareness of the importance of other behavioral, biological, and demographic factors contributing to ECC.

ECC remains a sizable and significant public health problem in developing countries and among minorities in developed countries (Tickle, 2006; Milnes, 1996). The high public cost of treating ECC (Weinstein, 1998), especially in severe cases in need of hospitalization and general anesthesia, implicates a crucial need for prevention of disease. Being one of the countries with the youngest populations and developing oral health services (Pakshir, 2004), the problem remains a huge public health challenge in Iran. The WHO, however, has no database on the oral health status of children less than three years of age.

A number of preventive measures are available for prevention of caries. The WHO Global Strategy for the prevention and control of non-communicable diseases suggests a new approach to managing the prevention and control of oral diseases through shared approaches taking into account the common risk factors of several chronic diseases (WHO, 2003a). It is highly recommended that oral health promotion and oral disease prevention should be integrated into broader health promotion (Petersen and Kwan, 2004).

So far, findings on the interplay of various factors and their impact on ECC are controversial (Harris et al., 2004). The present study tried to focus on recognition of the complexity of the etiology of ECC by addressing a more comprehensive set of factors that may contribute to ECC. The study also evaluated the impacts of an oral health educational intervention as part of general health services throughout infancy and toddler stages on ECC prevention.

## **2. REVIEW OF LITERATURE**

### **2.1. Early childhood caries**

ECC is a specific form of devastating caries that affect the primary dentition and may begin as soon as the infant teeth erupt (Huntington et al., 2002; Ramos-Gomez et al., 1999). ECC is neither self-limiting nor amenable to short term pharmacological management and remains a sizable and significant personal and public health problem (Jones et al., 2005).

#### **2.1.1. Measurement of ECC**

The most common index for measuring dental caries in the primary dentition is dmft index. This index is based on detection of dentinal caries in the past and present including the present untreated decay (dt) and evidence of past disease as teeth with filling (ft), or missing due to caries (mt). The dmf index has been used extensively for years and has gained wide acceptance throughout the world (Kingman and Selwitz, 1997; WHO, 1979).

The recommended diagnostic threshold for epidemiological surveys has been dentinal caries (WHO, 1997). However, the decline in the prevalence of caries has made the dmft index less informative regarding the changes in caries prevalence (Kingman and Selwitz, 1997); using the criteria of enamel caries may better reveal the changes in areas with lower caries prevalence. This is the case with the primary teeth of young children with rare dentinal caries (Drury et al., 1999). The reliability of diagnosing enamel caries is usually lower than that for dentinal caries (Ismail, 1997). There exists, however, some evidence that achieving good reliability in diagnosing enamel caries may be possible if suitable training is provided (Pitts, 1997).

A great variety of definition and diagnosis of ECC is used worldwide, and a clear classification is still to be developed (De Grauwe et al., 2004). ECC has been referred to as the caries on primary maxillary incisors; the number of maxillary incisors included in the case definition ranges from one to four teeth (Jose and King, 2003; Ismail and Sohn, 1999; Milnes, 1996). ECC has also been defined as the presence of any dmf teeth, regardless of being anterior or posterior (Carino et al., 2003). These definitions all focus on dentinal caries. Drury et al. (1999) defined ECC as the presence of one or more decayed (enamel and dentinal

caries), missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months age or younger. This definition has been adopted by the AAPD (2000) and afterwards by several researchers (Tsai et al., 2006; Hardison et al., 2003; Psoter et al., 2003; Shiboski et al., 2003).

### **2.1.2. Global prevalence of ECC**

Relatively few studies cover ECC prevalence in infants and toddlers, and the data available often are grouped into broad age categories. In general, the prevalence of caries in preschool children seems to be on the decline or the trend has reached a plateau in most of the developed countries (Nordblad et al., 2004; Holm, 1990) but may be increasing in some developed and several developing countries (CDC, 2007a; Pitts and Palmer, 1995). A considerable proportion of preschoolers thus are still affected by dental caries.

A comprehensive review of the occurrence of the caries on maxillary anterior teeth in children, including numerous studies from Europe, Africa, Asia, the Middle East, and North America, found the highest caries prevalence in Africa and South-East Asia (Milnes, 1996).

In Europe (Table 2.1.), investigations in England, Sweden, and Finland have reported the prevalence of ECC in those about three years old to range from below 1% to 32% (WHO, 2007a; Davies et al., 2001; Douglass et al., 2001). The prevalence is as high as 56% in some Eastern European countries (Szatko et al., 2004). Caries prevalence in US preschool children has been reported to be 17%; however, in various studies this prevalence has ranged from 4% to the more than 90% in some Native American populations (Berkowitz, 2003; Douglass et al., 2001; Reisine and Douglass, 1998; Tang et al., 1997; O'Sullivan et al., 1994). In Latin America, the prevalence of caries has been as high as 46% in 25- to 36-month-olds (Rosenblatt and Zarzar, 2002) and 67% in Native Canadian three-year-olds (Peressini et al., 2004).

In Asia (Table 2.2.), in the Far East region which seems to have one of the highest prevalence and severity for the disease, the prevalence in three-year-olds ranges from 36% to 85% (Tsai et al., 2006; Carino et al., 2003; Jin et al., 2003; Douglass et al., 1995; Mayanagi et al., 1995; Fujiwara et al., 1991), while in India a prevalence of 44% has been reported for caries in 8- to 48-month-olds (Jose and King, 2003). ECC has been considered at epidemic proportions in the developing countries (Weinstein et al., 1994). In the Middle East, the prevalence of caries

in three-year-olds has been reported as between 22% and 61% (Rajab and Hamdan, 2002; Al-Malik et al., 2001; Al-Hosani and Rugg-Gunn, 1998) and in Africa between 38% and 45% (Kiwanuka et al., 2004; Masiga and Holt, 1993).

Table 2.1. Prevalence and severity of ECC in countries in Europe, and in North and South America.

<b>Author</b>	<b>Year of report</b>	<b>Country</b>	<b>Age group</b>	<b>% with dmft &gt; 0</b>	<b>dmft</b>
Davies et al.	2001	England	36-49 mos	32	1.4
Hinds & Gregory	1995		18-30 mos	4	
			30-42 mos	14	
WHO <sup>a</sup>	2005	Sweden	3 yr	5	
Grindefjord et al.	1995		24-36 mos	11	
Hallonsten et al.	1995		18 mos	2	
Schroder et al.	1994		12-23 mos	1	
Wendt et al.	1991		12-14 mos	1	
			23-26 mos	8	
Nordblad et al.	2004	Finland	3 yr	16	0.3
WHO <sup>a</sup>	1997		3 yr	0	
Alaluusua & Malmivirta	1994		19 mos	8	
			36 mos	14	
Paunio et al.	1993		3 yr	6	
WHO <sup>a</sup>	1994	Italy	3 yr	1	0.3
Szatko et al.	2004	Poland	3 yr	56	2.9
Lopez Del Valle et al.	1998	Island	13-18 mos	11	
			19-24 mos	21	
			25-36 mos	27	
			37-48 mos	50	
Douglass et al.	2001	US	13-24 mos	4-13	
			25-36 mos	17-25	
			34-36 mos	25	
Tang et al.	1997		1 yr	6	
			2 yr	22	
			3 yr	35	
O' Sullivan et al.	1994	Native American	0-3 yrs	44-90	
Peressini et al.	2004	Canada, Manitoulin	3 yr	67	3.5
Rosenblatt & Zarzar	2002	Brazil	12-18 mos	9	0.4
			19-24 mos	28	1.5
			25-36 mos	46	2.0

<sup>a</sup> World Health Organization (WHO). Available at <http://www.whocollab.od.mah.se/euro/> (2007a)

**Table 2.2.** Prevalence and severity of ECC in countries in Asia and Africa.

Author	Year of report	Country	Age group	% with dmft > 0	dmft
King et al.	2003	China	0-4 yr	18	
Du et al.	2000		3 yr	36	
Douglass et al.	1995		3 yr	67	3.5
Mayanagi et al.	1995	Japan	2 yr	43	1.8
			3 yr	72	4.0
Tsubouchi et al.	1994		12-23 mos	13	
Fujiwara et al.	1991		1-1.5 yr	2	0.1
			1.5-2 yr	5	0.5
			2-2.5 yr	26	3.2
			2.5-3 yr	37	6.3
Tsai et al.	2006	Taiwan	1 yr	0	0
			2 yr	5	0.1
			3 yr	66	2.6
Vachirarojpisan et al.	2004	Thailand	11-14 mos	11	0.3
			15-19 mos	41	1.3
Carino et al.	2003	Philippines	3 yr	85	7.4
Jose & King	2003	India	8-48 mos	44	1.8
Rajab & Hamdan	2002	Jordan	1 yr	8	0.2
			2 yr	21	1.2
			3 yr	22	1.7
Hattab et al.	1999		12-23 mos	13	
			24-35 mos	21	
			36-47 mos	34	
Al-Hosani & Rugg-Gunn	1998	United Arab Emirates	2 yr	36-47	1.7-3.2
Al-Malik et al.	2001	Saudi Arabia	3 yr	61	3.6
Masiga & Holt	1993	Nairobi	3 yr	38	1.4
Kiwanuka et al.	2004	Uganda	3 yr	45	1.7
Roberts et al.	1993	South Africa	12-48 mos	37	

### 2.1.3. ECC in Iranian children

In Iran, studies conducted in children under age three are rare. The countrywide report for Iran (Samadzadeh et al., 1999) gives a prevalence of 47% for ECC in three-year-old children using the criteria of two affected maxillary incisors (mean dmft = 1.8). It mentions that approximately 98% of the dmft is due to caries. As a probable future for these three-year-olds, by six years of age the prevalence of caries in the primary dentition increases to 86% with a mean dmft of 4.8, which is much higher than the WHO goals for caries level in the primary dentition for the year 2000 (WHO, 2007b). Moreover, the latest country report (unpublished data for 2000) denotes a slight increase in the caries experience of three-year-



olds (mean dmft = 1.9). As Iran is one of the countries with the youngest populations in the world, 13% under age six, this increase in caries experience should be considered an alarming finding, regarding public health issues.

#### **2.1.4. Public health challenges regarding ECC**

This disease is more common in developing countries and among minorities in developed countries. Given the extent of the problem and regarding the responsibility of public health systems for controlling diseases of the disadvantaged, ECC continues to be a major public health problem (Tickle, 2006; WHO, 2003a; Weinstein, 1998; Milnes, 1996). It is not life-threatening, but its impact on individuals and communities, as a result of pain and suffering, impairment of function and reduced quality of life, is considerable (WHO, 2003a). The problem may spread, as ECC may also lead to more caries in the primary dentition and also in the mixed and permanent dentition (Ismail, 2003; Peretz et al., 2003; Shiboski et al., 2003; Warren et al., 2002; Almeida et al., 2000; Du et al., 2000; O'Sullivan and Tinanoff, 1996, Johnsen et al., 1986).

ECC's social and economic burdens make it a subject of great concern. The traditional restorative treatment for ECC is extremely costly (WHO, 2003a). Estimate for the cost of treatment averages around 400 United States Dollar (USD) for a dmf of 2 to 5 and if general anesthesia is needed, the total cost of treatment has been estimated to be 6000 USD per case (Ramos-Gomez et al., 1996). In fact, the restorative approach seems not to be cost-effective in many countries (Robert and Sheiham, 2002). While the cost of treatment appears to be high, it is important to note that only a minority of poor children have access to dental services (Weinstein, 1998). Most developing countries lack resources to meet the costs of treatment for dental caries in children (WHO, 2003a). More emphasis should therefore be put on prevention as denoted by the Ottawa charter (WHO, 1986) and suggested by WHO global oral health goals for the year 2020 (Hobdell et al., 2003).

The re-orientation of public health services from a restorative approach toward prevention cannot be successful without engaging the community. The assistance of the private dental sector and medical professionals in the community is essential. Public health authorities can organize, supervise and pay for the services carried out in the private sector (Milen et al., 1988). Establishing good oral health behaviors in infancy and early childhood is crucial for long-term oral health (WHO, 2003a). Understanding the etiology of the disease has a direct

influence on public health policy (Harris et al., 2004). Various parenting practices such as feeding and oral hygiene practices are implicated as risk factors for ECC, all being under influence of cultural, ethnic, and familial rules (Weinstein, 1998). Reliable estimates of the prevalence of ECC in each community, assessment of beliefs, values, perception, and behavior of parents, public health providers, and decision-makers regarding ECC seem to be essential prior to implementing a public health intervention for ECC.

## 2.2. Socio-behavioral aspects and ECC

In general, dental caries is considered a social and life style disease with its main etiologic factors being a) fermentable carbohydrates, b) cariogenic bacteria, c) a susceptible tooth, and d) length of exposure (Burt, 2005; Reisine and Douglass, 1998; Seow, 1998; Keyes, 1960). In young children there may be unique behavioral patterns associated with feeding habits and oral hygiene (Seow, 1998). In addition, as the children are in the stage of primary socialization, their childhood behaviors will persist into maturity. A number of behavioral, demographic, and clinically evident risk factors exist that may be related to risk for ECC. Among these, feeding habits and the baby bottle in particular, sugar intake, oral hygiene and daily toothbrushing do feature, all being influenced by parents' oral health conceptions and behaviors (Harris et al., 2004).

### 2.2.1. Demographic characteristics

Two major demographic factors have been addressed regarding the risk for ECC: socioeconomic status (SES), and race or ethnicity. SES is usually a mix of years of education, current income, and occupation held (Burt, 2005; Reisine and Psoter, 2001). Social class may influence caries risk in several ways: Individuals from lower SES groups experience financial, social, and material disadvantages that compromise their ability to care for themselves, obtain professional health care services, and live in a healthy environment (Reisine and Douglass, 1998). In addition, low-SES individuals have more fatalistic beliefs about their health and have a lower perceived need for care, leading to less self-care and lower utilization of preventive health services.

The possible influence of SES on dental health may also be a consequence of differences in dietary habits and the role of sugar in the diet (Ismail et al., 1997). In their summary evidence

on inequalities in oral health, Sheiham and Watt (2000) state that the main causes of inequalities in oral health are differences in patterns of consumption of non-milk sugars and fluoride toothpaste.

A discrepancy exists regarding the relationship between parents' SES and childhood caries rates. An inverse relationship between caries development in children and higher SES has been shown in several studies (Peres et al., 2005; Sayegh et al., 2005; Vachirarojpisan et al., 2004; Tinanoff et al., 2002; Vargas et al., 2002; Al-Malik et al., 2001; Gillcrist et al., 2001; Reisine and Psoter, 2001; Chu et al., 1999; Ismail, 1998; Beck et al., 1992), whereas some other researchers have failed to show such a clear relationship (Declerck et al., 2008; Du et al., 2000; Masiga and Holt, 1993).

A systematic review suggests that ECC is more common in children who live in poverty or poor economic conditions, those born to single mothers, and those with parents of low educational level, especially of illiterate mothers (Ribeiro and Ribeiro, 2004). The Second International Collaborative Study observed the impact of educational background on prevalence of dental caries for all countries but found it to be particularly strong when caries prevalence was high (Petersen, 2005; Chen et al., 1997).

In addition to SES, it has been suggested that ethnic minorities show an increased risk for caries (Ribeiro and Ribeiro, 2004; Shiboski et al., 2003; Davies et al., 2001; Kaste et al., 1996). However, it has been difficult to separate the cultural influences of ethnicity from the effects of low SES on prevalence of dental caries (Reisine and Douglass, 1998). Montero et al. (2003) found no significant differences in caries level when analyzed by ethnicity. Immigrant background has been reported to have a significant association with caries prevalence in children (Stecksen-Blicks et al., 2004). Reports of the influence of ethnicity on caries prevalence are difficult to compare due to the variety of definitions to assess ethnicity, ranging from nationality to origin or roots, and due to variation in confounding factors, such as dietary and oral hygiene habits (Vanobbergen et al., 2001).

In Iran, 55% of those entering universities are women. In general, 10% of women have a university education, 75% to 80% have an elementary to high school education while 10% to 15% of women under 40 in the whole country are illiterate (Iran Statistical Yearbook, 2002).

The illiteracy rate for women in Tehran is about 5%. One-third of family income is devoted to housing and less than 10% to health. The average number of children in the family is two and almost 90% of children under three are looked after by their mothers.

### **2.2.2. Behavioral issues in ECC**

It is now widely accepted that dental caries are mostly behavior-related (Petersen, 2003; Schou, 2000; Inglehart and Tedesco, 1995). The fundamental determinants of oral health are related to behaviors such as consumption of sugars, effective control of plaque, and optimal exposure to fluoride (Daly et al., 2002).

#### **Feeding habits**

ECC was historically attributed to inappropriate and prolonged bottle use or breastfeeding as its previous names, such as nursing caries, show. The rationale was the lactose of milk or sugar added to the bottle. Bottle-feeding and sleeping with a bottle have been considered cariogenic in several reports (WHO, 2007c; Azevedo et al., 2005; Hallet and O'Rourke, 2003; Oulis et al., 1999; Davies, 1998; al-Dashti et al., 1995; Johnsen, 1982). Milk-based formulas for infant feeding, even those without sucrose in their formulation, proved cariogenic in some studies (Erickson et al., 1998; Sheikh and Erickson, 1996). Nevertheless, cow's milk contains calcium, phosphorus, and casein, all of which are thought to inhibit caries. Studies have shown that the fall in plaque pH following milk consumption is negligible (Ribeiro and Ribeiro, 2004), and animal studies have shown that cow's milk does not produce caries, and that it has cariostatic action instead (Bowen and Pearson, 1993; Reynolds and Johnson, 1981). Furthermore, Rugg-Gunn et al. (1984) found an inverse relationship between consumption of milk and caries increment in a study of adolescents in England. An important aspect regarding bottle feeding seems to be the length of contact at nighttime. Greater time-length of bottle contact appears to be positively associated with caries (Reisine and Douglass, 1998). Improved research design, including more detailed definition and description of bedtime bottle use could better determine the role of nighttime bottle use in caries development.

Compared to cow's milk, breast milk, has a lower mineral content, a higher concentration of lactose (7% vs. 3%), and lower protein content, but these differences are probably insignificant in terms of cariogenicity (Seow, 1998). The WHO (2003a) has recommended that children be breastfed until age 24 months, because along with the positive health effects

of breastfeeding, several epidemiological studies have associated breastfeeding with lower levels of dental caries than with no breastfeeding (WHO, 2007c). On the other hand, some reports suggest prolonged exposure of teeth to daytime or nighttime breastfeeding (van Palenstein Helder et al., 2006; Azevedo et al., 2005; Sayegh et al., 2005; Valaitis et al., 2000; Davies, 1998) as risk factors for ECC. Based on these reports, weaning from the breast has been recommended by dental professionals soon after the child's first birthday (American Dental Association, ADA, 2007; Valaitis et al., 2000). Breastfeeding has been assumed to be associated with ECC when the consumption pattern was *ad libitum* feeding, frequent breastfeeding, prolonged breastfeeding, and mainly frequent breastfeeding during the night (WHO, 2007c; Ribeiro and Ribeiro, 2004).

In Iran, the health staff recommend breastfeeding for up to 24 months of age. For different reasons such as insufficient breast milk, bottle feeding with formulas may be recommended solely or in combination with breastfeeding. Cow's milk is not recommended before one year of age. After six months of age, the infant starts eating foods such as a soup or mixture containing meat, carrot, potato, green vegetables, rice (or cereal) and butter, all mashed and without spices and additives. Yolk is suggested to be consumed with bread and butter. Mashed fruits and a snack with rice, almond, sugar in milk or water are also commonly used. Three to five meals are usually recommended along with breast- or bottle-feeding. From one year of age onward, the child may eat the same foods and snacks as the other family members.

Thus far, reports on the interplay of the feeding habits and their impact on ECC remain controversial (Gussy et al., 2006; Ribeiro and Ribeiro, 2004; Reisine and Psoter, 2001; Reisine and Douglass, 1998). A wider spectrum of information about feeding habits would probably reveal the factors promoting ECC.

### **Sugar intake**

The recognition that sugars play an etiological role in dental caries has been with us for years (Gussy et al., 2006; Tinanoff et al., 2002; Keyes, 1960). The research in more recent decades has done much to define that role. While there is no question that fermentable carbohydrates are a necessary link in the causal chain for dental caries, recent reviews show the association between sugar intake and dental caries to be less strong as in the pre-fluoride era (WHO, 2007c; Burt and Pai, 2001). This suggests that the widespread exposure to fluoride in

developed societies has prevented dental caries even when the total amount of fermentable carbohydrates consumed has been high (Ismail et al., 1997). In developing societies, where fluoride use and other methods of preventing dental caries are less available, an increase in sugar consumption could thus have a significant detrimental effect on dental health.

The available evidence, although not being scientifically strong (Ismail et al., 1997), indicates that the level of dental caries is low in countries where the consumption of free sugars is below 15-20 kg per person per year (WHO, 2007c). For preschool children, however, the total amount of sugar is not predictive of dental caries, but frequent consumption of sugary snacks has been associated with ECC in some studies (Gussy et al., 2006; Carino et al., 2003; Chan et al., 2002; Reisine and Douglass, 1998). Frequent consumption of sugar favors the establishment of cariogenic bacteria and provides a continuous substrate that influences the initiation and progression of the caries (Gussy et al., 2006). Despite this, some studies have found no such relationship (Kiwanuka et al., 2004; King et al., 2003).

Patterns of sugar consumption are established early in life, and sugar consumption increases during the first two years of life (Rossow et al., 1990). The frequency of consumption of foods or drinks containing free sugars should be limited to a maximum of four times per day (WHO, 2007c). In the Middle East, sugar consumption is higher than in other developing countries (Sayegh et al., 2005) which may, if proper oral health promotion programs are lacking, lead to higher rates of dental caries (Ismail et al., 1997).

Sucrose is the most cariogenic sugar, with glucose, fructose and maltose only slightly less so (WHO, 2007c). Sugar present in fresh fruits and vegetables and in starchy foods is not an important cause of tooth decay (WHO, 2003a). Fruits have been found to be acidogenic, although less so than sucrose. Animal studies have shown that when fruit is consumed at very high frequencies (for instance 17 times a day) it may induce caries, but less so than sucrose (WHO, 2007c).

Antibiotics were previously assumed to have a possible impact by reducing the risk for dental caries, but no caries-reducing effect has been found in this regard (Mariri et al., 2003; Paunio et al., 1993). Antibiotics as well as other pediatric medicines such as powder inhalers and iron drops are considered as sources of sugar intake and are implicated in the increased risk for ECC (Ribeiro and Ribeiro, 2004). The trend to eliminate unnecessary sugars from all

medicines should continue, and as far as possible, all pediatric medicines should be sugar-free (WHO, 2003a).

### **Oral hygiene**

Caregivers should brush children's teeth twice a day using a small soft brush with a dab of fluoride toothpaste (Gussy et al., 2006; Douglass et al., 2004; Tinanoff et al., 2002). Excess toothpaste should be spit out, but rinsing should be discouraged because residual fluoride toothpaste on the teeth increases the caries preventive effect (Chestnutt et al., 1998). As young children lack the ability to clean their own teeth effectively, parents are recommended to clean their children's teeth at least until they reach school age (ADA, 2007; Choo et al., 2001).

Toothbrushing on a daily basis as opposed to less than daily seems to be the most important factor related to a decreased risk for ECC. In comparison, other factors such as the frequency of toothbrushing more than once a day, age at which brushing was started, parental supervision of toothbrushing, not having teeth brushed at bedtime, and use of fluoridated as opposed to non-fluoridated toothpaste are less important in increasing the risk for ECC (Harris et al., 2004). However, one systematic review (Reisine and Psoter, 2001) suggests that as most studies report that the teeth were brushed with fluoridated toothpaste, it is difficult to distinguish whether the effect of toothbrushing is a measure of fluoride application or whether it is the result of mechanical removal of plaque. In general, there is convincing evidence for the decay-preventing benefit of toothbrushing when used with fluoride toothpaste (Gussy et al., 2006; Marinho et al., 2003; Davies et al., 2002; Kay and Locker, 1998).

The majority of children (76%-99%) start toothbrushing before two years of age in several developed or developing countries (Pine et al., 2004). In Iran, the countrywide report (Samadzadeh et al., 1999) states that oral cleaning was practiced for only 59% of the three-year-olds, more commonly in children of highly educated parents. The association between more frequent toothbrushing and higher SES has also been clarified in some studies (Szatko et al., 2004; Paunio, 1994). Few studies, however, are available about these associations in very young children (Szatko et al., 2004; Paunio, 1994; Paunio et al., 1993; Blinkhorn, 1981).

### ***Dental plaque***

Dental plaque can serve as a proxy for oral cleaning. The presence of visible plaque and its early accumulation have been related to caries experience among children (Sayegh et al., 2005; Kiwanuka et al., 2004; Tinanoff et al., 2002; Habibian et al., 2001; Karjalainen et al., 2001; Beck et al., 1992). Alaluusua and Malmivirta (1994) have found that 91% of the children were correctly classified into caries risk groups solely based on the presence or absence of visible plaque. Despite that, the WHO database has provided no data regarding dental plaque in the youngest children.

The caries process is initiated in biofilm or dental plaque. The bacteria in the biofilm are always metabolically active, causing fluctuations in pH (Kidd and Fejerskov, 2004). The current concept of dental caries centers on the fermentation of carbohydrates by cariogenic plaque bacteria, producing organic acids which act on a susceptible tooth (Seow, 1998).

The primary caregiver of the infant, usually the mother, has been shown to provide the reservoir of Mutans streptococci (MS), the main cariogenic bacteria implicated in the initiation as well as in the progression of ECC, in the child (Gussy et al., 2006; Tinanoff et al., 2002; Seow, 1998). The exact method of transmission is unknown, but it is suspected to be due to close contact and sharing of food and eating utensils (Wan et al., 2001; Seow, 1998; Caufield et al., 1993). Mothers with infected infants had poorer oral hygiene, more periodontal disease, and lower SES, and snacked more frequently than did mothers with non-infected infants (Wan et al., 2001).

### **2.2.3. Formation of oral health behaviors**

Health behaviors are closely connected with ways of living. Theories from sociology, education, and psychology describe learning and behavioral change in any individual as well as in mothers of young children. The importance of family support in the development of appropriate oral health behaviors of children has been emphasized in the literature (Pine et al., 2000; Paunio, 1994; Grytten et al., 1988).

### **Models of health behavior**

#### ***Health Belief Model***

The Health Belief Model (HBM) is useful in predicting the likelihood of an individual's compliance with recommendations for preventive health behaviors (Overton Dickinson,



2005). This model was first introduced by Rosenstock et al. (1988) but remains a major construct that is still consulted for understanding behaviors (Daly et al., 2002; Søggaard, 1993). It is based on the theory that behaviors are directed by perceptions and beliefs and suggests that whether or not a person engages in preventive health action depends on these beliefs (Overton Dickinson, 2005). Additionally, cues or triggers such as a comment from a trusted friend or even a piece of information on the television that foster the behavior must be present (Daly et al., 2002). In short, it provides an outline of the essential factors involved in behavioral change and is probably the model most frequently used in health education research (Overton Dickinson, 2005; Søggaard, 1993).

The HBM can be a useful tool for designing change strategies, as well (Overton Dickinson, 2005). Early cross-sectional studies using the HBM to analyze preventive oral health behaviors were successful in differentiating those who brushed, flossed or visited the dentist from those who did not (Reisine and Douglass, 1998), although reservations have also been reported (Søggaard, 1993).

### ***Motivation and learning***

Motivation, which can be explained as the will to act, is an important factor in learning. It is either intrinsic (from within oneself) or extrinsic (from an outside source) (Overton Dickinson, 2005). Human Motivation Theory offers several models for understanding the internal and external forces that can move an individual to action.

Motivation, support, and education are the key factors in prevention programs that need to be emphasized in the future. The motivating and learning approach appears to be useful in dental settings, especially in periodontal maintenance (Wilson, 1998). Motivation counseling can help in reducing dental caries in young children (Weistein et al., 2004). Reinforcement by external motivation supports behavioral change (Overton Dickinson, 2005), and early oral health education combined with some external motivation can be a valuable tool to prevent caries in young children.

### **Cultural influences on oral health beliefs and behaviors**

To understand why patients engage in risk behaviors associated with their oral health, health practitioners need to understand the patient's cultural background (Broder et al., 2003).

Without this understanding, miscommunication occurs and can lead to adverse health outcomes.

Behavioral norms essentially are shared beliefs, values or practices that societies impose on individuals, and mothers or caregivers are unlikely to administer procedures or practice behaviors that are not shared by the community in which they live or the cultural subgroups to which they belong (Horowitz, 1998). Infant feeding practices are heavily influenced by cultural factors including social and family norms (Gussy et al., 2006). It thus seems important that educational efforts to establish behavioral norms for good oral health for infants and toddlers must be widespread and acceptable to the local cultural group. Efforts may be facilitated by using health care workers and educators who are members of the community (Horowitz, 1998).

### **Formation of oral health behaviors in early childhood**

The formation of habits is part of the complex process of socialization. Habits develop under norms appreciated in the parental culture and are affected by not only the knowledge but also one's values, attitudes of the individual's immediate environment, and a parent's personal habits (Petersen, 2007). The establishment of oral self-care is acquired by learning from models as part of the primary socialization process (Åstrom, 1998; Grytten et al., 1988). The modeling process succeeds only if the model is of high status, and the child has a positive emotional charge toward it (Overton Dickinson, 2005; Paunio et al., 1993). Because the family is the child's most dominant social environment in early childhood, the role of family and the mother is the most important in transmitting socialization. In this regard, parents' beliefs regarding regular toothbrushing for their children and their own toothbrushing has been positively associated with the oral cleaning behaviors of their children (Okada et al., 2002; Mattila et al., 2000; Pine et al., 2000; Paunio, 1994; Hyssälä et al., 1991; Blinkhorn, 1981). Furthermore, children's oral self-care is better when their mothers undertake regular check-ups (Gratrix et al., 1990). The introduction of sugary foods and drinks at an early age also leads to the establishment of a habit that persists into maturity (Chan et al., 2002).

## 2.3. Prevention of ECC

Most interventions to prevent or arrest ECC have focused on reducing the availability of refined carbohydrate, reducing microbial burden, increasing resistance of the teeth, or a combination of these approaches (Gussy et al., 2006; Featherstone, 2004)

### 2.3.1. Prevention approaches

Preventive strategies are divided into two distinct groups: strategies aimed at the whole population, whether diseased or not, and those aimed at groups or individuals at risk (Rose, 2001; Twetman et al., 2000).

A population strategy, which focuses on health and the causes of occurrence of dental disease, is feasible in populations with a high prevalence of oral diseases (Twetman et al., 2000). In population strategy, efforts are to shift the risk distribution of the entire population to a more favorable level. This was the dominant approach during the high caries area in the 1970s and 1980s. Examples of such population strategies are water fluoridation, comprehensive use of fluoride toothpaste, and mandatory recalls for dental education (Twetman et al., 2000; Burt, 1998). It is suggested that dental caries might be better prevented by concentrating on a population approach, as new caries will also occur in those with low levels of disease (Daly et al., 2002).

Targeting individuals at risk attempts to protect susceptible individuals from developing further disease by changing their risk factors (Rose, 2001). This approach is advocated in countries with decreased prevalence and increasing polarization of caries (Twetman et al., 2000). A risk approach seeks to identify through screening and protect susceptible individuals or sections of the population, either as a group or as individuals.

The effectiveness of a risk approach at individual level has been questionable in some studies (Seppä, 2001). The accuracy of identifying the individuals at risk is low, whereas communities at risk can be defined, such as low-SES groups. Therefore, at the public health level it has been argued that a policy for caries-preventive strategies should be based on a "population" or "directed population" approach (Batchelor and Sheiham, 2002). Health promotion involves the population as a whole in the context of their everyday life, rather than

focusing only on people at risk for specific diseases, by attempting to influence the social norms within society and promoting the positive benefits of healthy behaviors (Daly et al., 2002). Population strategies and risk strategies are not to be regarded as alternatives, can, however, be applied together both to reduce the general level of risk factors in the population and to control the disease in individuals with high disease activity (Daly et al., 2002; Twetman et al., 2000).

### **2.3.2. Community-based measures**

Based on the role and the responsibility of the main decision-maker to carry out the measures, dentistry has several caries preventive measures to offer. There are three principal measures to prevent ECC: 1) Community-based measures, 2) Professional measures and 3) Home-care measures (Twetman et al., 2000; Ismail, 1998). Community-based measures are mainly organized and provided by public health authorities and need to be funded and carried out nationwide. Examples of such measures are national educational programs and water fluoridation. Professional measures are conducted at the dental office by a dental professional. The home-care measures include the development and support of self-care habits and emphasize the patient's own responsibility in managing the disease, such as with oral hygiene routines and dietary and feeding habits.

Oral health problems have risk factors in common with a number of important general health chronic diseases and conditions, and it seems wasteful to target each disease separately when they have similar origins (Sheiham and Watt, 2000). As regards to young children, despite the suggestion by dental professionals that the child's first dental visit should occur by the time of first tooth eruption and no later than one year of age (AAPD, 2007; Twetman et al., 2000), the majority of children are not examined by a dentist until they reach three years of age (Douglass et al., 2004; Wendt et al., 2001; Samadzadeh and Bayat, 1999; Kamp, 1991). Consequently, it is highly recommended that oral health promotion and oral disease prevention should be integrated into broader health promotion (Petersen and Kwan, 2004). The integration of oral health into general health, utilizing the existing maternal and child services should be based on the assumption that ECC is an infectious disease relating to behavioral and social factors, with its prevention being a public, not an oral health goal (Weinstein, 1998). Community-based oral health education delivered in general health settings can achieve wider coverage of a population at a lower cost and may reduce inequalities in children's oral health. The related strategies are included in the Ottawa Charter

for Health Promotion (WHO, 1986): community action and support, environmental change, legislation, improving personal skills, and empowering people to become stakeholders in society and to challenge the structures which determine their health.

### **2.3.3. Measures for preventing ECC**

In general, all measures for caries control aim to prevent the onset of caries, to arrest progression of caries lesions manifested both sub-clinically and clinically, and even to repair them (Winston and Bhaskar, 1998; Ten Cate and Duijsters, 1982). Prevention of ECC might be achieved by education of prospective and new parents on good oral hygiene and dietary practices, by agents such as fluoride, and by use of non-cariogenic sweeteners (Featherstone, 2006; Kowash et al., 2000).

#### **Dietary modification and oral hygiene**

Dental caries cannot occur without the substrate component of sugar. Therefore, much professional advice and practical research has focused on modification of the infant diet and feeding habits through education of the parents (Gussy et al., 2006). The possibility of behavioral changes in dietary practices is, however, still controversial. A community-based oral health education program mainly focusing on changing the undesirable feeding habits of infants and toddlers showed an overall reduction of 25% in the prevalence of ECC among children during three years (Ismail, 1998). Conversely, some have found that despite their knowledge of the association between sweet fluids in the bottle and dental caries, parents continue to add refined carbohydrates to their children's bottle (Gussy et al., 2006).

The effectiveness of oral hygiene measures in young children depends on the attention and awareness of caregivers (Twetman et al., 2000). A systematic review (Kay and Locker, 1996) suggests that behaviors such as toothbrushing can be changed to some extent. Desirable oral hygiene practices have been established in children by training and counseling their mothers (Nurko et al., 2003; Rong et al., 2003).

#### **Fluorides**

The effect of fluoride in reducing caries is well established. Fluoride may be delivered in two ways: topically and systemically. The topical modalities mainly include fluoride toothpaste, fluoride varnishes, gels, and mouth rinses. The widespread use of fluoride toothpaste is thought to have made a significant contribution to the overall reduction in caries over the past

three decades (Gussy et al., 2006; Jones et al., 2005; Newbrun, 1989). Furthermore, the results of a recent systematic review suggest fluoride toothpaste to be the most cost-effective home-care measure for prevention of ECC (Twetman, 2008). The recommendation to use fluoride toothpaste should be accompanied with population-based health education to improve oral health at all ages from infancy onward (Jones et al., 2005; Seppä, 2001; Twetman et al., 2000). Because small children usually swallow 30% of the paste, it is important to limit the amount of toothpaste to a pea size or less (Gussy et al., 2006; Twetman et al., 2000). According to Douglass et al. (2004), the amount of toothpaste should not exceed the size of a rice grain or the tip of a pencil eraser for children as young as 6 to 12 months of age. Fluoride products such as toothpaste, mouth rinse, and dental office topicals have been shown to reduce caries between 30% and 70% compared with no fluoride therapy (Featherstone, 2004; Jenkins, 1985).

The most common method for systematically applied fluoride is fluoridated drinking water shown to be effective in reducing the severity of dental decay in entire populations (Featherstone, 2004). Reductions in childhood dental caries attributable to fluoridation were approximately 40% to 60% from 1949 to 1979, but in the next decade, the estimates were lower: from 18% to 40% (CDC, 2001; Evans et al., 1996; Newbrun, 1989). This is likely caused by the increasing use of fluoride from other sources, with the widespread use of fluoride toothpaste probably being the most important factor (Seppä, 2001; Twetman et al., 2000; Ismail, 1998).

In Iran, all adults' toothpastes contain fluoride, but for children non-fluoridated brands also exist. While fluoride varnishes are not common, fluoride gels are available and are more or less applied free of charge or at a subsidized price in public health centers for the children. Daily or weekly fluoride mouth rinses are both available, the one most commonly used being weekly 0.2% NaF mouth rinse which is delivered free of charge to all school children (Samadzadeh and Bayat, 1999). Drinking water contains less than 0.3 parts per million (PPM) fluoride in most of Iran's northern and western provinces. Central and eastern areas contain 0.3-0.6 PPM, while in southern Iran some provinces have more than 0.6 PPM (0.6-1.3 PPM) of fluoride in their drinking water (Unpublished data).

## **Xylitol**

One of the most significant contributions to dental caries is the frequency of ingestion of fermentable carbohydrates. One solution is reducing the frequency of ingestion, which is a behavioral subject. However, substituting for the fermentable carbohydrates such as sucrose such non-cariogenic sweeteners as xylitol has been effective in reducing caries (Scheinin et al., 1976) or the pathological challenge (Söderling et al., 2000; Mäkinen et al., 1989) in individuals. Several clinical studies have shown that consumption of xylitol reduces the incidence of dental caries in school children (Honkala et al., 2006; Alanen et al., 2000; Isokangas et al., 1993, 1991, 1988). Consumption of xylitol by mothers prevents the transmission of MS, and this has been effective in reducing the MS count in children (Söderling et al., 2000). When xylitol gum or candy were used several times daily, the effectiveness in prevention of dental caries in the permanent teeth ranged from 30% to 60% (van Loveren, 2004). Applying xylitol chewing gums or candies in caries prevention for infants and toddlers might be rather impractical except for involving their mothers. The effectiveness of mother-targeted interventions in terms of costs, compliance, and motivation needs further investigations (Twetman et al., 2000).

### **2.3.4. Oral health education**

Oral health education is a designed package of information, learning activities, or experiences that are intended to produce improved oral health (Overton Dickinson, 2005). With the primary goal of disease prevention, its purpose is to facilitate decision-making for oral health practices and to encourage appropriate choices for these behaviors.

Effective health education may thus (Adair and Ashcroft, 2007):

- Produce changes in knowledge
- Induce or clarify values
- Bring about some shift in belief or attitude
- Facilitate the achievement of skills
- Effect change in behaviors or lifestyle

During recent decades, oral health education has been considered an important and integral part of dental health services (Overton Dickinson, 2005; Kay and Locker, 1996). Oral health education has evolved from the traditional approach of solely providing information for the

target population into the new approaches that incorporate various models of sociology, psychology, and learning styles in order to facilitate learning and behavior change.

All health education messages should be simple, consistent and evidence-based (Twetman et al., 2000). Not all oral health education activities produce positive changes in oral health behaviors. To be successful, an oral health education plan must assess and accommodate the knowledge levels, cultural norms, values, beliefs, attitudes, opinions, psychological factors and environment of the intended audience (Overton Dickinson, 2005, Twetman et al., 2000).

Brown (1994) reviewed 57 of the various types and combinations of educational and behavior modification techniques with subjective approach. He concluded that oral health education can result in improvements in oral health behaviors and objective measures of oral health status but is less effective in changing attitudes and knowledge. On the contrast, a systematic review and meta analysis on effectiveness of oral health education (Kay and Locker, 1996) indicated that oral health knowledge and attitude can be improved through education. However, the changes in gingival health, if any occurred, were usually small and of unknown clinical significance, and for plaque a small reduction occurred. Later, Kay and Locker, based on their second review (1998), concluded that oral health promotion is successful in reducing caries if it leads to increased use of fluoride-containing agents. Recently, some studies on oral health education and dietary counseling for mothers of very young children have reported promising findings in caries prevention (Felden et al., 2007, Rong et al., 2003; Ekstrand et al., 2000). Oral health education programs, as part of general health services throughout infancy and toddler stages, may succeed in helping parents adopt healthy habits before non-desirable habits get established (Harrison and Wong, 2003; Kowash et al., 2000).

The increasing pressure on health care resources raises questions about the cost-effectiveness of all forms of health service provision. This is also the case with respect to preventive interventions, since they have long been presumed to reduce disease, and therefore lower the demand for health services and the resultant costs (Kay and Locker, 1996). A recent report (Kowash et al., 2006) shows the best cost-benefit ratio for an oral health education program compared to several other prevention programs including water fluoridation, fissure-sealant therapy, and a slow-releasing fluoride device.



Health professionals have an ethical responsibility to spread information about disease and its prevention to the whole population irrespective of what population does with the knowledge; the ultimate goal is to effect behavior change, encourage healthy lifestyle and promote health (Kay and Locker, 1996). Thus far, the evidence of effectiveness for oral health promotion and educational activities against dental caries is rated insufficient as regards the very small number of studies, their poor quality, and inconsistent findings (Adair and Ashcroft, 2007; Rozier, 2001).



### **3. AIM OF THE STUDY**

#### **3.1. General aim**

The general aim of the study was to determine the prevalence of and risk factors for ECC in children 12 to 36 months of age and to evaluate the impacts of an educational intervention on ECC prevention in a community with a very young population and developing oral health system.

#### **3.2. Specific aims**

To achieve the general aim, the following specific aims were set:

1. To describe the occurrence and intensity of ECC in infants and toddlers and the visible plaque on upper central incisors of these children in Tehran, Iran (I, II, III).
2. To investigate factors related to the child's good oral hygiene and the relationship between oral hygiene and ECC (I, III).
3. To analyze impacts of feeding habits and daytime sugar intake on ECC occurrence (II).
4. To evaluate the impact of an educational intervention on ECC in infants and toddlers (IV).

#### **3.3. Hypotheses**

Working hypotheses in the study were as follows: among these young children,

- a) ECC is related to their feeding habits, oral hygiene, and to their mothers' oral health behaviors.
- b) Improvement in their oral health can be achieved through oral health education provided to the mothers by the non-dental staff of public health centers.



## 4. SUBJECTS AND METHODS

The present study is part of a joint program between the University of Helsinki, Finland and Shaheed Beheshti Medical University, Iran, initiated by WHO, Eastern Mediterranean Regional Office (EMRO) in 2002.

### 4.1. General description of the study

The target population included children between 12 and 36 months of age and their mothers attending the vaccination and development assessment offices of the public health centers of Tehran city. Both cross-sectional and longitudinal designs were used in this study. The cross-sectional part was carried out on 12- to 36-month-olds and the interventional part on the cohort of 12- to 15-month-olds.

Preceding the vaccination, the mother was first interviewed with a questionnaire, and the child's clinical dental examination was carried out in a private room close to the vaccination room. In those health centers randomly assigned to take part in the intervention, mothers with 12- to 15-month-old children received education on caries prevention from the vaccination staff. The length of follow-up was six months. The outcome was measured as differences in increments of enamel and dentinal caries and as mothers' perceptions about the usefulness of intervention.

### 4.2. Study backgrounds

Iran covers an area of 1.6 million km<sup>2</sup> with a population of about 70 million and a growth rate of 1.5% annually (Iran Statistical Year Book, 2002). Of the whole population, 13% are under six years of age, making Iran one of the countries with the youngest population in the world (Pakshir, 2004). The capital city is Tehran with about eight million inhabitants.

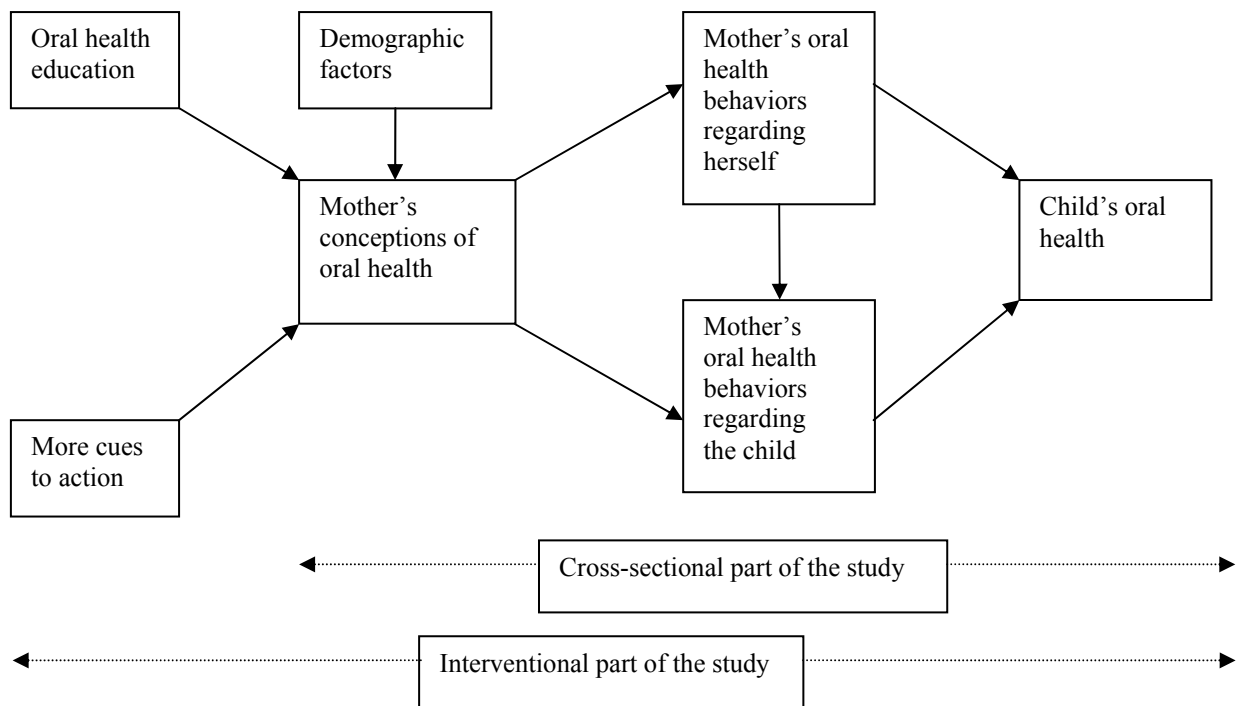
Health services are provided by both private and public sectors. In 1972, in collaboration with WHO, a pilot study of an integrated health system in one province led to establishing health houses and training auxiliary local health workers in the public health sector. Later, a more organized health system for a more equitable allocation of resources for primary health care

was established all over the country. However, oral health care was integrated into the countrywide primary health care network no earlier than 1997. The integrated oral health system is mainly focusing on 6- to 12-year-olds by means of a school-based national program, and on pregnant or lactating mothers to provide them preventive and restorative dental treatments (Pakshir, 2004). Public health centers comprise of departments for mother and child health, family planning services, vaccination, general health, professional health, and in 60% of the centers, oral health. The coverage of vaccination is between 94% and 98% in the whole country (WHO, 2007d).

In several countries and also in Iran, the majority of young children are not examined by a dentist until they reach three years of age (Douglass et al., 2004; Wendt et al., 2001; Samadzadeh et al., 1999; Kamp, 1991) due to demographic and behavioral barriers, and sometimes unavailability of dental service. This aspect provides the rationale to integrate oral health promotion and oral disease prevention into broader health promotion programs for these children (Petersen and Kwan, 2004).

### 4.3. Theoretical model of the study

The theoretical framework for the present study (Figure 4.1.) was based on HBM that explains the behaviors to be directed by perceptions and beliefs and suggests the situations in which a person engages in preventive health actions (Overton Dickinson, 2005; Sogaard, 1993; Rosenstock et al., 1988). The model suggests mothers' conceptions of oral health to be affected by demographic characteristics and direct their oral health behaviors regarding themselves and their children. These oral health behaviors, including feeding habits, sugar intake, oral cleaning and oral hygiene, determine the children's oral health status (applied in the cross-sectional part of this study: I, II, III). In this model, oral health education (interventional part: IV) may change the mothers' conceptions of their children's oral health and also in regards to their own oral health. Extra motivation such as reminders during the intervention period will act as more cues to action and help in establishing desirable oral health behaviors in mothers. The mothers' desirable oral health behaviors regarding their children or themselves will lead to the better oral health of the children.



**Figure 4.1.** Theoretical model of the study, modified from the Health Belief Model (HBM) by adding mother and child aspects (Rosenstock et al., 1988)

#### 4.4. Pilot study

Before the study, a pilot study was carried out in a health center on 10 children and their mothers, outside of the study population, mainly to assess the feasibility of the study.

Based on experience in the pilot study, minor revision was done on the questionnaire by adding and omitting some questions after the pilot study. In addition, for some questions, the response alternatives were expanded to include more possible options.

#### 4.5. Cross-sectional part of the study

##### 4.5.1. Study subjects and data collection

Using a list provided by the Ministry of Health and Medical Education, 18 out of the 102 public health centers were randomly selected to represent the districts in Tehran. The cross-sectional data were collected from January to March 2005. During a period of four working days at each center, between 20 and 35 children were enrolled per center, resulting in a

sample of 504 children comprising 254 boys and 250 girls. The child's age was recorded with an accuracy of within one day. In order to ensure greater homogeneity with regard to the extent of the primary dentition, three age groups were formed: 12 to 15 months (n = 242), 16 to 23 months (n = 156), and 24 to 36 months of age (n = 106). The two youngest groups were somewhat overrepresented due to the recommendation that vaccination should take place at 12 and 18 months of age. In description of caries experience and visible plaque status of these young children more details were presented by dividing the children into four age groups in the first original article. Later, it was decided to regroup the children into three age groups to facilitate further analysis as regards to associating factors.

#### **4.5.2. Survey questionnaire**

The examiner dentist interviewed the mothers with a pre-tested, structured questionnaire which was created according to previous studies with validated questions (Pine et al., 2004; Tseveenjav, 2004; Hallett and O'Rourke, 2002; Quinonez et al., 2001; Chen et al., 1997). The questionnaire covered demographic backgrounds, feeding habits, daytime sugar intake, mother and child's oral cleaning habits and mother's perceptions of her ability to maintain the child's oral hygiene. The duration of the interview was 10 to 15 minutes.

#### **Demographic backgrounds**

Child's birthday, gender, birth order, primary caregiver, age of mother, and SES of the family served as the background information. Information about the child's primary caregiver was obtained, along with alternatives such as mother, grandmother, or others. For the mother's age, accuracy was within one year.

SES covered parents' level of education and family income. Information regarding level of education was requested separately for the father and mother on a 7-point scale ranging from illiterate to doctoral degree. The parents' level of education was defined as the highest level of either parent's education and then categorized into low (primary school or illiterate), moderate (diploma or high school education), or high (university education). For 19% of the enrolled children, parents' level of education was low, for 47% moderate, and for 34% high.

The response to an open-ended question about the family income per month was to be given in Rials (10 000 Rials ~ 1 Euro in 2005). The reported income was then standardized for a family of four and corrected for non-tenant families by adding a fixed amount (100 Euro) in



order to approximate net family income. The indicator of family income was later categorized as low (less than 180 Euro), moderate (180-359 Euro), or high (at least 360 Euro). For 12% of the enrolled children, family income was low, for 47% moderate and for 41% high. Distribution of the children by parents' level of education and family income showed no differences between the age groups or genders.

### **Feeding habits**

The questions on feeding habits covered feeding method, total duration of prior breastfeeding, total duration of prior bottle-feeding, and nighttime feeding practices. The question about the feeding method had three response alternatives: breastfeeding only, bottle-feeding only, or both. The responses to this question were later dichotomized as solely breastfed or not. The total duration of breastfeeding or bottle-feeding was recorded in months.

### ***Nighttime feeding practices***

For nighttime feeding practices, mothers were asked to report feeding at bedtime for the purpose of helping the child fall asleep. The mothers were asked to respond by selecting one of four alternatives: breast, bottle containing liquids other than water, both breast and bottle, or neither breast nor bottle given at bedtime. Those who, at bedtime, were both breastfed and bottle-fed ( $n = 13$ ) were excluded from further analyses of feeding methods.

Information about feeding during the night was elicited by two questions. The responses to the question "What is done if the child wakes up during the night?" were categorized (related scores in parentheses) as a) comforting the child or giving him/her a pacifier or a bottle containing water (0) and b) either breastfeeding or giving a bottle containing a liquid other than water (1). Preliminary analysis showed that with three exceptions, the bottle contained milk. These three outliers were also excluded from further analysis.

The responses to the question "How many times do you usually feed your child during the night?" indicated the frequency of feedings (other than water) during the night, and were categorized as none (0), one to two times per night (1), three to seven times per night (2), or the whole night (3). Sugar intake during the night (lactose) was then operationalized as separately calculated burdens of nighttime breastfeeding and bottle-feeding. The higher

scores indicated a higher burden of night-feeding in terms of sugar intake. The burden of nighttime breastfeeding, ranging from 0 to 3, was categorized as none (0), low (1), or high (2-3). Burden of milk-bottle feeding during the night was dichotomized into non-existent (0), or existent (1-2). For a further analysis, nighttime feeding was also determined as a dichotomy to show absence (0) or presence (1) of any feeding (breast or bottle) during the night.

### **Daytime sugar intake**

The indicator of child's daytime sugar intake combined four aspects. The responses and the related scores (in parentheses) were categorized as follows:

- 1) Two most common contents of daytime bottle, subsequently categorized as neither being sweet (0), one being sweet (1), or both being sweet (2);
- 2) Frequency of giving sugary snacks: seldom or never (0), once a day (1), twice a day (2), three times a day (3), four times a day (4), or five times a day or more (5);
- 3) Frequency of antibiotic administration defined as the number of courses administered during the previous 12 months, categorized as: no usage (0), 1 to 2 courses (1), 3 to 5 courses (2), or more than 5 courses (3);
- 4) Iron drop usage, categorized as: no usage (0), usage followed immediately by water (1), or usage without any water (2).

The higher scores indicated a higher sugar intake. The sum of these scores, ranging from 0 to 12, described daytime sugar intake as low (0-5), moderate (6), or high (7-12).

### **Oral cleaning for the child and the mother**

Oral cleaning for the child included cleaning frequency, cleaning device, and adult's role in oral cleaning for the child. The question "How often are your child's teeth cleaned?" offered five response alternatives, later categorized as: "More than once a day," "Once a day," "Less than once a day," or "No cleaning." Ultimately, two separate dichotomies were formed: "Twice daily" or "Less" and "Daily" or "Less," to reveal factors related to oral cleaning for the child on a twice daily basis and a daily basis.

The answers to the question about the cleaning device were categorized into "Toothbrush," "Washcloth, gauze, etc," or "Nothing." Information about the adults' role in the oral care of the children was elicited by asking: "Who performs the child's toothbrushing?" The responses were categorized as: "The child alone," "The child with supervision or help by adults," or "The adults alone." The data about using fluoride toothpaste for the child was not

analyzed as those rather few mothers who were using toothpaste for the children's tooth brushing could not make sure whether it was a fluoridated or non-fluoridated brand.

Mother's own oral cleaning was assessed in terms of the frequency of her own toothbrushing. The answers to the question "How often do you brush your teeth?" were categorized into: "More than once a day," "Once a day," and "Less than once a day."

### **Mother's perceptions about the child's oral hygiene**

Mothers' perceptions of their ability to maintain their children's oral hygiene was measured by three choice of statements (Pine et al., 2004), as follows: 1) "I don't know how to brush or clean my child's teeth properly." 2) "We don't have time to brush or clean our child's teeth twice a day." 3) "We can not make our child brush or clean his/her teeth twice a day." The responses were given on a 5-point Likert scale ranging from strongly agree to strongly disagree and scored as follows (in parentheses): Strongly agree (1), Agree (2), No opinion (3), Disagree (4), Strongly disagree (5).

### **4.5.3. Clinical dental examination**

Prior to the clinical dental examinations, the examiner dentist (SM), with five years of experience as a practicing dentist, was further trained by an experienced pediatric dentist who was the head of a university department of pediatrics. The double examination resulted in kappa values of 0.8 for recordings on dental plaque and 1.0 on dt.

The child was examined with the help of a headlamp and a plane dental mirror with the mother and examiner sitting in a knee-to-knee position, the child on their laps and the mother controlling his/her feet and hands. The criteria for caries diagnosis were according to WHO recommendations for oral health surveys (WHO, 1997). ECC was defined as the presence of any dmft. All dmft in this child population was due to dt except for one two-year-old girl with two filled teeth.

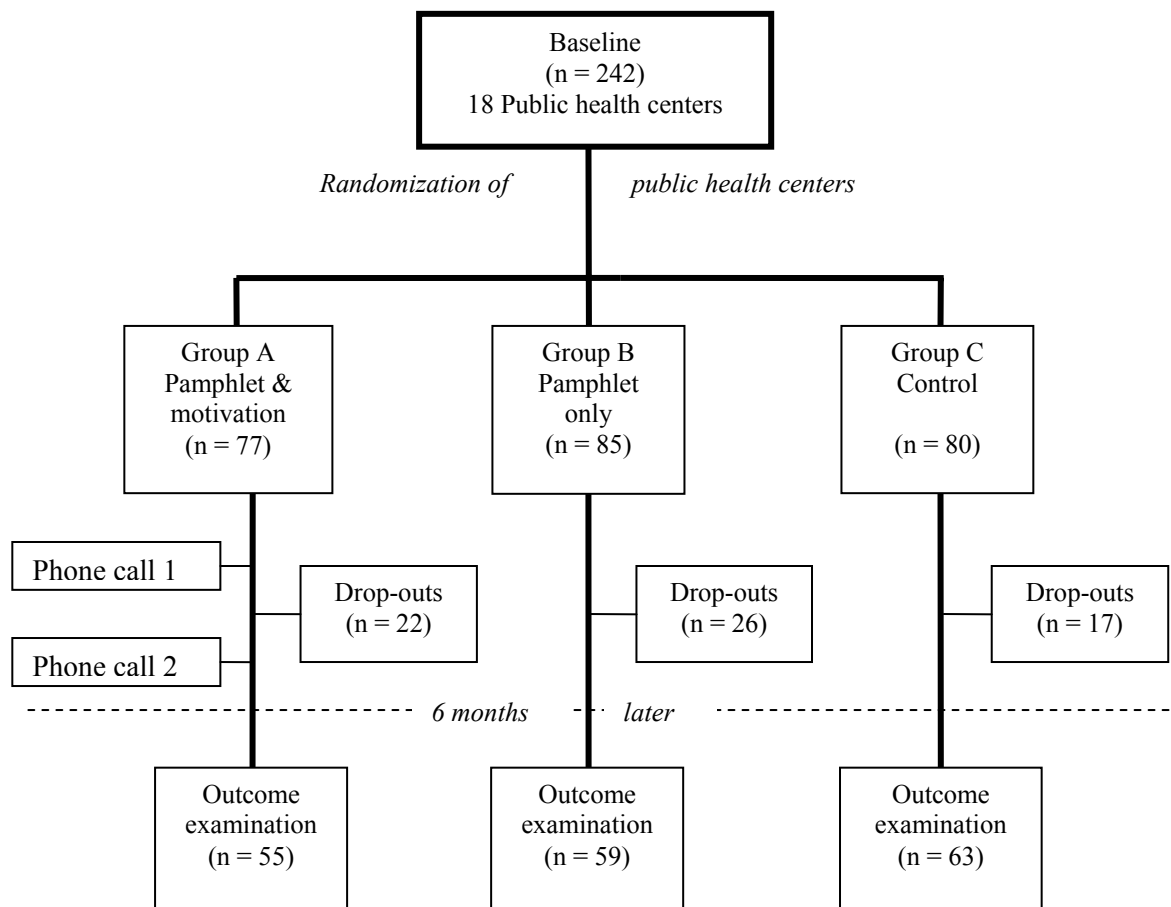
Dental plaque was visually inspected on the labial surfaces of upper central incisors as index teeth and recorded as (scores in parentheses) no plaque (0), plaque present at gingival margin only (1), or abundant dental plaque (2) covering more than gingival margin of the tooth. Plaque score was calculated as the sum of plaque scores on index teeth of the child. Child's

oral hygiene was defined in a dichotomy as “Good” (absence of visible plaque) or “Poor” (presence of visible plaque).

#### 4.6. Interventional part of the study

##### 4.6.1. Sampling, randomization, blinding

The cohort of 12- to 15-month-olds ( $n = 242$ ) of this study was divided into three arms by randomly assigning the health centers into the two groups of intervention and one control group; consequently, six centers were devoted to each group (Figure 4.2.). The whole randomization and intervention process was supervised by a dentist not involved in the clinical examinations and interviews. The examining dentist was unaware of the allocation of the groups. The mothers received the intervention in the vaccination room, before the children received the vaccination. All clinical dental examinations were organized to be synchronized with the children’s routine vaccination visits, and mothers were not aware of possible dental examinations on the day of attending the health centers.



**Figure 4.2.** Flow chart of the interventional study on 12- to 15-month-olds.

#### **4.6.2. Clinical dental examination**

At baseline, 15 children were examined to determine intra-examiner reliability for detecting enamel caries (Kingman and Selwitz, 1997; WHO, 1979) on the labial surface of the upper central incisors, resulting in a kappa value of 0.6 for the number of upper central incisors with enamel caries. This calibration process was repeated before the outcome examinations, and the kappa values for intra-examiner reliability were 0.7 for de and 1.0 on dt. The child was examined with the help of a headlamp and a plane dental mirror with the mother and examiner sitting in a knee-to-knee position.

#### **4.6.3. Intervention to prevent caries**

The intervention was educational by means of a two-side A4-size folded pamphlet created for the present purposes (Table 4.1.). The pamphlet covered topics relevant to the oral health of infants and toddlers such as nighttime feeding, sugar intake, transmission and acquisition of oral bacteria, oral cleaning habits, and the importance and appropriate use of fluoride. The pamphlet also used simple language and cheerful colors and illustrations of babies to maintain the mother's attention and interest. Additional motivation for following oral health instruction was provided by verbal instructions and two reminder phone calls for one of the intervention groups. The whole program was integrated into the health staff's duties, and no extra personnel were needed. After the vaccination of 12-month-olds, the importance of on-time visit for the next shot (the date was written on their vaccination card as is commonly done) was emphasized to mothers in all groups.

**Pamphlet and motivation (Group A).** The staff at the vaccination offices provided the mothers with the pamphlet on caries prevention together with five minutes of oral health instructions for early childhood. In addition, the health center staff phoned these mothers twice at two-month intervals to remind them of the oral health instructions given.

**Pamphlet only (Group B).** The vaccination staff gave the same pamphlet on caries prevention to the mothers with no more explanation than the comment that it would be useful to read.

**Controls (Group C).** The control group received no caries prevention information during the six-month follow-up period in this program. After the outcome examination, these mothers as well, received the same pamphlet on caries prevention from vaccination staff.

**Table 4.1.** Main content of the oral health instructions included in educational intervention to prevent caries in 12- to 15-month-olds.

<b>Main subjects in pamphlet</b>	<b>Main messages<sup>a</sup></b>
Feeding habits	<ul style="list-style-type: none"> <li>• After the first tooth eruption, try to stop nighttime feeding for the child.</li> <li>• Do not let your child sip from the bottle during the day or sleep with the bottle at night.</li> </ul>
Sugar intake	<ul style="list-style-type: none"> <li>• Try not to use sugary snacks and drinks more than twice daily.<sup>b</sup> (the same for both adults and children)</li> <li>• Avoid adding sugar to the child's bottle content.</li> <li>• Give water to your child after taking medicines.</li> </ul>
Transmission of the bacteria	<ul style="list-style-type: none"> <li>• Avoid tasting your child's food with the same spoon you use to feed him/her.<sup>b</sup></li> <li>• Avoid sharing spoons, glasses or any other feeding utensils with your child.<sup>b</sup></li> </ul>
Oral hygiene	<ul style="list-style-type: none"> <li>• Brush or at least wipe your child's teeth after the time of first tooth eruption.<sup>b</sup></li> <li>• Use less than a pea-size amount of the children's fluoride toothpaste to brush your child's teeth at least twice daily.<sup>b</sup></li> <li>• Brush your own teeth with fluoride toothpaste at least twice daily.<sup>b</sup></li> </ul>

<sup>a</sup> The main contents of this pamphlet were based on these references: (Gussy et al., 2006; Hallett and O'Rourke, 2006; van Palenstein Helderman et al., 2006; Ribeiro and Ribeiro, 2004; Marinho et al., 2003; Davies et al., 2002; You et al., 2002; Kay and Locker, 1998; Reisine and Douglass, 1998; Seow et al., 1998).

<sup>b</sup> These were included in verbal oral health instructions.

#### **4.6.4. Evaluation of the intervention**

Evaluation covered those children who attended the outcome examination. Outcomes were determined as numbers of teeth with new dentinal caries (dt) and of upper central incisors with new enamel caries (de) and as numbers of children developing new dt and de during the six-month period. For comparisons of the intervention groups with the control group, increments in mean dt and de and percentages of children who had developed new dt or de were defined for each group. These percentages were calculated as follows:

$$100 \times \frac{\text{No. of children with new dt or de}}{\text{No. of children who could be at risk of developing new dt or de}} \%$$

This excluded from the de-related calculations those children who had de on the both incisors at baseline (n = 12). Based on these percentages, Number Needed to Treat (NNT) was defined separately regarding dt and de.

In addition, the subjective evaluation of the study was carried out as a short interview by means of two questions to the mother: 1) How satisfied were you with the pamphlet? and 2) How much did the pamphlet influence your oral health behaviors? The responses were given on six-point scale from “Very much” to “Very little.” The response also included the alternative “No opinion.”

#### 4.7. Ethical consideration

The study was approved by Ethics Committee of the School of Dentistry, Shaheed Beheshti Medical University. The mothers gave their informed written consent to participate in the study; only two refused. The subjects were entered into the database with a numerical code only.

#### 4.8. Statistical analysis

Evaluation of statistical significance between groups to be compared was made by means of t-test and ANOVA for mean values and Chi-square test for frequencies. Logistic regression models were fitted to the data, and corresponding odds ratios (OR) and their 95% confidence intervals (95% CI) were calculated to evaluate the strength of associations. Goodness of fit was assessed by means of Hosmer and Lemeshow test. Comparisons regarding the intervention were made separately between each intervention group and the control group. For intervention analysis, Kruskal-Wallis and Mann-Whitney U-test served for assessing the statistical significance of the differences in averages, and Chi-square test for differences in frequencies. NNT was calculated as 1/ARR where ARR = Absolute Risk Reduction. The ARR for each of the intervention groups was decided by subtracting the percentage of children developing new dt or de in an intervention group from that of the control group. The data were analyzed by SPSS, version 13.





## 5. RESULTS

### 5.1. ECC in Tehran, Iran (I, II)

ECC occurred in 3% to 26% of the children and was more prevalent the older the children were (Table 5.1.). For the youngest age group (12- to 15-month-olds) the prevalence was 3%, and for the 24- to 36-month-olds 26% ( $p < 0.001$ ). The prevalence of ECC was 33% in the subgroup of 26- to 36-month-olds (article I). The prevalence of ECC was related neither to the child's gender, birth order, his/her primary caregiver (mother or else), to parents' level of education, nor family income.

Table 5.1. also shows the mean number of dmft in the children. Older children showed higher dmft ( $p < 0.001$ ), but with no gender differences. In children of the families with moderate-income, dmft was lower than in the other children ( $p = 0.05$ ). Children of highly educated parents showed lower dmft than did other children ( $p = 0.04$ ).

**Table 5.1.** ECC in 12- to 36-month-olds ( $n = 504$ ) in Tehran, Iran, according to demographic background.

<b>Factor</b>	<b>% with ECC</b>	<b>dmf teeth<sup>a</sup> Mean (SD)</b>
<b>Age (months)</b>		
12-15	3	< 0.1 (0.2)
16-23	12	0.3 (1.1)
24-36	26	0.9 (2.0)
p-value	< 0.001	< 0.001
<b>Gender</b>		
Boys	11	0.3 (1.2)
Girls	9	0.3 (1.1)
p-value	0.46	0.88
<b>Parents' level of education</b>		
High	7	0.2 (0.6)
Moderate	11	0.4 (1.3)
Low	14	0.4 (1.4)
p-value	0.17	0.04
<b>Family income</b>		
High	13	0.4 (1.5)
Moderate	7	0.2 (0.7)
Low	12	0.4 (1.1)
p-value	0.09	0.05

Statistical evaluation by Chi-square test and ANOVA.

<sup>a</sup>All dmft (decayed, missing and filled teeth) were due to dt except for two filled teeth.

## 5.2. Oral hygiene and ECC (I, III)

### 5.2.1. Dental plaque

Visible dental plaque appeared on at least one upper central incisor for 65% of the 12- to 15-month-olds and for 76% of the 24- to 36-month-olds. The prevalence of visible plaque (Table 5.2.) did not differ by the age group, gender, parents' level of education or family income. Plaque scores were higher, the older the children ( $p < 0.001$ ) and the lower the parents' level of education ( $p = 0.02$ ).

**Table 5.2.** Presence of dental plaque in 12- to 36-month-olds (n = 504) in Tehran, Iran according to demographic backgrounds.

<b>Factor</b>	<b>% with visible plaque</b>	<b>Plaque score <sup>a</sup> Mean (SD)</b>
<b>Age (months)</b>		
12-15	65	1.6 (1.5)
16-23	71	2.4 (1.7)
24-36	76	2.6 (1.7)
p-value	0.12	< 0.001
<b>Gender</b>		
Boys	71	2.1 (1.6)
Girls	66	2.0 (1.7)
p-value	0.25	0.50
<b>Parents' level of education</b>		
High	67	1.9 (1.6)
Moderate	67	2.0 (1.7)
Low	76	2.5 (1.6)
p-value	0.23	0.02
<b>Family income</b>		
High	66	2.0 (1.7)
Moderate	68	2.1 (1.7)
Low	81	2.5 (1.6)
p-value	0.07	0.12

Statistical evaluation by Chi-square test and ANOVA.

<sup>a</sup> Plaque score calculated as the sum of plaque on upper central incisors.

### 5.2.2. Mothers' perceptions about children's oral hygiene

Table 5.3. shows responses to the three statements describing mothers' perceptions of their ability to maintain the children's oral hygiene according to the parents' level of education. More mothers from low-educated families stated negative perceptions about maintaining the

child's oral hygiene with no differences according to children's age or gender. The majority of mothers affirmed that they had time to clean their children's teeth.

**Table 5.3.** Comparison (%) of mothers' responses to statements regarding perceptions of ability to maintain oral hygiene for their 12- to 36-month-old children, in Tehran, Iran according to parents' level of education.

Statements <sup>a</sup>	Parents' level of education	Responses (%)				
		Strongly agree	Agree	No opinion	Disagree	Strongly disagree
1. I don't know how to brush or clean my child's teeth properly.	High	21	35	2	36	6
	Moderate	22	33	2	41	2
	Low	32	41	0	27	0
2. We don't have time to brush or clean our child's teeth twice a day.	High	2	16	0	71	11
	Moderate	3	26	0	63	8
	Low	5	36	0	52	7
3. We can not make our child brush or clean his/her teeth twice a day.	High	5	27	8	48	12
	Moderate	7	29	6	51	7
	Low	13	35	6	44	2

Statistical evaluation by Chi-square test: ( $p < 0.05$ ) when comparing high and low parental education.

<sup>a</sup> According to Pine et. al., 2004.

### 5.2.3. Oral cleaning

Of the mothers, 68% reported brushing their own teeth at least once a day, among whom 11% reported brushing more than once a day. Oral cleaning once a day was reported for 34% of all children. For 5%, mothers reported twice daily oral cleaning, and for 38%, no cleaning. Among those children whose teeth were cleaned ( $n = 227$ ), the most common cleaning device was a toothbrush (70%), followed by a washcloth or gauze (19%). Of those children for whom the use of a toothbrush was reported ( $n = 160$ ), 35% brushed by themselves, and 20% with help or supervision of an adult. For 45% of the children, an adult performed the brushing. Adults were more involved in oral cleaning for the younger children ( $p = 0.03$ ). Adults' involvement was not associated with parents' level of education or family income.

For all children ( $n = 504$ ), the frequency of oral cleaning on a daily basis was directly proportional to the mother's own toothbrushing frequency as the strongest factor (OR = 1.9)

when controlling for the child's demographic backgrounds (Table 5.4.). The frequency of oral cleaning for the child was higher for the children of those mothers who indicated that they knew how to brush the children's teeth (OR = 1.3) and that they were able to make their children brush their teeth twice a day (OR = 1.3). Another logistic regression model (Table 5.4.) showed that the frequency of oral cleaning for the child on a twice daily basis was directly proportional to the mother's own toothbrushing frequency (OR = 5.1).

**Table 5.4.** Factors related to oral cleaning on daily or twice daily basis for 12- to 36-month-olds (n = 504) in Tehran, Iran, as explained by two logistic regression models.

Parameters in the model <sup>a</sup>	Daily basis			Twice daily basis		
	OR	95% CI	p-value	OR	95% CI	p-value
Mother's toothbrushing frequency	1.9	1.3-2.6	<0.001	5.1	2.0-13.1	0.001
I don't know how to brush or clean my child's teeth properly. <sup>b</sup>	1.3	1.1-1.5	0.010	1.2	0.8-1.8	0.418
We don't have time to brush or clean our child's teeth twice daily. <sup>b</sup>	1.0	0.8-1.3	0.776	0.9	0.5-1.6	0.739
We can not make our child brush or clean his/her teeth twice daily. <sup>b</sup>	1.3	1.0-1.5	0.025	1.5	0.9-2.7	0.124
Child's age	1.1	1.0-1.1	<0.001	1.1	1.0-1.1	0.057
Child's gender: 1 = boys, 2 = girls	1.1	0.7-1.8	0.545	0.9	0.3-2.6	0.897
Parents' level of education	0.9	0.8-1.1	0.407	1.1	0.7-1.7	0.748
Family income	1.0	1.0-1.0	0.886	1.0	1.0-1.0	0.717

Goodness of fit with Hosmer and Lemeshow test (p > 0.4).

<sup>a</sup> Variables were used in their continuous form except for gender.

<sup>b</sup> Strongly agree = 1, Strongly disagree = 5

Good oral hygiene defined as no visible plaque on upper central incisors was more likely for the children whose mothers reported a higher frequency of their own toothbrushing (OR = 1.7) (Table 5.5.). Frequency of oral cleaning for the child was not related to the good level of child's oral hygiene.

Further analysis among those who used a toothbrush for oral cleaning (n = 160) was carried out, with adults' involvement in brushing also included. Results were similar as the only factor associating with child's good oral hygiene was mother's toothbrushing frequency (OR = 1.7).

**Table 5.5.** Factors related to good oral hygiene (no visible plaque on upper incisors) in 12- to 36-month-olds (n = 504) in Tehran, Iran, as explained by a logistic regression model.

Parameters in the model <sup>a</sup>	Estimate of strength	Standard error	OR	95% CI	p-value
Mother's toothbrushing frequency	0.513	0.146	1.7	1.3-2.2	<0.001
Frequency of oral cleaning for the child	0.036	0.080	1.0	0.9-1.2	0.650
I don't know how to brush or clean my child's teeth properly. <sup>b</sup>	0.097	0.081	1.1	0.9-1.3	0.232
We don't have time to brush or clean our child's teeth 2/day. <sup>b</sup>	-0.124	0.102	0.9	0.7-1.1	0.223
We can not make our child brush or clean his/her teeth 2/day. <sup>b</sup>	0.014	0.092	1.0	0.8-1.2	0.877
Child's age	-0.027	0.016	1.0	0.9-1.0	0.088
Child's gender: 1 = boys, 2 = girls	0.267	0.199	1.3	0.9-1.9	0.180
Parents' level of education	-0.058	0.090	0.9	0.8-1.3	0.516
Family income	0.001	0.001	1.0	1.0-1.0	0.662

Goodness of fit with Hosmer and Lemeshow test (p = 0.9).

<sup>a</sup> Variables were used in their continuous form except for gender.

<sup>b</sup> Strongly agree = 1, Strongly disagree = 5

#### 5.2.4. ECC in relation to dental plaque

For all children, the presence of ECC was more likely the higher the plaque score (OR = 1.5), as shown in a logistic regression analysis controlling for child's age, gender, parents' level of education, and family income (Table 5.6.). The model fitted well (p = 0.7).

**Table 5.6.** Association between dental plaque (poor oral hygiene) and presence of ECC among 12- to 36-month-olds (n = 504) in Tehran, Iran, as explained by a logistic regression model.

Parameters in the model <sup>a</sup>	Estimate of strength	Standard error	OR	95% CI	p-value
Plaque score	0.434	0.206	1.5	1.0-2.3	0.035
Age in months	0.131	0.020	1.1	1.1-1.2	<0.001
Gender: 1 = boys, 2 = girls	-0.443	0.326	0.6	0.3-1.3	0.175
Parents' level of education	-0.247	0.156	0.8	0.6-1.1	0.113
Family income	0.001	0.001	1.0	1.0-1.0	0.082

Goodness of fit with Hosmer and Lemeshow test (p = 0.7).

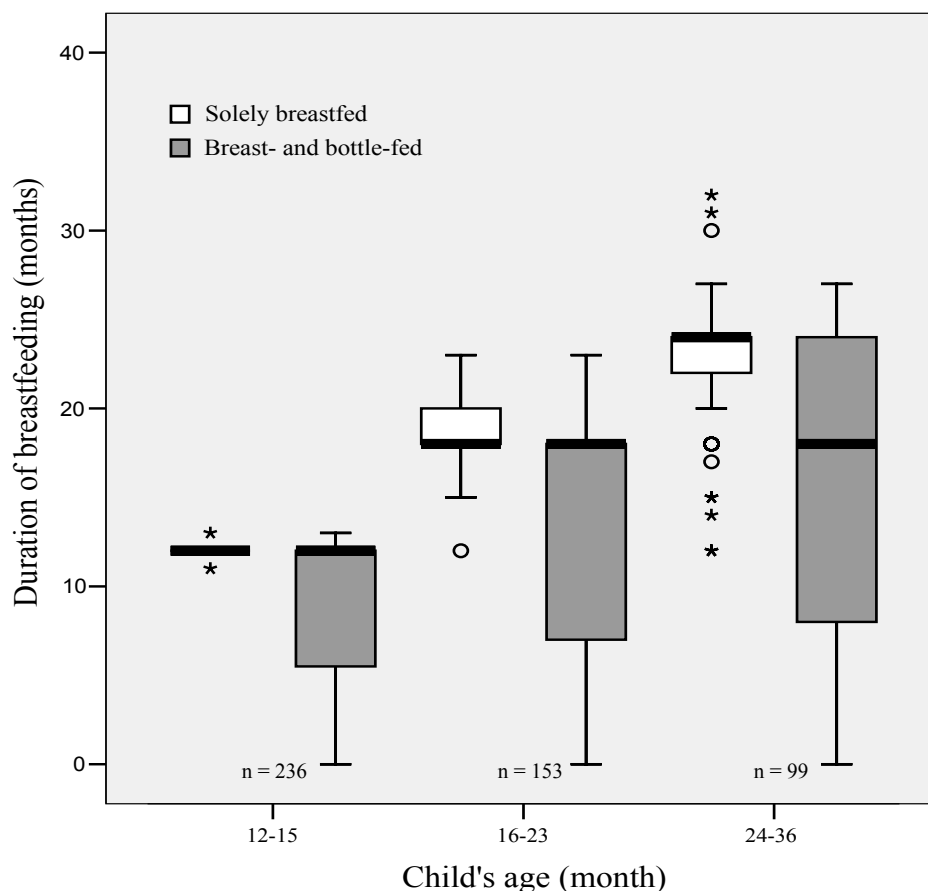
<sup>a</sup> Variables were used in their continuous form except for gender.

### 5.3. Feeding, sugar and ECC (II)

#### 5.3.1. Feeding habits and sugar intake

Breastfeeding was the norm: of the children, 56% were solely breastfed, 42% were both breastfed and bottle-fed, and 2% were solely bottle-fed. Being solely breastfed was less common among the children of high-income families (49% vs. 59%-62%) than among the moderate- and low-income families ( $p = 0.04$ ). Mean duration of breastfeeding for the solely breastfed 24- to 36-month-olds was 22.8 months (95% CI 21.8, 23.9) and for breast- and bottle-fed 24- to 36-month-olds, 15.4 months (95% CI 12.5, 18.3). Median duration of breastfeeding for this age group was 24 months. Figure 5.1. shows distributions of the children according to the duration of breastfeeding separately in solely breastfed and breast- and bottle-fed children according to age group.

**Figure 5.1.** Distribution of 12- to 36-month-olds ( $n = 488$ )<sup>a</sup> in Tehran, Iran, by duration of breastfeeding in solely breastfed and breast- and bottle-fed children according to age group.



Bold line = Median, Circles = Mild outlier, Star = Extreme outlier

<sup>a</sup> 16 were excluded to facilitate analysis.

The distribution of the children by burden of nighttime feeding and sugar intake, according to age group is shown in Table 5.7. Burden of nighttime breastfeeding was higher for the younger age groups ( $p < 0.001$ ). The burden of milk-bottle feeding during the night was existent for 11% of the children, being lower for the older age groups ( $p = 0.02$ ). Daytime sugar intake was high for 35% of the children and varied by age ( $p = 0.001$ ). No differences appeared in these figures between boys and girls.

**Table 5.7.** Distributions of the 12- to 36-month-olds ( $n = 488$ )<sup>a</sup> in Tehran, Iran, by burden of nighttime feeding and sugar intake, according to age group.

Factor	Age in months			Total n (%)
	12-15	16-23	24-36	
<b>Burden of the nighttime breastfeeding</b>				
None	68 (29)	55 (36)	83 (84)	206 (42)
Low	72 (30)	50 (33)	6 (6)	128 (26)
High	96 (41)	48 (31)	10 (10)	154 (32)
p-value	<0.001			
<b>Burden of the nighttime milk-bottle feeding</b>				
Non-existent	208 (88)	133 (87)	96 (97)	437 (89)
Existent	28 (12)	20 (13)	3 (3)	51 (11)
p-value	0.024			
<b>Daytime sugar intake</b>				
Low	132 (56)	65 (43)	31 (31)	228 (47)
Moderate	37 (16)	28 (18)	25 (25)	90 (18)
High	67 (28)	60 (39)	43 (44)	170 (35)
p-value	0.001			

Statistical evaluation by Chi-square test.

<sup>a</sup> 16 were excluded to facilitate analysis.

### 5.3.2. ECC in relation to feeding habits and sugar intake

Higher ECC prevalence was more likely (OR = 2.1) in the solely breastfed children (Table 5.8.). ECC showed no relationship with daytime sugar intake, burden of nighttime feeding or SES. The same was observed for the numbers of dt and being solely breastfed; dt was higher in solely breastfed children (Table 5.8.). Those children with a low burden of nighttime breastfeeding exhibited lower dt ( $p < 0.001$ ).

**Table 5.8.** ECC in 12- to 36-month-olds (n = 488)<sup>a</sup> in Tehran, Iran, in relation to feeding habits and sugar intake.

Factor	n (%) with ECC			Decayed teeth (dt)		
	Age in month			Mean		
	12-15	16-23	24-36	12-15	16-23	24-36
<b>Feeding method</b>						
Breast- and bottle-fed	2 (2)	5 (8)	6 (17)	0.0	0.2	0.4
Solely breastfed	4 (3)	12 (14)	20 (32)	0.1	0.3	1.1
	OR = 2.1; 95% CI 1.0-4.2			p < 0.01		
<b>Duration of breastfeeding</b>						
0-6 months	0 (0)	2 (13)	1 (14)	0.0	0.3	0.3
>6 months	6 (3)	15 (11)	25 (27)	<0.1	0.3	0.9
	OR = 1.7; 95% CI 0.5-6.0			p = 0.25		
<b>Burden of the nighttime breastfeeding</b>						
None	1 (2)	6 (11)	22 (26)	0.0	0.2	0.7
Low	2 (3)	3 (6)	0 (0)	0.0	0.1	0.0
High	3 (3)	8 (7)	4 (40)	<0.1	0.5	2.5
	OR = 1.7; 95% CI 0.7-3.7			p < 0.01		
<b>Burden of the nighttime milk-bottle feeding</b>						
Non-existent	5 (2)	15 (11)	24 (25)	0.0	0.3	0.9
Existent	1 (4)	2 (10)	2 (67)	0.0	0.3	1.0
	OR = 1.5; 95% CI 0.5-4.3			p = 0.9		
<b>Feeding at bed-time</b>						
No breast or bottle	1 (2)	2 (8)	2 (15)	0.0	0.2	0.4
Bottle-feeding	1 (4)	1 (6)	2 (17)	0.0	0.3	0.4
Breastfeeding	4 (3)	14 (13)	22 (30)	0.0	0.3	1.0
	OR = 1.9; 95% CI 0.7-5.2			p = 0.1		
<b>Daytime sugar intake</b>						
Low	3 (2)	6 (9)	7 (23)	<0.1	0.2	0.7
Moderate	0 (0)	4 (14)	8 (32)	0.0	0.2	1.3
High	3 (4)	7 (12)	11 (26)	<0.1	0.4	0.7
	OR = 1.3; 95% CI 0.6-2.7			p = 0.3		

Statistical evaluation by logistic regression modeling and ANOVA, controlling for child's age. ORs are calculated for the last category with the first one as reference.

<sup>a</sup> 16 were excluded to facilitate analysis.



Occurrence and severity of ECC in subgroups according to presence of visible plaque and any nighttime feeding (either breast or bottle) are shown in Table 5.9. The differences between the groups remained statistically non-significant.

**Table 5.9.** ECC in 12- to 36-month-olds (n = 488)<sup>a</sup> in Tehran, Iran, in relation to visible plaque and nighttime feeding.

Subgroups	n (%) with ECC			Decayed teeth (dt) Mean		
	Age in month			Age in month		
	12-15	16-23	24-36	12-15	16-23	24-36
No visible plaque and no nighttime feeding	0 (0)	1 (8)	6 (26)	0.0	<0.1	0.7
Either visible plaque or nighttime feeding	2 (2)	5 (9)	14 (24)	0.0	0.2	0.7
Both visible plaque and nighttime feeding	4 (3)	11 (13)	6 (33)	<0.1	0.3	1.6
p-value	0.7	0.7	0.7	0.8	0.6	0.2

Statistical evaluation by Chi-square test and ANOVA, for each age group.

<sup>a</sup> 16 were excluded to facilitate analysis.

Table 5.10. shows the impact of feeding habits and sugar intake on ECC occurrence when controlled for the child's dental plaque, age, gender, parents' level of education and family income. ECC was more likely to occur among those older (OR = 1.2) and among those for whom a burden of milk-bottle feeding at night existed (OR = 4.9). Breastfeeding *per se*, its duration, its nighttime burden, and daytime sugar intake were not related to ECC. The model fitted well (Hosmer and Lemeshow, p = 0.5).

**Table 5.10.** Impact of feeding habits and daytime sugar intake on presence of ECC among 12- to 36-month-olds (n = 488)<sup>a</sup> in Tehran, Iran, as explained by a logistic regression model controlling for the children's dental plaque and demographic backgrounds.

<b>Parameters in the model<sup>b</sup></b>	<b>Estimate of strength</b>	<b>Standard error</b>	<b>OR</b>	<b>95% CI</b>	<b>p-value</b>
Feeding method: 1 = Breast and bottle, 2 = Breast only	1.025	0.770	2.8	0.6-12.7	0.183
Duration of breastfeeding	-0.045	0.044	1.0	0.9-1.0	0.305
Duration of bottle-feeding	-0.017	0.045	1.0	0.9-1.1	0.710
Burden of the nighttime breastfeeding	0.258	0.212	1.3	0.9-2.0	0.224
Burden of the nighttime milk-bottle feeding	1.591	0.483	4.9	1.9-12.6	0.001
Feeding at bedtime					
1 = No breast or bottle			1.0		
2 = Bottle	-0.590	0.881	0.6	0.1-3.1	0.503
3 = Breast	0.568	0.612	1.8	0.5-5.9	0.353
Daytime sugar intake	0.118	0.095	1.1	0.9-1.4	0.214
Plaque score	0.211	0.112	1.2	1.0-1.5	0.060
Age in months	0.180	0.035	1.2	1.1-1.3	<0.001
Gender: 1 = boys, 2 = girls	-0.407	0.364	0.7	0.3-1.2	0.264
Parents' level of education	-0.272	0.175	0.8	0.5-1.1	0.120
Family income	0.001	0.001	1.0	1.0-1.0	0.040

Goodness of fit with Hosmer and Lemeshow test (p = 0.5).

<sup>a</sup> 16 were excluded to facilitate analysis.

<sup>b</sup> Variables were used in their continuous form except for feeding method, feeding at bedtime and gender.

## 5.4. Educational intervention on ECC (IV)

### 5.4.1. Attendance and drop-out

At baseline, 242 mother and child pairs were enrolled in the study (See Figure 4.2) among whom 177 pairs (group A = 55, group B = 59, and group C = 63) attended the outcome examinations. Background factors did not differ either between those who attended the outcome examinations and the drop-outs (n = 65) or among the three groups. The baseline presence and number of caries (dt and de) and number of teeth did not differ significantly between the drop-outs, those who attended the outcome visit and the three intervention groups (Table 5.11.). The mean age of the children was 12.3 months (SD = 0.4) at the baseline and 18.3 months (SD = 0.6) at the outcome.

**Table 5.11.** Baseline dental findings in 12- to 15-month-olds who attended outcome examinations (n = 177) and in drop-outs (n = 65), enrolled to educational intervention in Tehran, Iran.

Groups	n	No. of teeth	dt <sup>a</sup>	dt > 0	de <sup>a</sup>	de > 0
		Mean (SD)	Mean (SD)	n (%)	Mean (SD)	n (%)
A = Pamphlet & motivation	55	6.3 (2.0)	0.04 (0.19)	2 (4)	0.25 (0.67)	7 (13)
B = Pamphlet only	59	6.2 (1.7)	0.02 (0.13)	1 (2)	0.15 (0.48)	6 (10)
C = Control	63	6.4 (1.9)	0.03 (0.25)	1 (2)	0.08 (0.37)	3 (5)
p-value		0.4	0.7	0.7	0.3	0.3
Participants	177	6.1 (2.0)	0.05 (0.27)	2(3)	0.11 (0.40)	5(8)
Drop-outs	65	6.3 (1.9)	0.03 (0.19)	4(2)	0.16 (0.52)	16(9)
p-value		0.5	0.7	0.7	0.7	0.4

Statistical evaluation between groups by Kruskal-Wallis for averages and Chi-square test for frequencies.

<sup>a</sup> dt: number of teeth with dentinal caries, de: number of upper central incisors with enamel caries.

### **5.4.2. Impact of intervention on caries**

Regarding enamel caries, from those upper incisors having de at the baseline, 6 of 14 teeth in group A (Pamphlet & Motivation), 5 of 9 teeth in group B (Pamphlet only) and none of the 5 teeth in the control group recovered. Table 5.12. describes the increments in the number of de and in the percentage of children developing new de in those at risk. Group A revealed no increment in de. Group B showed slightly lower increments in number of de and in percentage of children developing new de than in the controls ( $p > 0.05$ ). NNT was 4 for group A and 9 for group B.

Increment in dentinal caries as numbers of new dt and percentage of children developing new dt in the intervention groups was minor and showed no differences in comparison with the control group ( $p > 0.05$ ) (Table 5.12.). The estimate of NNT was slightly smaller for group A than that for group B (13 vs. 17).

### **5.4.3. Subjective evaluation of the intervention**

The vast majority of mothers were satisfied with the pamphlet in both intervention groups (Table 5.13.), with no difference in their satisfaction according to SES backgrounds.

Regarding self-perceived change in their oral health behaviors, 64% of mothers considered this to be very much or much, 20% moderate, 12% little and 4% had no opinion. Compared to group B, those in group A expressed the view that the pamphlet had more influence on their oral health behaviors ( $p = 0.05$ ) (Table 5.13.).

**Table 5.12.** Incremental changes in mean number of upper central incisors with enamel caries (de) and mean number of decayed teeth (dt) and percentage of children developing new de or dt during the 6-month educational intervention among 12- to 15-month-olds in Tehran, Iran.

Dental findings	Groups			p-value (A vs. C)	p-value (B vs. C)
	A = Pamphlet & motivation n = 55	B = Pamphlet only n = 59	C = Control n = 63		
n (%) children with new de <sup>a</sup>	0 (0)	8 (14)	16 (26)	<0.001	0.208
Mean de (SD) <sup>a</sup>	0 (0)	0.2 (0.6)	0.4 (0.7)	<0.001	0.066
n (%) children with new dt	3 (5)	4 (7)	8 (13)	0.177	0.276
Mean dt (SD)	0.1 (0.6)	0.1 (0.1)	0.2 (0.7)	0.188	0.265

Statistical evaluation by Mann-Whitney U-test for averages and Chi-square test for frequencies.

<sup>a</sup>The de analysis is for those with at least one sound central incisor at the baseline (n for A = 48, B = 56, C = 61).

**Table 5.13.** Comparison (%) of mothers' responses to questions regarding subjective evaluation of educational intervention for their 12- to 15-month-olds in Tehran, Iran, according to intervention groups.

Questions	Groups <sup>a</sup>	Responses (%)					
		Very much	Much	Moderately	Little	Very little	No opinion
1. How satisfied were you with the pamphlet?	A	40	53	4	0	0	3
	B	38	47	10	0	0	5
2. How much did the pamphlet influence your oral health behaviors?	A	31	46	13	7	0	3
	B	24	26	28	15	2	5

Statistical evaluation by Chi-square test (p = 0.5 for question 1. and p = 0.05 for question 2.).

<sup>a</sup> Groups: A = Pamphlet & motivation, B = Pamphlet only.



## 6. DISCUSSION

### 6.1. General discussion

The present study assessed the risk factors for ECC in terms of feeding habits, sugar intake and oral hygiene in 12- to 36-month-old children and evaluated the impacts of an educational intervention via mothers on caries prevention in early childhood. The data collection consisted of interviewing the mothers with a structured questionnaire, and clinical dental examination for all children at baseline and for the cohort of 12- to 15-month-olds at their six-month follow-up.

The prevalence of ECC was rather high and ranged between 3% and 26% in the three age groups, all ECC being due to untreated decayed teeth, with two exceptions. The majority of the children in all age groups showed visible plaque on central upper incisors, which is considered to predict elevated caries risk at preschool age (Tinanoff et al., 2002; Karjalainen et al., 2001; Alaluusua and Malmivirta, 1994).

A lack of sufficient oral hygiene behaviors was apparent, as just 68% of mothers reported brushing their own teeth on a daily basis, and only 39% reported oral cleaning on a daily basis for their children. Unfortunately, more than half of all mothers stated that they did not know how to brush or clean their children's teeth. Good oral hygiene and higher frequency of oral cleaning were more likely for the children whose mothers reported a higher frequency of their own toothbrushing, thus emphasizing the mothers' role (Mattila et al., 2000; Paunio, 1994) in the oral health care of children.

Prolonged breastfeeding was the norm: of all the children, 98% were solely or partly breastfed. This is much higher than in Nordic countries, where 2% of children are breastfed at 18 months of age (Hallonsten et al., 1995). Night-feeding, which is considered as a dentally non-desirable feeding habit (Azevedo et al., 2005; Valaitis et al., 2000), was frequently reported for the present children. ECC were more likely to occur among those for whom the burden of milk-bottle feeding at night existed, which concurs with some previous studies (Azevedo et al., 2005; Hallet and O'Rourke, 2003; Valaitis et al., 2000). Breastfeeding *per*

se, its duration and its nighttime burden were not related to ECC in accordance with the WHO (2003a) recommendation for breastfeeding children up to 24 months of age.

The educational intervention was designed to be implemented by non-dental staff of public health centers because these are in frequent contact with mothers and young children. It included oral health instruction for the children with some instructions for recommended oral health behaviors for the mothers. The intervention was successful in preventing caries increments. Extra motivation seemed to increase the effectiveness of educational intervention as revealed by a lower NNT and more positive self-perceived behavioral changes in mothers in the pamphlet and motivation group compared to the group receiving only pamphlet.

## 6.2. Methodological aspects

### 6.2.1. Subjects and sampling

The general problem in an oral health study of very young children is that they are not readily accessible and a representative sample is difficult to achieve. In some developed countries such as the Nordic countries, children from age 0 to 17 are entitled to regular oral health care free of charge, and as a consequence they are easily available in dental settings. In several other countries, there are mother and child clinics which might only serve lower SES groups of children (Milnes, 1996).

In Iran, children's vaccinations are widely performed in evenly distributed public centers regardless of a family's socio-economic situation. The high coverage of vaccination (WHO, 2007d) provided the opportunity to reach the target age group in the whole city of Tehran. The similarity in the distribution of the present child population by the parents' level of education to that of the general urban population in Iran (Iran Statistical Year Book, 2002; Samadzadeh et al., 1999) speaks for the representativeness of the present sample. Synchronizing the data collection with the vaccination program had also an advantage for the interventional part of the study: the mothers were not aware of the probable dental examination and interview either for the baseline or outcome examination. Probably due to this, there was no difference in the baseline data between the drop-outs and those who participated in the outcome examination.



### 6.2.2. Questionnaire

The mothers were interviewed by a structured questionnaire to reduce non-responses, misconceptions, and errors that might happen with a self-administered questionnaire (Sjöström et al., 1999). The data collection was carried out in a private room to ensure that the mothers were able to concentrate on questions and also to avoid shame for their probable non-desirable responses. It was also pointed out to mothers that the data would be analyzed with a numerical code only to get a true picture of the situation. However, as in any questionnaire survey, the tendency among the participants to give favorable responses, which is referred to as social desirability (Sjöström and Holst, 2002), might have affected the responses.

Questions were selected from validated questionnaires (Pine et al., 2004; Tseveenjav, 2004; Hallet and O'Rourke, 2002; Quinonez et al., 2001; Chen et al., 1997). Only minor changes such as omitting some questions and adding some new response alternatives to provide a wider range of possible answers were carried out after a pilot study. The pilot study was conducted outside the study population, mainly for testing the feasibility of the study.

In order to get a more comprehensive assessment of the possible implications of nighttime feeding in development of ECC, several aspects relating to this factor were included in the structured interview, and frequency analysis was conducted. This approach offered the advantage of covering the total exposure period or the total burden of nighttime feeding, as was also considered in a recent study (van Palenstein Helder et al., 2006). In studies where simply the presence or absence of the behavior is recorded (Sayegh et al., 2005; Hallet and O'Rourke, 2002), this total exposure period will be ignored.

Well-designed studies on the diet of preschoolers have considered detailed sugar intake by providing food and beverage diaries and validated questionnaires (Marshall et al., 2005). Young children, however, have some additional common sources of sugar intake. As milk or complementary food are ineffective in prevention of iron deficiency (WHO, 2003b), iron drops are widely administered for children up to 24-month of age, and these commonly contain sugar. Antibiotics are also considered as sources of sugar intake and are implicated in increasing the risk for ECC (Ribeiro and Ribeiro, 2004; Mariri et al., 2003). Therefore, the present measurement of daytime sugar intake was defined to cover a broader range of sugar-containing substances consumed by children, including antibiotics and iron drops. The sugar

intake, however, was assessed by a single questionnaire and not through a diary. This might result in rather lower reliability for the variable and in neglect of some hidden sugars in the diet, and can be considered as a limitation in this study.

### **6.2.3. Clinical dental examination**

Applying the WHO criteria in definition of dental caries is recommended for caries diagnosis in epidemiological studies (WHO, 1997). However, use of enamel caries is helpful in detecting changes in caries level in areas with moderate or low prevalence of caries (Kingman and Selwitz, 1997), which is commonly the case for the very young children. Regarding the use of enamel caries criteria two main aspects should be considered: Applying recordings of enamel caries significantly adds to the time for data collection (Drury et al., 1999), and the reliability of diagnosis for enamel caries is usually lower than for dentinal caries (Ismail, 1997). In this study, only upper central incisors were examined for enamel caries because these teeth are normally present in all 12- to 15-month-olds. In addition, the selection of upper incisors offered the best control for lighting and moisture in the field environment and resulted in the substantial reliability of the examiner. An additional light source (headlamp), recommended for improvement of the examiner diagnosis while applying the enamel criteria (Assaf et al., 2006), was also utilized in clinical examinations.

## **6.3. Discussion of results**

### **6.3.1. ECC occurrence**

The prevalence of ECC in this child population was between 3% and 26% depending on the age group which is not among the highest in comparison with the neighborhood countries in the Middle East (Rajab and Hamdan, 2002; Al-Malik et al., 2001; Hattab et al., 1999; Al-Hosani and Rugg-Gunn, 1998; Janson and Fakhouri, 1993). The present ECC prevalence is lower than that of the Far East Asian reports (Tsai et al., 2006; Carino et al., 2003; Jin et al., 2003; Douglass et al., 1995; Mayanagi et al., 1995; Fujiwara et al., 1991), but it is considerably higher than that reported in some Nordic countries such as Finland and Sweden (WHO, 2007a; Nordblad et al., 2004; Douglass et al., 2001; Milnes, 1996). The higher prevalence of caries in developing countries may be in part due to developing oral health systems with impaired service coverage. This barrier has been encountered and solved in some developed countries by providing high quality free-of-charge service for all children

and adolescents, with emphasis on prevention (Nordblad et al., 2004). The children with ECC participating in this study had not received restorative treatment except for one case, implicating the low possibility of receiving treatment for young children in Iran and emphasizing the importance of prevention. Taking into account the young population of the country (Pakshir, 2004) and rather high prevalence of ECC for these children, a public health approach to reach this young population seems to be essential.

### **6.3.2. Oral hygiene and ECC**

The frequency of oral cleaning in this child population was at a very low level compared to data reported from developed countries. For the present children, few mothers reported the recommended level of oral cleaning, while tooth brushing twice daily is practiced almost as a norm (85%-97%) for one- to four-year olds in several Nordic countries and in the USA (Pine et al., 2004; Hallonsten et al., 1995; Grytten et al., 1988). Recent reports show that just 57% to 67% of Iranian dental educators, dental students and dentists perform twice daily toothbrushing (Ghasemi et al., 2007; Khami et al., 2007, 2006), which is less than what is expected for dental professionals. This reflects the professionals' attitude toward preventive dentistry and indicates that they may not emphasize the importance of recommended oral self-care to patients as well as to mothers of these young children. Furthermore, this suggests an overall lack of emphasis on infants' oral health care in the whole community and among dental and medical professionals. Since the foundation of oral health behaviors of adults is already laid during early childhood (Petersen, 2007), it would be of great importance to improve the oral health behaviors in the early years of life.

The positive relationship between the mother's own toothbrushing frequency and the child's oral hygiene was an encouraging finding. It indicates that the mothers who brush their own teeth more frequently are more competent in performing oral cleaning for the child. Mothers play a key role not only as facilitators of oral cleaning of very young children, but also as transmitters of oral health behaviors to them (Mattila et al., 2000; Paunio, 1994). The present mothers played a dominant role in achieving children's good oral hygiene regardless of the families' SES. This calls for more attention to mothers' own oral hygiene behaviors regarding oral health promotion programs for children during early childhood.

Parents' attitudes toward their perceived ability to maintain their children's oral hygiene has been positively correlated with preschool-aged children's oral cleaning frequency or oral

health status (Finlayson et al., 2005; Pine et al., 2004). The present findings agree with these reports by revealing that mothers' positive conceptions of maintaining children's oral hygiene were related to the higher frequency of oral cleaning for the child. However, mothers' conceptions played no clear role in this child population's level of oral hygiene.

Many reasons may be attributed to the lack of relationship between the frequency of oral cleaning and the level of oral hygiene among these children. One may be that the frequency of oral cleaning for the majority of these children was less than the twice daily oral cleaning recommended by dental professionals (AAPD, 2007). Another reason may be the low involvement of adults in children's oral cleaning compared to that reported from several developed countries. The majority of adults in developed countries are involved in brushing the teeth of their one- to four-year-olds (Pine et al., 2004) in accordance with oral health care recommendations for young children (Choo, 2001; AAPD, 2000). Ultimately, the mothers reported a lack of skill in oral cleaning for the child that might be related to non-effective plaque removal. All these reasons indicate insufficient oral health knowledge and skills among the mothers and imply their increased need for more education in preventive oral health care.

As a result of insufficient cleaning, poor oral hygiene in terms of high occurrence of dental plaque dominated among these one- to three-year-olds. The present figures for dental plaque exceed those of some recent studies (Kiwauka et al., 2004; Habibian et al., 2001). Our finding that presence of ECC and dental plaque are directly proportional is in line with earlier studies (Sayegh et al., 2005; Kiwauka et al., 2004; Tinanoff et al., 2002; Habibian et al., 2001; Alaluusua and Malmivirta, 1994). Although the prevalence of ECC for the present children was not among the highest in developing countries, the high occurrence of dental plaque indicates increased risk for future caries, calling for imperative procedures to improve oral hygiene.

### **6.3.3. ECC, feeding and sugar**

One of the major challenges denoted by WHO (2003a, b) is to facilitate awareness-raising activities in the promotion of breastfeeding. Among other important health benefits of breast feeding for infant and mother, breast milk is suggested to prevent the occurrence of ECC. On the other hand, prolonged exposure of teeth to breastfeeding has been suggested as a risk factor for ECC (Azevedo et al., 2005, Sayegh et al., 2005). The majority of the present

children were exposed to prolonged breastfeeding, as the average duration of breastfeeding in these children is rated at the highest level (very good) according the WHO (2003b) criteria for children under 36 months. The multivariable analysis taking into account feeding habits, oral hygiene and demographic backgrounds, indicated that in line with two recent papers (Dye et al., 2004; Ribeiro and Ribeiro, 2004) and WHO recommendations, neither breastfeeding *per se* nor its duration was related to ECC. In several developed countries, the duration of breastfeeding is much lower than for the children in the present study (CDC, 2007b; Hasunen, 2001; Hallonsten et al., 1995). In light of the present findings in a population where prolonged breastfeeding has been the norm, new guidelines regarding feeding in early childhood seem essential to promote children's' feeding habits according to the WHO recommendation for 24 months of breastfeeding.

Feeding during the night may lead to prolonged exposure to fermentable carbohydrates and create a dentally harmful environment in the oral cavity (Hallet and O'Rourke, 2006; van Palenstein Helderma et al., 2006; Ribeiro and Ribeiro, 2004; Hallet and O'Rourke, 2003; Huntington et al., 2002; Olmez and Uzamris, 2002; Oulis et al., 1999; Seow, 1998). Among all factors investigated in this study, the burden of nighttime milk-bottle feeding showed the most prominent impact on presence of ECC. The strong impact of nighttime bottle-feeding might be partly attributable to the fact that the oldest age group included only three subjects having nighttime bottle-feeding, two of whom (67%) presented with caries. However, it is notable that 11% of all children have experienced this practice. Although the use of a wide variety of methodologies makes comparisons difficult, it seems that nighttime feeding among the present one- to three-year-olds was more common than that reported for corresponding age groups elsewhere (van Palenstein Helderma et al., 2006; Schroth and Moffatt, 2005; Hallet and O'Rourke, 2003; Douglass et al., 2001). This alarming finding points to the need to provide mothers with instructions and guidance by health professionals. Either the mother should not administer the bottle at all, as the child may even refuse breastfeeding after bottle use (WHO, 2003b), or stop it when the child is 12 to 14 months of age (AAPD, 2007). It would be also useful to recommend a rich meal before bedtime for the children to help them sleep through the night without a need for more feeding.

A diet rich in non-milk extrinsic sugars has been considered cariogenic for infants' and toddlers' teeth (Marshall et al., 2005; Jose and King, 2003), although reservations have also been reported (Kiwanuka et al., 2004; King et al., 2003; Matee et al., 1994). In the present

study, the multi-variable analysis revealed no relationship between child's daytime sugar intake and ECC. A weak or non-existent relationship between sugar intake and caries may be attributed to either extensive use of fluorides or widespread sugar intake (Harris et al., 2004; Burt and Pai, 2001); the latter may be more related to the present setting. Along with the possibility of increased caries risk in the future (Karjalainen et al., 2001), high sugar intake also has been linked to obesity and related conditions (AAPD, 2007). On the other hand, the combined variable of visible plaque and nighttime feeding failed to explain the prevalence of ECC, suggesting some other contributing factors for development of ECC. Therefore, limitation of sugar intake for these young children seems crucial as regards to a common risk factor approach taking into account both general and oral health (Sheiham and Watt, 2000). In addition, it would be of great importance to guide mothers as to the possible cariogenicity of pediatric medicines and iron drops. The cariogenic sugars have been eliminated from medicines in some countries, but this should be widespread so as to include all pediatric medicines in all countries (WHO, 2003a).

#### **6.3.4. Intervention to prevent caries**

The present randomized trial demonstrated that an educational intervention to prevent caries implemented by general health staff and targeting mothers of young children was effective in slowing down the development of enamel caries in intervention groups, in particular for those receiving motivation from the health staff.

The encouraging finding of the success of the present intervention in caries prevention agrees with the results of some previous studies on oral health education and dietary counseling for mothers of very young children (Felden et al., 2007; Ekstrand et al., 2000), whereas reservations about the effectiveness of educational methods in caries prevention have also been raised (Rozier, 2001). The recovery of some of the enamel caries in the present study may be due to the intervention, as no such recovery occurred for the controls. In future, enamel caries may progress to dentinal caries, in particular with a lack of sufficient fluoride application (Hausen et al., 2007; Ismail, 1997). In the present intervention, the importance and appropriate use of fluoride for the young children was emphasized according to the evidence-based knowledge of the effectiveness of fluoride toothpaste in caries prevention (Gussy et al., 2006; Marinho et al., 2003; Davies et al., 2002; You et al., 2002; Kay and Locker, 1998). The use of fluoride toothpastes is considered to be a public health measure,

and every effort must be made to develop affordable fluoride toothpastes for use in developing countries (WHO, 2003b).

In the present study, the caries increment in children in the group whose mothers received verbal explanation on oral health instructions and recall phone calls was lower than that in the other groups. In addition, mothers reported more positive self-perceived behavioral changes than those in the group with a pamphlet only. The present findings concur with those of other studies considering reinforcement of mothers' information and motivation of the mothers to follow oral health instructions as determinants increasing the effectiveness of oral health promotion interventions (Plutzer and Spencer, 2007; Weinstein et al., 2004).

Health promoting behaviors are established in infancy and early childhood (Petersen, 2007). Because young children do not commonly attend dental care settings before the age of three years in many countries, professionally applied oral health promotion might not be considered a proper approach in these countries (Douglass et al., 2004; Wendt et al., 2001, Samadzadeh et al., 1999). The countries with free-of-charge dental services have been successful in reaching these young children, but costs in these countries are high as a result of using a dentist-dependent oral health promotion. To provide environmental support (WHO, 1986), the oral health promoting programs should be given in a setting accessible for all the population, while preserving health care financial resources. Therefore, along with the new approaches of public health, oral health promotion should be integrated into the existing preventive programs implemented by other health professionals (Sheiham and Watt, 2000). This can be accomplished by applying a "common risk factor approach" which is highly recommended for health promotion (Sheiham and Watt, 2000). This approach takes advantage of the common risk behaviors regarding the impacts of diet and hygiene in general health as well as dental health. In young children, some other behavioral aspects such as breastfeeding and transmission of bacteria can be best addressed by the common risk factor approach. In the present study, the vaccination offices of public health centers seemed to be appropriate, where available non-dental staff could provide mothers with oral health instruction along with their other daily duties for promoting the general health of children.





## **7. CONCLUSIONS**

1. A rather high prevalence of ECC and dominance of untreated caries in Iran call for an improvement in children's oral health maintenance among all who serve as the primary caregivers of young children.
2. Oral cleaning in early childhood seems to be insufficient regarding its inception, frequency, and adults' responsibility regarding it. Regular and frequent oral cleaning in early childhood needs emphasis. In addition, the most prominent factor showing a relationship with the children's good oral hygiene was higher frequency of mothers' toothbrushing.
3. ECC was associated with milk-bottle feeding at night as the strongest factor among all feeding habits and oral hygiene. Milk-bottle feeding at night should be curtailed for children, whereas prolonged breastfeeding appears to have no such negative dental consequences.
4. Education regarding infants' and toddlers' oral health by non-dental staff in general health settings seems a feasible way of preventing or slowing down caries development in early childhood in countries with a developing oral health system.

## **8. RECOMMENDATIONS**

1. Community-based oral health educational programs involving non-dental health staff in public health centers should be established to include all health care facilities that children from all socio-economic levels visit from infancy on. The program should take advantage of a common risk factor approach to optimize the benefits from providing both general and dental health.
2. General health practitioners, pediatricians, and nurses should be encouraged to integrate oral health education into health instructions delivered to parents of young children.
3. Parents should be encouraged to realize that they play the dominant role as models for their children. Parents' own oral health behaviors and their active role in performing oral cleaning for their children should be emphasized in dental and general health settings. Public health

centers which provide counseling for expectant parents should cover oral health topics in their education.

4. A multi-sectoral approach should be considered in oral health promotion for children. Therefore, for delivering oral health-related messages to the parents and their children, oral health-related topics should be briefly included in all educational settings from kindergartens to colleges. The mass media, in particular television, could be an auxiliary help in transferring oral health messages to the parents and children.

5. Further research is needed to assess the possible barriers to implementation of an oral health educational program by non-dental staff of public health centers and other medical professionals. Evaluation of their oral health knowledge, attitudes, and practice or considering ways to keep them motivated seems to be useful in enhancing the chance for a successful program.

## 9. SUMMARY

The countrywide report for Iran gives a prevalence of 47% for ECC in three-year-old children, with a dmft of 1.8. It notes that approximately 98% of the dmft is due to caries. As Iran has one of the youngest populations in the world, with 13% under six years of age, the high number of decayed primary teeth is an alarming finding.

The present study assessed the prevalence of and risk factors for ECC in children 12- to 36-month-old and evaluated the impacts of an educational intervention on ECC in 12- to 15-month-old cohort. The working hypotheses were that a) ECC is related to the children's feeding habits, oral hygiene, and to the mothers' oral health behaviors and that b) Improvement in the children's oral health can be achieved through oral health education given to the mothers by non-dental staff of public health centers.

The target population included 12- to 36-month-olds and their mothers attending the vaccination offices of public health centers of Tehran city; 18 public health centers were randomly selected. On four working days devoted to each health center, all target children were enrolled, resulting in 504 children, 254 boys and 250 girls. Preceding the vaccination, each mother was first interviewed with a structured questionnaire, and then the child's clinical dental examination was carried out in a private room close to the vaccination room. The questionnaire covered background factors, feeding habits, daytime sugar intake, mother's and child's oral cleaning habits and mother's perception toward her ability to maintain the child's oral hygiene.

In addition, 12- to 15-month-olds ( $n = 242$ ) were assigned to a six-month interventional study. Health centers were randomly divided into three groups: two for intervention and one as the control. Before the vaccine shot, each mother in the intervention groups received education on caries prevention from the vaccination staff with extra motivation as reminder phone calls in one of the intervention groups. The outcome was measured as differences in increments of enamel and dentinal caries and as mothers' perceptions of the usefulness of intervention.

The results show that the prevalence of ECC was between 3% and 26% in the three age groups and was not related to the child's demographic backgrounds except for the child's age. All dmft was due to untreated caries except for one child.

The majority of the children showed visible plaque on central upper incisors. Of the mothers, 68% reported brushing their own teeth on a daily basis. Over half the mothers stated that they did not know how to brush or clean their children's teeth. Oral cleaning on a daily basis was reported for 39% of the children, and for 38%, no cleaning. The frequency of oral cleaning and the good oral hygiene of the child were directly proportional to the mother's own toothbrushing frequency. The presence of ECC was more likely to occur in the children with poor oral hygiene (OR = 1.5).

Breastfeeding was the norm: of these children, 98% were solely or partly breastfed. The burden of nighttime breastfeeding was high for one third of the children. The burden of milk-bottle feeding during the night was existent for 11% of the children. ECC was more likely to occur among those milk-bottle-fed at night (OR = 4.9). Neither breastfeeding *per se*, nor its duration, nor its nighttime burden was related to ECC. The indicator of daytime sugar intake did not show a clear relationship to ECC.

During the intervention, no new enamel caries appeared on upper central incisors of the group who had received a pamphlet and extra motivation. The group receiving the pamphlet only also showed lower increments in developing new enamel caries, but the difference was not significant when compared to controls. Increment in new dt was minor and showed no differences between groups ( $p > 0.05$ ). Mothers reported more positive self-perceived behavioral changes in the pamphlet and motivation group than those in the group with a pamphlet only.

In conclusion: The majority of the 12- to 36-month-olds were exposed to dentally non-desirable dietary habits, lack of recommended oral cleaning and improper oral hygiene, therefore they were susceptible to ECC. Mothers stated that they lacked the skills to properly clean the children's teeth. On the other hand, mothers' higher frequency of oral cleaning indicated better oral hygiene for the children. Educational intervention applying a pamphlet with some extra motivation appeared to be successful in caries prevention in early childhood.

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**12. APPENDIX**.....Questionnaire

(Questions not used for the present study are excluded.)

Questionnaire number		Date of examination		Area code	
Center name		Center code		Turn	

**1. Background information**

- 1.1. Child's name: .....
- 1.2. Address: .....
- 1.3. Telephone number: .....
- 1.4. Date of birth; (dd/mm/yy): .....
- 1.5. Gender: 1. Boy 2. Girl
- 1.6. What is the child's birth order? .....
- 1.7. Who looks after the child during the day?
  - 1. Mother
  - 2. Kindergarten staff
  - 3. Grandma
  - 4. Others
- 1.8. How old is the child's primary care giver?.....Years

**2. Socio- Economic Status**

- 2.1. How much is the household income in one month?  
 Rials
- 2.2. Do you live in a rent house? 1. Yes 2. No
- 2.3. All together including yourself, how many people regularly live in the same house with the child?  
 Children : ..... Adults (older than 15) : .....

**2.4. What is the highest level of the mother's education?**

- 1. Illiterate
- 2. Primary, secondary
- 3. High school, diploma
- 4. Associate degree
- 5. Bachelor's degree
- 6. Master's degree
- 7. Doctorate

**2.5. What is the highest level of the father's education?**

- 1. Illiterate

- 2. Primary, secondary
- 3. High school, diploma
- 4. Associate degree
- 5. Bachelor's degree
- 6. Master's degree
- 7. Doctorate

**3. Medicines**

- 3.1. How often did your child take antibiotics during the last 12 months?  
 .....Courses
- 3.2. Does or did the child use iron drops? 1. Yes 2. No
- 3.3. Does or did the child have something after iron drops?
  - 1. Water
  - 2. A sweet liquid or solid
  - 3. Nothing
  - 4. Others .....

**4. Mothers' perception of their perceived ability to maintain the children's oral hygiene**

Please answer the following questions with:

- 1. Strongly agree, 2. Agree, 3. Disagree, 4. Strongly disagree, 5. I don't know

Statements	1	2	3	4	5
1. I don't know how to brush or clean my child's teeth properly.					
2. We don't have time to brush or clean our child's teeth twice a day.					
3. We can not make our child brush or clean his/her teeth twice a day.					

**5. Feeding habits and snacking**

- 5.1. How long has the child been breastfed? .....Months
- 5.2. At what age did the child get introduced to the bottle?.....Months old
- 5.3. What is or was the duration of bottle feeding? .....Months
- 5.4. What is the first most frequent content of the bottle in the daytime?
  - 1. Water
  - 2. Breast milk
  - 3. Cow's milk
  - 4. Formula

5. Sweet liquid
6. Others

**5.5. What is the second most frequent content of the bottle in the daytime?**

1. Water
2. Breast milk
3. Cow's milk
4. Formula
5. Sweet liquid
6. Others

**5.6. Does the child sleep with the bottle (other than water) or breast in his/her mouth at bedtime?**

1. Breast
2. Bottle
3. Both
4. None

**5.7. If the child gets up in the night what do you usually do to make him/her sleep?**

1. Breast feeding
2. Bottle containing milk
3. Bottle containing a sweet liquid
4. Bottle containing water
5. No feeding, other behaviors like comforting him/her and walking

**5.8. How many times do you usually feed your child during the night?**  
..... Times

**5.9. How often does the child eat sugary meals, snacks, and drinks in a day?**

1. About 5 times a day or more
2. About 4 times a day
3. About 3 times a day
4. About twice a day
5. About once a day
6. Occasionally, not every day
7. Rarely or never

**6. Oral cleaning**

**6.1. What is used to clean the teeth of the child?**

1. Washcloth
2. Gauze
3. Toothbrush
4. Water

5. Teeth are not cleaned at all
6. Others

**6.2. Who performs the child's toothbrushing?**

1. The child alone
2. Another child
3. The child with supervision of adults
4. The child with the help of adults
5. The adults alone

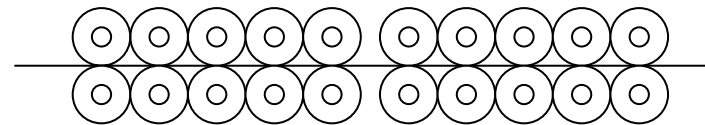
**6.3. How often are the child's teeth usually brushed or cleaned?**

1. Irregularly or never
2. Once a week
3. A few (2-3) times a week
4. Once a day
5. More than once a day

**6.4. How often do you brush your teeth?**

1. Irregularly or never
2. Once a week
3. A few (2-3) times a week
4. Once a day
5. More than once a day

**7. Examination and Observation:**



Red = Decay  
 Blue = Filling  
 Green mark = Erupted  
 e = Enamel caries on the labial surface of central incisors

**7.1. Dental status**

dt     mt     ft   
 ECC  (0 = No ECC, 1 = ECC)  
 S-ECC  (0 = No S-ECC, 1 = S-ECC)  
 N.O.T   
 Enamel caries  (0 = No, 1 = On right incisor, 2 = On left incisor, 3 = On both)

**7.2. Oral hygiene**

Is there any plaque on the right incisor?   
 Is there any plaque on the left incisor?   
 (0 = No visible plaque, 1 = On gingival margin only, 2 = More visible plaque)