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Oral Health among Iranian Preadolescents: A School-Based Health Education Intervention

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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 8 October, 2010 at 12 noon.

Helsinki 2010

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ISBN: 978-952-92-7966-1 (paperback)
ISBN: 978-952-10-6460-9 (PDF)
Yliopistopaino 2010
Electronic version available at http://ethesis.helsinki.fi/

"In the name of Him who created and sustains the world,
He knoweth of the things that exist not, of secrets that are untold,
The two worlds are as a drop of water in the ocean of His knowledge."

Saadi, Iranian poet (13th Century A.D)

To My Mother;

The Sun of My Life.

ABSTRACT

Saied-Moallemi Z. Oral Health among Iranian Preadolescents: A School-Based Health Education Intervention. Department of Oral Public Health, Institute of Dentistry, University of Helsinki, Finland, 2010. 100 pp. ISBN 978-952-92-7966-1.

The present study assessed oral health and its determinants among Iranian preadolescents, and evaluated a school-based health education programme aimed to promote their oral health.

The target population of this study comprised a random sample of the third-grade school children (n = 459) of all public primary schools in 19 areas of Tehran city. The data came from a clinical examination of the children and two self-administered questionnaires: one for children, and one for mothers. All of the children completed their questionnaires in class under supervision. The clinical dental examination was then performed for recording children's oral health. Each child was asked to take home a cover letter and the mother's questionnaire, to be completed and returned to school. The questionnaires covered background factors, oral self-care (OSC) behaviours and oral health-related knowledge and attitude statements.

After baseline data collection, a community trial was designed as a 3-month school-based intervention study. For the intervention trial, the third-grade classes as the clusters were randomly assigned to the intervention and control groups. Three kinds of intervention were implemented, one in class, one via the parents, and one as a combination of these. One group served as controls with no intervention. The outcome measures of the study were changes in plaque and bleeding scores recorded.

The results showed that mean dmft was 3.75 (SD = 2.8) for the primary teeth and mean DMFT was 0.4 (SD = 0.9) for the permanent teeth. All children had plaque on at least one index tooth and bleeding on probing in at least one index tooth occurred in 81%. About one-third (34%) of the children reported favourable OSC and less than half (46%) of the children reported brushing their teeth at least twice daily. Girls reported favourable OSC (OR = 2.0), had decay-free teeth (OR = 1.8) and treated permanent teeth (OR = 3.3) more than did boys. Higher parental education had a positive influence on the some of the aspects of children's oral health status (ORs from 1.2 to 1.6), but no influence on children's reported tooth brushing and OSC. Mother's oral health-related aspects, i.e., mother's favourable OSC, high knowledge levels of and positive attitudes towards oral health, and active supervision of the child's tooth brushing had a positive effect on all aspects of children's oral health status and behaviours (ORs from 1.3 to 1.9). After the intervention, the results showed a strong intervention effect on healthy gingiva in both groups where parents were involved: the

parental-aid group (OR = 7.7, 95% CI 2.2-27.7) and combined group (OR = 6.6, 95% CI 2.0-22.1).

To improve children's oral health, community school-based oral health educational programmes should be established to include all primary schools. These programmes should benefit from the common risk factor approach – to optimise their benefits for both general and oral health – and a multi-sectored approach – to employ for communication between the community, the school, and the family. Parents should be made aware how imperative is their modelling role in their children's oral health and behaviour. Oral health interventions should empower the parents' ability to improve their own oral health behaviour and then to transfer that healthy behaviour to their children.

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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. Saied-Moallemi Z, Virtanen JI, Tehranchi A, Murtomaa H. Disparities in oral health of children in Tehran, Iran. Eur Arch Paediatr Dent 2006;7:262-264.

II. Saied-Moallemi Z, Murtomaa H, Tehranchi A, Virtanen JI. Oral health behaviour of Iranian mothers and their 9-year-old children. Oral Health Prev Dent 2007;5:263-269.

III. Saied-Moallemi Z, Vehkalahti MM, Virtanen JI, Tehranchi A, Murtomaa H. Mothers as facilitators of preadolescents' oral self-care and oral health. Oral Health Prev Dent 2008;6:271-277.

IV. Saied-Moallemi Z, Virtanen JI, Ghofranipour F, Murtomaa H. Influence of mothers' oral health knowledge and attitudes on their children's dental health. Eur Arch Paediatr Dent 2008;9:79-83.

V. Saied-Moallemi Z, Virtanen JI, Vehkalahti MM, Tehranchi A, Murtomaa H. School-based intervention to promote preadolescents' gingival health: a community trial. Community Dent Oral Epidemiol 2009;37:518-526.

In addition, unpublished analyses and results have been presented.

ABBREVIATIONS

ANOVA	Analysis of variance
BI	Bleeding index
CI	Confidence interval
CPI	Community periodontal index
CRFA	Common risk factor approach
DT	decayed permanent teeth
dt	decayed primary teeth
DMFT	decayed, missing, and filled permanent teeth
dmft	decayed, missing, and filled primary teeth
FB	Favourable behaviour
FT	Filled permanent teeth
ft	filled primary teeth
GEE	Generalized estimating equations
HPS	Health Promoting School
MOE	Ministry of Education
MOHME	Ministry of Health and Medical Education
MT	Missing permanent teeth
mt	missing primary teeth
NNT	Number needed to treat
OR	Odds ratio
OSC	Oral self-care
PI	Plaque index
PHC	Primary Health Care
PPM	PRECEDE-PROCEED model
RCT	Randomized controlled trial
RI	Restoration index
SD	Standard deviation
SES	Socio-economic status
UB	Unfavourable behaviour
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WHO	World Health Organization

CONTENTS

1. INTRODUCTION

Oral health, an integral part of general health, significantly impacts quality of life. “It enables an individual to speak, eat and socialize without active disease, discomfort or embarrassment” (WHO, 2003a). Oral diseases can lead to irreversible damage and unnecessary pain, and further result in dental anxiety, general health problems, depression, low self-esteem, lost school time and poor quality of life (WHO, 2003a; ADA, 2004).

Despite great improvement in oral health, many countries still encounter oral diseases, particularly in disadvantaged segments of the population (Petersen, 2005a). Caries decline in developed economies has resulted in a polarization of caries prevalence (Vehkalahti et al., 1997; Whelton, 2004), and the improvements have now halted in younger age groups (Moynihan & Petersen, 2004). A global increase in the prevalence of dental caries is predicted to be a pending public health crisis (Bagramian et al., 2009).

Increasing levels of dental caries among children are observable especially where preventive oral care programmes are not established (Ismail et al., 1997; Sckiguchi & Machida, 1999; WHO, 2000). In most low- and middle-income countries, the general population does not benefit from systematic oral health care, nor have preventive programmes been instituted (The Lancet, 2009). Globally, the greatest burden of oral diseases is among underprivileged populations (Petersen, 2008).

Gingival bleeding and dental plaque are common in school-aged children worldwide (Almeida et al., 2003; Martens et al., 2004), causing unsatisfactory oral health among children. Their oral health is therefore a significant public health concern; reducing the burden of oral diseases in schoolchildren is a global goal of the WHO (Hobdell et al., 2003a).

Dental caries and periodontal disease can be viewed as behavioural diseases (Schou & Blinkhorn, 1993) preventable by simple oral hygiene practices. Physical, biological, environmental, behavioural, and lifestyle-related factors (Eriksen et al., 2006; Selwitz et al., 2007) have been described as determinants of health. As these determinants have significantly influenced oral health (Petersen, 2005b) efforts to prevent and control oral diseases should therefore focus on these underlying factors (Watt, 2002a). More research should be devoted to identifying and reducing risk factors and the burden of oral disease in the developed and emerging economies.

The preadolescent period is a critical time to establish attitudes and beliefs and shape an individual’s health behaviour. During the stage of childhood to adolescence, health

behaviours consolidate and probably will not change beyond adolescence (Kelder et al, 1994; Kuusela et al., 1996; Åstrøm, 2004). Stability and early consolidation have particularly been evident for tooth brushing behaviour (Åstrøm & Jakobsen, 1998). During their school years children are receptive to accepting and maintaining positive health behaviours (Addy et al., 1994): the earlier the habits are established, the longer their impacts last (WHO, 2003a). To adopt good oral health behaviour early in life is easier than to change detrimental oral health behaviours later in a child's development (Schou & Blinkhorn, 1993; Kelder et al., 1994). Favourable tooth brushing behaviour has been shown to remain more stable than does unfavourable behaviour (Åstrøm & Jakobsen, 1998). To target children therefore in kindergarten and primary school is of importance (WHO, 2003a).

The family is a key social organization having the primary responsibility for the proper development of both child and parental health (Åstrøm, 1998; Pine et al, 2000). Research shows that parental oral health-related knowledge, belief, and attitudes influence the oral health and oral health behaviour of their children (Pine et al., 2000; Okada et al., 2001; Szatko et al., 2004; Poutanen et al., 2007a). In the family, especially the role of the mother has attracted attention in relation to a child's oral health habits and status (Åstrøm, 1998; Okada et al, 2002; Mahejabeen et al, 2006). Mothers are regarded as very significant mediators in their children's health actions (Honkala et al., 1983; Okada et al, 2001; Poutanen et al., 2007a). To find factors promoting the child's oral health, more research on family characteristics and parent-child relations would be suggested (Christensen, 2004), especially in cultures similar to Iran's in which mothers play a significant role in rearing their children.

Among a range of suitable settings for targeting defined population groups, school has been the main setting for oral health promotion interventions (Watt, 2005). The school years represent a very influential time when lifelong beliefs and attitudes are developing (Kwan et al., 2005). Oral health-related intervention through the school can improve the child's oral health and oral health behaviour. Globally, approximately 80% of children attend primary schools (WHO, 2003a); this means to almost all of the 6 to 11-year-old Iranian children, due to its compulsory education (MOE, 2007).

Preadolescents and adolescents make up the largest demographic sector of the population of Iran, about one-third of the whole, making Iran one of the youngest countries in the world. The primary health care (PHC) system in Iran has been well organized during 30 years, however, it is more targeted on children under age 6 and pregnant mothers. Oral health care was integrated into the PHC system in 1995. A national oral health promotion programme for Iranian primary schoolchildren was initiated in 1998 (Samadzadeh et al., 2000). Despite a low

caries prevalence among 12-year-old children (DMFT = 1.86: MOHME, 2009), oral hygiene and tooth brushing behaviour are unsatisfactory.

The present study aimed to determine factors related to oral health of children and evaluated a school-based health education programme in order to reach to the ultimate goal of promoting oral health among children.

2. LITERATURE REVIEW

2.1. Oral health promotion

2.1.1. The concepts of health- and oral health promotion

Among a variety of definitions of health promotion, the WHO (1986) definition has been accepted as a useful description of contemporary practice: "Health promotion is the process of enabling individuals and communities to increase control over the determinants of health and thereby improve their health. Health promotion represents a mediating strategy between people and their environment, combining personal choice and social responsibility for health to create a healthier future." Health promotion focuses on the determinants of health; socio-economic and environmental factors, as well as the individual health-related behaviours (Daly et al., 2002). Indeed, a major emphasis in health promotion is "to make the healthy choices the easy choices" (Milio, 1986).

By focusing on the role of social environments, social organisations, and public policies in promoting health, the new concept of what Kickbusch (2003) called "the third public health revolution" emerged. Nutbeam (1998a) provides a useful summary of this revolution: "the new public health is distinguished by its basis in a comprehensive understanding of the ways in which lifestyles and living conditions determine health status, and a recognition of the need to mobilize resources and make sound investments in policies, programmes and services which create, maintain and protect health by supporting healthy lifestyles and creating supportive environments for health."

Dental health education has traditionally concentrated on oral health through learning activities directed at promoting individual behaviour change, primarily through the acquisition of oral health knowledge (Watt et al., 2001). Dental health education is defined as "a planned package of information, learning activities, or experiences that are intended to promote dental health" (Overton Dickinson, 2005). Oral health literacy emphasizes the availability of skills to obtain, understand, and use information for appropriate oral health decisions (Horowitz & Kleinman, 2008).

While dental health education was the dominant practice in the 1970s and 1980s, the discipline of oral health promotion has emerged in the 1990s based on the WHO definition (Watt et al., 2001). The principles of this new movement has been recognition of the importance of the social, political, and environmental determinants of oral health and the need to reduce oral health inequalities (Ashton & Seymour, 1990).

As for the major chronic diseases, socio-environmental factors are distal causes of oral diseases (Petersen, 2005b). Psycho-social, economic, political, and environmental factors are known to be social determinants of health (Marmot & Wilkinson, 1999; Newton & Bower, 2005). Public health strategies therefore need to be directed at the underlying determinants, "the causes of the causes" (Rose, 1992; Sheiham, 2000; Watt, 2005). Contemporary oral health promotion seeks to promote oral health by improving both the ways people live as well as the conditions of living relevant to oral health (Schou & Locker, 1997).

Health promotion can operate by five different approaches: preventive, behavioural change, educational, empowerment, and social change (Daly et al., 2002). The aim of the "preventive approach" is a reduction in disease levels, in which the health professional acts as the expert and the patients are passive recipients of preventive care. Fissure sealant is one example of this kind of oral health promotion. "Behaviour change" (such as health education advice by dentists) aims to encourage individuals to take responsibility for their health and adopt a healthier lifestyle. This approach is based upon the theory that the provision of information will change behaviour.

The "educational approach" (such as school-based educational programmes) aims to provide individuals not only with knowledge but also with skills and attitudes to make informed choices about their health-related behaviour. In the "empowerment approach", individuals learn to identify their own concerns and priorities, and to develop the confidence and skill to address these issues. The approach of "social change" addresses the importance of socio-economic and environmental factors in determining health. It therefore aims at changing the physical, social, and economic environments to promote health and well-being. Implementation of water fluoridation is an example of this approach. A combination of approaches is, however, the best way to promote oral health (Daly et al., 2002).

Population- vs. Risk-Based Approaches

Rose (1992) described two basic types of preventive approach, the high-risk and the population approach. The high-risk approach aims to focus attention on individuals at high risk who have been identified through screening tests and offered preventive support (Watt, 2005). This approach is very popular with many health professionals as it fits well with a clinical approach to prevention. This approach is criticized in terms of its underlying concept and long-term success (Rose, 1992; Batchelor & Sheiham, 2002). As it is not directed at the underlying determinants of disease; new high-risk individuals will constantly be emerging.

In the population approach, public health measures are implemented to reduce the level of risk in the whole population, shifting the whole distribution to the left (Rose, 1992). This more

radical approach aims to address the underlying causes of disease across the whole population. Examples of the population approach in oral health include fluoridation of water supplies, dental education through the mass media, and restriction of sugar intake by regulation or by financial incentives.

The targeted or directed population approach is another option that involves focusing action on higher risk groups or subpopulations. Rather than screening methods to identify the higher risk groups, epidemiological and/or socio-demographic data serve to define a particular subpopulation (Watt, 2005). This approach intends to reduce the disadvantages and to enhance the advantages of a population and a high-risk approach. In the prevention of oral diseases, the high-risk approach has been largely dominant. What is now increasingly acknowledged is that a combination of the high-risk and directed population approaches is the best option (Rose, 1992; Beaglehole & Bonita, 1998; Petersen, 2003; Watt, 2005).

2.1.2. Health behavioural models

An extensive range of models and theories have been proposed to explain human behaviour change. The guiding principles found in health behaviour models provide useful methods to promote individual behaviour and health (Hollister & Anema, 2004). The psychological models of behaviour change provide a framework for understanding the process of behaviour change and the influence of social circumstances of individuals upon their behaviour (Yevlahova & Satur, 2009).

A first stage of psychological research on behaviour change started from the late 1920s. These behavioural-centred learning theories started with “classical conditioning” (Pavlov, 1927). This theory was applied in dental research for analyzing dental fear: originally neutral stimuli in a dental chair or the sound of a high-speed hand-piece might, through classical conditioning, be able to evoke a fear reaction in a young child, because of their association with the pain experienced during a dental procedure (Milgrom et al., 1985). “Operant conditioning” (Skinner, 1984) postulates that the probability of achieving a certain reaction increases if this reaction is positively reinforced: giving rewards to children when they brush their teeth will increase the frequency of this activity (Iwata & Becksforth, 1981).

The second stage (1950s and 1960s) of behavioural change research focused on underlying cognitive information. The idea was that behaviour can be changed because of the person’s own information processing and thinking, so this phase can be described as one stage of general cognitive theories. Bandura’s theory (1965) on modelling and observational cognitive learning states that behaviour change can result from observational learning. An anxious child

who observes another child being cooperative during a dental examination might learn by modelling this behaviour (McMurray et al., 1985).

The third stage of research is the stage of a specific social-cognitive approach to behaviour change. The Health Belief Model (Becker, 1974), Self-Efficacy (Bandura, 1977) and the Theory of Reasoned Action (Ajzen & Fishbein, 1980) are some of the main theories at this stage that have been used broadly in oral health research.

The "Health Belief Model" proposes that when individuals consider changing their behaviour they engage in a cost/benefit analysis of the situation. This would include an assessment of their susceptibility to the health threat, the perceived severity of that threat, and the perceived value of changing the behaviour in question. In addition, a cue (such as advice from a dentist or a piece of information on television) is needed to initiate an alteration in behaviour. Applying this theory to an oral health condition such as early childhood caries, the primary caregiver should believe that the child is susceptible to dental caries, that primary teeth are important and dental caries is a serious threat to them, that dental caries can be prevented, and the caregiver must be willing to limit the child's exposure to fermentable carbohydrates and must assist the child in practicing good oral hygiene (Hollister & Anema, 2004). Cross-sectional studies have shown a strong association between Health Belief Model stages and good oral health (Nakazono et al., 1997; Pine et al., 2000).

Perceptions of "Self-Efficacy" refer to the confidence of people in their ability to behave in certain ways. Better tooth brushing self-efficacy is related to a higher frequency of tooth brushing and less visible plaque (McCaul et al., 1985; Syrjälä et al., 1999). Confidence in one's ability to prevent periodontal disease significantly predicts adherence to oral hygiene regimens (Tedesco et al., 1991).

The "Theory of Reason Action" stresses the importance of attitudes and intentions in changing behaviour. In addition, one aspect of this theory is subjective norm that includes the role of other people in behaviour. A firmer intention to brush the teeth has been related to a higher reported frequency of tooth brushing (Tedesco et al., 1991; Syrjälä et al., 2002).

Theories at the third stage are logically a consequence of the ideas discussed in the first stage as well as the second stage of the prior research. However, different health behaviour models emphasize different aspects of health behaviour and do not cover all aspects of this issue. Some theories (for example, the Health Belief Model) stress situational characteristics (such as socio-demographic characteristics) and do not consider psychological aspects, and others (the Self-Efficacy and the Theory of Reasoned Action) stress the significance of

psychological factors (such as cognition) and neglect to include situational characteristics (Inglehart & Tedesco, 1995a).

Inglehart and Tedesco (1995a) therefore suggested the "New Century Model of Oral Health Promotion" based on earlier health behaviour models. This model explained that patients' behaviour is formed by cognitive, affective, and behaviour factors interacting in a complex pattern with the time perspective and the patients' situation. These authors argued that past behaviour is the best predictor of future behaviour. In addition, general health-related behaviour (such as diet and smoking) and dental health-connected behaviour (such as teeth grinding) should be considered as predictors of behaviour. A life-span approach to oral health promotion (time perspective) explains that oral health care practices must become a habitual part of a person's life to be effective. Considering situational factors such as socio-economic factors or educational level is crucial in determining oral health behaviour. The model could in part explain levels of oral self-care among adults with diabetes and account for the better understanding of the complexity of health promotion (Karikoski et al., 2002).

Different levels of behavioural change models

Behavioural change interventions are targeted at three main tiers: the individual, interpersonal, and community level (Linden & Roberts, 2004). Factors influencing behaviour at the individual level include knowledge, attitudes, and belief systems. The Health Belief Model (Becker, 1974) and the Stages of Change Model (Prochaska et al., 1992) are examples of models at an individual level. At the interpersonal level, the individual is influenced by close relationships with family, friends, and colleagues. How the person interacts with his or her immediate environment so that the desired behavioural change is achieved is the focus of the Social Learning Theory (Bandura, 1986 & 1977). Community factors include norms or standards of behaviour that all individuals are expected to follow within that community. These norms include lifestyle behaviours as well as the threats posed by environmental factors. The two theories that target these factors are the Diffusion of Innovations (Rogers, 1995) and the Theories of Organizational Change (Anson, 1994; Bridges & Mitchell, 2000; Bunker & Alban, 1997).

No single theory or model is appropriate as a guide in designing health interventions. What is preferable is to combine various behavioural models under the umbrella of an intervention to achieve the greatest impact on the target population (Linden & Roberts, 2004; Adair & Ashcroft, 2007). Two well-developed models currently being used for theses purposes are Social Marketing (Andreasen, 1995) and the PRECEDE-PROCEED Model (Green et al., 1980; Green & Kreuter, 1991). These models combine elements of the individual, interpersonal, and community levels.

The PRECEDE-PROCEED model is a planning model that provides a structure for the process of systematic development and evaluation of a behaviour-change intervention. The model was designed to provide a systematic approach to the planning, delivery, and evaluating of health promotion programmes. The core principle of this model is that behavioural change is a voluntary activity. As such, the basic tenet of the model is to lead individuals to play an active role in defining problems and goals and to develop and implement action plans (Linden & Roberts, 2004).

The PRECEDE-PROCEED model is multi-dimensional, founded in the social/behavioural sciences, epidemiology, administration, and education. "PRECEDE (*P*redisposing, *R*einforcing, and *E*nabling *C*onstructs in *E*ducational *D*iagnosis and *E*valuation) outlines a diagnostic planning process to assist in the development of targeted and focused public health programmes. PROCEED (*P*olicy, *R*egulatory, and *O*rganizational *C*onstructs in *E*ducational and *E*nvironmental *D*evelopment) guides the implementation and evaluation of the programmes designed using PRECEDE" (Green et al., 1980; Green & Kreuter, 1991). The purpose of this model is to direct one's initial attention to outcome and emphasizes that the influencing factors important to an outcome must be identified before the design of any intervention (Watson et al., 2001). During the PRECEDE phase, when the diagnostic process is performed, it is very important to identify and to rank the factors influencing outcomes. Each factor should be rated in terms of its importance to the health problem and in terms of its changeability. Afterwards, high priority for program planning can focus on more important and more changeable factors (PPM, 2010).

The comprehensive nature of the PRECEDE-PROCEED model allows its application in a variety of settings such as school health education (PPM, 2010). Furthermore, the model is an organizing framework for application of multiple health behaviour theories, such as the Stages of Change Model, the Health Belief Model, the Social Learning Theory, and the Diffusion of Innovations (Glanz & Rimer, 1995). In oral health research, the model proved a "useful guide to characterize resources, barriers, and organizational factors, proved a feasible method for building upon existing local resources and addressing oral health concern in the community" (Watson et al., 2001; Karim, 2006, Dharamsi et al., 2009). This model was also useful for designing a standardized oral cancer curriculum (Cannick et al., 2007). The underlying PRECEDE-PROCEED structure has been a guide to policymakers and public health professionals to choose the most effective way to reach the US public (SCDHEC, 2008).

2.1.3. School-based oral health promotion

A range of settings can serve for oral health interventions to target defined population groups. For example, nurseries, youth centres, colleges, workplaces, places of worship, and

community centres may provide suitable settings in which to target defined population groups (Watt, 2005). However, schools have been the main setting for oral health intervention promotions among children (Towner, 1993; Watt, 2005), offering an environment for improving health, self-esteem, behaviours, and life skills (St Leger, 2001; WHO, 2003a). Globally, as approximately a mean 80% of children attend primary schools, schools remain "an important setting, offering an efficient and effective way to reach over 1 billion children worldwide and, through them, families and community members" (WHO, 1996a). School can be conducive to the development of a healthy lifestyle, with its existing structure and system in place; it provides an excellent opportunity for health promotion of children (WHO, 2003a; Moysés & Rodriques, 2006). School-based oral health promotion programmes can be efficient, effective, cost-effective, and beneficial to the entire community (WHO, 2003a).

The Ottawa Charter for Health Promotion (WHO, 1986) outlined five health-promotion action areas: Build healthy public policy, Create supportive environments, Strengthen community action, Develop personal skills and Reorient health services. School is one of the best settings to effectively implement these actions (WHO, 2003a). The school years are an extremely influential period, because lifelong oral health beliefs and attitudes, as well as healthy behaviours are developing (WHO, 2003a; Kwan et al., 2005). Moreover, the school years have the advantage of regularly reinforcing health messages.

The idea of promoting health in schools commenced from the early 1990s (Beattie, 1996). For many years, school-based health promotion programmes were implemented as traditional health education through the school curriculum (Nutbeam, 1997; Moysés & Rodriques, 2006). The systematic reviews on oral health interventions concluded, however, that school-based educational programmes had no noticeable effect on caries increment and had only a small positive but temporary effect on plaque level, even when daily brushing at school was part of the programme (Sprod et al., 1996; Kay & Locker, 1998). Watt & Marinho (2005), in their review of the previous reviews, noting some limitations in the previous reviews, proposed that these results should be viewed with caution; however, they did confirm a short-term achievement in reduction in plaque and of gingival bleeding.

In clinical research, the randomized controlled trial (RCT) has been advocated as the gold standard for assessing effectiveness. However, the relevance and applicability of the randomized controlled trial in the evaluation of health promotion has been questioned and challenged (RED, 1996; Speller et al., 1997). In fact, in community settings, designing a study such as a RCT causes difficulties (Watt & Marinho, 2005) and is not feasible and applicable method. A recent WHO report (1998a) has stated: "The use of randomized control trials to evaluate health promotion initiatives is, in most cases, inappropriate, misleading and

unnecessarily expensive." Therefore a range of evaluation methods to assess the impact and effect of health promotion interventions are required (Nutbeam, 1998b; WHO, 1998a). Both quantitative and qualitative methods are required to fully evaluate the range of outcomes relevant to oral health promotion actions (Watt et al., 2001).

In any case, the reason that many oral health education programmes have appeared to fail to improve children's oral health behaviour is in part due to the lack of adequate dental educational materials. To enhance knowledge of the audience requires adequate attention to research preceding the development of appropriate, acceptable and efficacious dental health-education materials (Kay & Baba, 1991). Educational materials which present attractive and relevant subjects to each age-group could stimulate better oral health behaviour (Redmond et al., 2001).

To find strategies for youth health promotion for different countries, including education, public policies, laws, and regulations, is important to enhance the capacity of young people to make healthy lifestyle choices (Nutbeam, 1997). Besides many similarities between the countries, each country based on its regulations, finance, culture, and so forth should find suitable ways to promote health.

School-based oral health programmes in different countries

The effect of a 6-year oral health education programme was evaluated in primary school in Belgium (Vanobbergen et al., 2004). This programme consisted of annual one-hour instruction for children and teachers. The authors found that the programme did not result in a significant reduction in the caries prevalence measured; however, it has been effective in improving (some) of the children's reported oral health behaviour.

Among 10-year-old children in England, the effectiveness of a dental health education programme was tested (Worthington et al., 2001). This programme comprised four one-hour lessons by a dental nurse at school, and home work involving parents was an integral part. The control group had no intervention. After 7 months, the children on the programme had significantly lower mean plaque scores and greater knowledge than did the control children. Redmond and colleagues (1999), among 12-year-old English children investigated a school-based dental health education programme involving three lessons and discussions in each 6-month period by a dental nurse. Parental support was also requested. This intervention programme resulted in an improvement in knowledge of dental disease and in reported oral hygiene, as well as an increase in the reported duration of brushing.

Among Irish school children aged 7 to 12, an oral health programme was developed by means of a television campaign, run over a 6-week period, with video clips promoting key oral health messages (Friel et al., 2002). Concurrently, an oral health education programme was delivered to the children by a dental nurse. Positive changes occurred in the dental health knowledge and behaviour of these children after the dental nurse's intervention. More improvements were seen amongst those who reported having seen the TV programme, but the campaign itself had little apparent impact on the children. These results confirm that mass media campaigns can supplement the activities of health professionals to provide knowledge and effect behavioural change.

A similar type of population strategy in oral hygiene instruction has been implemented in the Nordic countries (Burt, 1998). Based on this strategy, a comprehensive programme of oral health care for children under 17 began from 1972 in Finland (Honkala et al., 1991). One of its main points was arranging oral health education for school classes by the oral public health care system. A positive trend in oral health behaviour could partly be explained by this national oral health promotion programme. Along with a sharp decline in caries, a high-risk strategy recommends to give oral health instructions to the group of adolescents with unfavourable oral health behaviour, which seems to have taken place in Finland (Honkala et al., 2002).

Oral health counselling in changing children's oral hygiene habits was evaluated among Finnish 11- to 13-year-olds (Kasila et al., 2006). A dental hygienist giving normative advice was the most common counselling strategy; however, the dental hygienist-centred discussion by one-side delivery of information is insufficient behaviour-change.

In Tanzania, weekly supervised tooth brushing and monthly lessons on aspects of oral health during one school year in grade 4, carried out by their teachers did not result in significant reduction in plaque score, gingival bleeding, or DMFT value (van Palenstein Helderman et al., 1997). In Zimbabwe, a one-time training of teachers in aspects of oral health was ineffective in lowering plaque levels among grade 2 and grade 4 children over a period of 3.5 years (Frencken et al., 2001). Authors declared that considering the low caries increment observed over the study period, the effect of the oral health programme on caries levels in the study group was inconclusive.

Chinese first-grade school children after a 6-year period of a school-based oral health promotion program showed improved attitudes to dental care and oral health behaviour (Tai et al., 2001). Their oral health status in regards to both dental and gingival status also improved. The programme consisted of a one-hour oral health education instruction for children, their

parents, and teachers once each year, as well as yearly dental examinations at school and referrals to a dental clinic. In Indonesia, a weekly supervised tooth-brushing and a monthly oral health-education programme by teachers among children in second grade (Hartono et al., 2002) showed, after 1.5 years, a moderate positive effect on oral health knowledge, on plaque level, and on the effectiveness of tooth brushing. The caries experience did not, however, differ among experimental and control schools.

In Canada, the effectiveness was evaluated of two methods of dental health education for improving oral hygiene knowledge among high-risk grade-one students (Hawkins et al., 2000). Most of these children were of a low socio-economic class and with an immigrant history. Students received a classroom-based dental health education lesson with and without two small-group sessions run by a dental health educator. After the intervention, both groups displayed improved oral hygiene knowledge, but the classroom plus small-group sessions method was more effective than was the single class-room lesson. A multi-week oral health education among 6- to 15-year-olds in Chicago enhanced children's oral health knowledge and reduced their plaque and gingival bleeding scores over a 4-week period (Biesbrock et al., 2004). Among Brazilian 13-year-old school children, the effect upon dental health knowledge and behaviour of a comprehensive and a less comprehensive preventive programme was compared in a 3-year follow-up study (Buischi et al., 1994). Children in both groups received oral hygiene training, while children in the comprehensive programme had more presentations and group sessions on oral health, and their parents and teachers received an oral presentation. Both groups showed more correct knowledge and better reported behaviour than did controls who had any of the other programmes; however, significant differences in knowledge as well as in reported behaviour were observable among children in the comprehensive group.

In Iran, a national oral health promotion programme for schoolchildren aged 6 to 12 years was initiated by the Department of Oral Health, Ministry of Health, in 1997 (Samadzadeh et al., 2000). This programme has included weekly use of 0.2% sodium fluoride mouth rinse supervised by health counsellors and volunteer teachers at school. In addition, by referral of the children to a health centre, low-cost facilities for basic curative and preventive treatments have been provided in this national programme. Annual oral health education has also been performed by health counsellors for the children. Caries experience among 12 year olds remained at the same level after six years (MOHME, 2000, 2009). While, sugar consumption increased during the last decades (Ghassemi et al., 2002).

Health Promoting Schools

The concept of the Health Promoting School (HPS) (WHO, 1996b) has been developed to address school health in a more comprehensive way. The HPS is defined as a school that

constantly strengthens its capacity as a healthy setting in which to live, to learn, and to work (WHO, 1998b). The elements of the curriculum, the environment, health services, the community relationship, and school policies should be considered in establishing an HPS (WHO, 1996b). An HPS provides opportunities to reduce inequality among children, as well as among the population as a whole (Kwan et al., 2005; Moysés & Rodriques, 2006). School can provide an important network and channel to the local community. Health promotion activities can be targeted at the home and throughout the community by school personnel. Similarly, through the pupils, health promotion messages can be passed on to other members of the family. This school-home-community interaction is an important aspect of an HPS (Booth & Samdal, 1997).

Evidence-based evaluation of the impact of the HPS approach is limited but promising (Lister-Sharp et al., 1999). Fully supported healthy schools result in health gains for the children and staff of the schools (Moon et al., 1999). The oral health of 12-year-old children in deprived areas in Brazil was compared in supportive and non-supportive schools (Moysés et al., 2003). Results showed that schools with the highest level of implementation of health-promoting policies had higher percentages of caries-free children and fewer children with dental trauma. A 3-year follow-up study among Chinese school children in grade one was performed by means of daily oral hygiene instruction and supervised tooth brushing by teachers, as well as oral health education for mothers. The program had positive effects on gingival bleeding score and the reported oral health behaviour of children. However, the program demonstrated no positive effect on dental caries incidence rate (Petersen et al., 2004). The HPSs have positively impacted health-related attitudes and behaviours among children in the UK (Gill et al., 2009).

The HPSs, however, face many challenges in the promotion of health and oral health (Kwan et al., 2005). Sustainable funding, resources, and trained personnel are lacking (MacGregor, 1999). All components of an HPS may not be encompassed in all of these schools (Denman et al., 2002); “to create a coherent, complementary, and integrated approach” is particularly challenging. “Without supportive policies, infrastructure, budget, and commitment from various government departments”, the obstacles may remain insurmountable (Kwan et al., 2005).

Implementation of a combined oral health prevention programme comprising oral health education and other prevention programmes such as milk fluoridation in England (Riley et al., 2005), fissure sealant and scaling in Cape Town, South Africa (Lalloo & Solanki, 1994), use of different forms of fluorides, fissure sealing, and professional plaque control in Denmark (Petersen & Torres, 1999), and use of fluoride, fissure sealant, and restorative treatment of

dental caries in Kuwait (Vigild et al., 1999a) show high effectiveness of such programmes in reducing the prevalence of dental caries. However, evaluation of human and financial resources is required to assess the overall cost-effectiveness of these kinds of programmes (Lalloo & Solanki, 1994).

Due to scarce resources in the health-care sector, selecting the best preventive approach necessitating the fewest resources is vital (Oscarson et al., 2003). Especially in countries with a developing oral health care system, a suitable educational programme must go without costly professional input (Watt & Marinho, 2005). On the other hand, in Finland, intensifying prevention (counselling, F-varnish applications, F-lozenges, sealants, and chlorhexidine) has produced no additional benefit among low-risk children compared to basic prevention (counselling, one F-varnish application/year) (Hausen et al., 2000).

Promotion of oral health in schools, aiming at developing healthy lifestyles and self-care practices in children and young people is one of the most recent policies and strategies recommended by the World Health Assembly: "An integrated approach that combines school health policy, skill-based health education, a health-supportive school environment, and school health services can tackle major common risk factors and contribute to effective control of oral disease." (Petersen, 2008)

2.1.4. Family context for oral health promotion among children

The family plays a crucial role in children's general health and oral health. "The family is clearly a complex site for the reception, transmission and communication of health information." (Holland et al., 1996). Health behaviours are woven into the daily life of family members during establishment of sustainable routines (Christensen, 2004). The influence of parents on their children's oral health is central (Mattila et al., 2005a). The family is a key social organization in society with its primary mission to undertake the appropriate development of child and parent health (Åstrøm, 1998; Pine et al., 2000). This emphasizes the importance of primary socialization (Blinkhorn, 1978) and the transmission of health knowledge and behaviour, especially from mother to child, and suggests the special responsibility of mothers to provide health care and support for their children (Okada et al., 2002; Mahejabeen et al., 2006).

The family is considered a powerful social environment to promote physical and emotional well-being, to prevent and control diseases, to influence concepts about health and health behaviours (Moysés & Rodriques, 2006). Beliefs about oral health, oral hygiene habits, a healthy diet, appreciating dental care are examples of practices forged within the family

(Inglehart & Tedesco, 1995b). Health beliefs seem to develop during preadolescence, which means that the family is a significant source of those beliefs.

Christensen (2004) proposed a theoretical framework of the "health-promoting family". In this model, "family can ideally be seen as an ecocultural milieu that works to promote children's health, well-being and development, and reduces children's risk behaviour". She suggests that the family can also be seen as support for the development of the child as a "health-promoting actor". "Parents retain a central role in providing care and support, and in strengthening and monitoring children/young people in their growing up. However, the interactive and pluralistic character of health means that children have in a larger measure than before to create meaning for themselves and to develop their own positive health practices. In this process, parents are seen as very important mediators in children's health actions rather than being seen as having the main direct influence upon them."

The way families support or promote health among children is influenced by the family structure and family support functions (Pratt, 1991). "A family structure is typically defined by who the family members are and by their relationship to each other, for example in terms of marriage and parenthood" (Cheal, 2002). The family structure is considered as organizations and abilities that allow families to offer support to healthy practices. Family cohesiveness and structure, such as good and long lasting relationships, and frequent and regular contacts among members, are considered important for children's well-being and health behaviour (Wadsworth, 1999; Moysés & Rodriques, 2006; Park, 2007). Distressed families have been shown to be associated with poor child oral health (Wandera et al., 2009).

Family functions offer "a way of looking at the activities that families do together in order to meet their needs within a context of assumed mutual responsibility" (Cheal, 2002). Family functions are the dynamics or mechanisms that in a family provide support for the health practices of its members (Pratt, 1991). This includes links between family and external groups and resources to support activities of its members, the support of information offered by the family, the model copied from parents and the ability to inculcate social norms, values, and culture by the process of socialization (Moysés & Rodriques, 2006). The establishment of public policies centred on support to the family will be an important strategy for the health promotion of children (Moysés & Rodriques, 2006). Targeting families for intervention to promote and establish favourable oral health behaviours can be a very effective preventive strategy (Pine et al., 2000).

2.2. Epidemiological view

2.2.1. Oral health status

2.2.1.1. The concepts of health and oral health

Health has been defined as the absence of disease, and disease as a divergence from normality (Boorse, 1977). In a holistic view in which the whole person is taken into account, the World Health Organisation has defined health as: "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1946). This definition, though, has been criticized as being an unrealistic and unachievable state, but it identifies the fact that health has dimensions other than the physical. Ewles & Simnett (1999) have outlined six dimensions for health: physical, mental, emotional, social, spiritual, and societal. The importance of each is likely to vary at different periods of life.

Oral health is described as "The optimal state of the mouth and normal functioning of the organs of the mouth without evidence of disease" (NIH, 2009). This characterizes oral health as the absence of disease. Yewe-Dyer (1993), in a broader description of oral health, defined it this way: "Oral health is a state of the mouth where disease is contained, future disease is inhibited, the occlusion is sufficient to masticate food and the teeth are of socially acceptable appearance". A more appropriate definition, in the holistic approach, would be "A comfortable and functional dentition that allows individuals to continue their social role" (Dolan, 1993). The broader concept of oral health-related quality of life defines oral health not only as an absence of disease but also includes functional aspects and social and psychological well-being (Locker, 1988). A recent WHO definition of oral health (WHO, 2003a) summarises the holistic concept of oral health: "Oral health enables an individual to speak, eat and socialise without active disease, discomfort or embarrassment. Oral health is fundamental to general health and well being, significantly impacting on quality of life. It can affect general health conditions".

2.2.1.2. Dental caries and periodontal diseases

Dental caries and periodontal diseases are the most common oral pathologies. Dental caries is one of the most prevalent chronic diseases of people worldwide and throughout their lifetimes (Selwitz et al., 2007). It is also one of the most common chronic childhood diseases with, a substantial proportion of children affected (WHO, 2001a) and it is an important cause of disability in many countries (WHO, 2002). Similar to dental caries, gum disease affects children worldwide, and in many countries it is one of the most common diseases (WHO, 2003a). Childhood oral diseases can lead to irreversible damage, pain, disfigurement, more serious general health problems, lost school time, low self-esteem, and poor quality of life.

Poor oral health affects the growth, development, and well being of children and has a significant impact on later life (Acs et al., 1992; Davies, 1998).

Oral diseases are the world's fourth most expensive disease to treat (Petersen, 2008). Dental services constitute about 5% to 10% of the total health expenditure in industrial countries each year (AIHW, 1998; Sheiham, 2001). This poses a problem for many emerging economies; the expenditure of providing traditional operative dental care could exhaust the whole country's health budget, a budget that is already fully stretched or even does not exist (Yee & Sheiham, 2002; WHO, 2003a). Meanwhile, treatment approaches alone will never eradicate oral diseases (Watt, 2005), and the oral health of a population can not be improved merely by applying the restorative approach (Anusavice, 2005). Social and educational costs are also significant, for example, more than 50 million hours are annually lost from school due to children's oral diseases (Gift et al., 1992).

Dental caries is the result of mineral loss of dental hard tissues attributable to the activity of biofilm on the tooth surface. As a multi-factor disease, the extent and rate of dental caries depend on physical and biological risk factors, including inadequate salivary flow and composition, high numbers of cariogenic bacteria, insufficient fluoride exposure, and genetic factors (Fejerskov & Kidd, 2003). Dental caries is, moreover, related to one's behaviour and lifestyle. These behavioural factors include poor oral hygiene and frequent consumption of refined carbohydrates (Touger-Decker & van Loveren, 2003; Moynihan & Petersen, 2004). Improved oral hygiene and daily use of fluoride toothpaste have been confirmed to arrest active enamel lesions (Löe, 2000; Davies et al., 2003). Other factors related to caries risk included social status, level of education, poverty, and deprivation (Ramos-Gomez et al., 2002; Krol, 2003; Curzon & Preston, 2004; Petersen, 2005b).

The periodontal diseases are highly prevalent and can affect up to 90% of the worldwide population (Pihlstrom et al., 2005). The mildest form of periodontal disease is gingivitis, which result from accumulation of dental plaque on the tooth adjacent to the gingiva (Moore & Moore, 1994). In addition to pathogenic micro-organisms in dental plaque, genetic and behavioural factors, especially smoking, are contributory causes of periodontal diseases (Michalowicz et al., 2000; Johnson & Slach, 2001). The signs of gingivitis are distinguishable among most children and adolescents worldwide (Petersen & Ogawa, 2005). According to WHO data (2001a), 50 to 100% of 12-year-olds show signs of gingivitis. Gingivitis could well be seen as a behavioural disease; it is reversible by simple and effective oral hygiene (Pihlstrom et al., 2005). The effective removal of dental plaque is essential to dental and periodontal health throughout life (Löe, 2000). Dental self-care practices in childhood are associated with periodontal diseases in adulthood (Lissau et al., 1990).

2.2.1.3. Global prevalence of dental caries

In economically developed countries, the caries decline has levelled off in the last three decades; simultaneously this trend has resulted in a polarization of caries prevalence in these countries (Vehkalahti et al., 1997; Vanobbergen et al, 2001a; Whelton, 2004). However, improvements have now halted in younger age groups (Moynihan & Petersen, 2004). In some countries with emerging economies, increasing levels of dental caries among children are evident, especially for those countries with no preventive oral care programmes (Ismail et al., 1997; Sckiguchi & Machida, 1999; WHO, 2000). In those countries where fluoride is unavailable, and populations have more opportunity to consume free sugars and other fermentable carbohydrates, the prevalence of decay has been increasing (Moynihan & Petersen, 2004). Globally, the greatest burden of oral diseases lies on disadvantaged and poor populations (Petersen, 2008). In most low- and middle-income countries, the general population does not benefit from systematic oral health care, and no preventive programmes exist (The Lancet, 2009).

A decline in dental caries has also been apparent in Middle Eastern countries; but in some of these countries dental caries is on the rise (WHO, 2009). Caries levels in Iranian adolescents compared to most of the neighbouring countries are rather low (WHO, 1999; Al-Mutawa et al., 2006; Meyer-Lueckel et al., 2007), with a clear decline during recent decades (Pakshir, 2004). The most recent national study among Iranian 12-year-old children has shown a mean DMFT of 1.9, and 40% of the children were caries-free (**Table 2.1**).

Table 2.1. Mean DMFT among Iranian 12-year-old children studied during the last 50 years

Authors, publication year	Survey time	Mean DMFT	Caries-free children (%)	Location
Leous, 1990	A review study from 1959 to 1989	1.8 to 4.0	No report	Review from 12 surveys
Jaber Ansari, 1998	1990-1992	2.4	31	National
Samadzadeh et al., 2001	1995	2.0	17	National
MOHME, 2000; Pakshir, 2004	1998-1999	1.5	48	National
Momeni et al., 2006	1999	0.8	64	Tehran, Isfahan
Daneshkazemi & Davari, 2005	2001	1.8	29	Yazd, Hadi Shahr
Meyer-Lueckel et al., 2007	2003	1.1	52	Tehran, Semnan, Dibaj
MOHME, 2009	2004	1.9	40	National

Surveys in the table arranged according to survey time.

2.2.2. Oral health behaviour and self-care

2.2.2.1. The concept of oral self-care (OSC)

Health behaviour has been defined as human activities protecting, promoting, or maintaining the health of the individual (Glanz et al., 2002). Regular learned measures by which people try to maintain oral health or prevent oral diseases are considered to be oral health behaviours (Honkala et al., 1981), including oral hygiene, dietary habits, use of fluoride toothpaste, and use of dental services. These behaviours may be divided into self-care behaviours (oral hygiene, dietary habits, use of fluoride toothpaste) and dental service utilization (Honkala et al., 1981). Petersen and colleagues (2008) declared that health behaviours comprise health-risk behaviour (such as smoking, alcohol use, and consumption of sugary foods/drinks); health-promoting behaviour (oral hygiene practices, healthy dietary habits, and general hygiene practices); and help-seeking behaviour (visit to physician or dentist). Åstrøm and Rise (2001) confirmed the two dimensions of oral health behaviours as health-enhancing and health-detrimental behaviours. Åstrøm (2009) suggested later three dimensions for oral health behaviour reflecting sugar intake, drug use (smoking and alcohol) and oral health-enhancing behaviour (use of dental floss and annual dental attendance).

Tooth brushing behaviour, use of fluoride toothpaste and sugary snacking are accepted as oral self-care behaviours. First regarding tooth brushing, effective removal of dental plaque is essential to dental and periodontal health (Lewis & Ismail, 1994; Löe, 2000). Thus brushing, as a mechanical measure for removing dental plaque, is the most appropriate and effective oral hygiene habit (Honkala, 1993; Löe, 2000; Vehkalahti & Widström, 2004). No technique of tooth-brushing has been revealed as obviously better than others: the brushing strokes should be repeated on all accessible tooth surfaces. Using adequate time and care, it is possible to obtain a rational degree of cleanliness (Löe, 2000). In determining efficacy of plaque removal, the individual's dexterity and thoroughness are more critical than technique or design (Mandel, 1993). Frequency of tooth-brushing is the most important factor, and then adequate technique and duration of brushing (Honkala, 1984; Kuusela et al., 1997a). Twice-daily tooth brushing has been the commonly accepted recommendation for prevention of oral diseases (Brothwell et al., 1998; Löe, 2000; Sheiham, 2001).

Fluoride has contributed largely to caries reduction, as it alters the resistance of the teeth to demineralization as well as the speed of remineralization of the enamel surface following a plaque acid challenge. Without any dietary modifications, topical fluoride in either toothpaste, mouth rinses or varnishes can reduce caries in children by between 20 and 40% (Moynihan & Petersen, 2004). Systematic reviews based on the controlled trials have shown the clear effectiveness of topical fluoride against dental caries (Marinho, 2009). Twetman and

colleagues (2003), based on their systematic review of the caries-preventive effect of fluoride toothpaste, reinforced the importance of daily tooth brushing with fluoride toothpaste for preventing dental caries. For prevention of caries, tooth brushing is not so important in itself; it is the regular delivery of fluoride from toothpaste that provides the major anti-caries effect (Sheiham & Bönecker, 2006). There exists good evidence, therefore, to recommend twice-daily tooth brushing with fluoride toothpaste (Brothwell et al., 1998; Davies et al., 2003). The effect of fluoride toothpaste has increased with higher levels of dental caries experience, higher fluoride concentration, higher frequency of use, and supervised tooth brushing (Marinho et al., 2003). Other topical fluorides (mouthrinses, gels, or varnishes) have a small additive effect to fluoride toothpaste used alone in caries reduction (Marinho et al., 2004).

Sugars are undoubtedly the most important dietary factor in the aetiology of dental caries (Rugg-Gunn, 1993; Moynihan & Petersen, 2004). In experimental gingivitis, frequent sugar intake resulted also in increased gingival inflammation (Sidi & Ashley, 1984). Sugar intake and levels of dental caries can be compared at country level; an association between levels of caries and per capita sugar availability has emerged (Sreebny, 1982; Ruxton et al., 1999). Both the frequency and total intake of sugars are related to dental caries (Moynihan & Petersen, 2004). Several reviews show that the current levels above 60 g/person/day for teenagers and adults lead to an increased rate of caries (Sheiham, 2001; Moynihan & Petersen, 2004; Moynihan, 2005). For pre-school and young children, intake should be about 30 g/person/day (Sheiham, 2001). A longitudinal ecological study among 5- and 12-year-olds in the UK for over 50 years showed a strong positive correlation between dmft/DMFT and sucrose availability (Downer, 1999). Reduction in sugar availability from 50 to 12 kg/person/year due to United Nations sanctions on Iraq in 1990 was related to a marked caries reduction in Iraqi children over a 5-year period (Jamel et al., 2004). The WHO (2003b) has recommended that free sugars should contribute no more than 10% to energy intake (which equates to <15-20 kg/year). Moreover, the frequency of consumption of foods containing free sugars should be limited to a maximum of four times a day.

Exposure to fluoride coupled with reduction in the sugar intake has been shown to have an additive effect on caries reduction. In the presence of adequate exposure to fluoride, consumption of sugars remains a moderate risk factor for caries in most people (Burt & Pai, 2001). Widespread exposure to fluoride moves the S-shape dose-response curve for sugar and caries (Newbrun, 1982) to the right and raises the safe level of sugar intake (Sheiham, 1991a).

2.2.2.2. Global view of oral health behaviour

The trend towards more frequent performance of dental hygiene practices has been continuous (Addy et al., 1990; Murtomaa & Metsäniitty, 1994; Kuusela et al., 1997b; Taani,

2001; Hugoson et al., 2005), however, tooth brushing behaviour among children in many countries is still unsatisfactory (WHO, 2003a). A cross-national study (Currie et al., 2000) in the European countries and USA reported that children in Sweden, Denmark, and Switzerland are most likely to brush their teeth more than once a day, with overall levels over 80%. In contrast, less than half of children brush their teeth more than once a day in Lithuania, Finland, Belgium (Flemish) and Greece. Maes and colleagues (2006) in their recent survey among 32 countries reported more or less similar results.

Adolescents in Africa brushing their teeth twice a day comprise from 28 to 46% (Petersen & Mzee, 1998; Petersen et al., 2002). African-Americans have been less likely than whites to brush their teeth (Ronis et al., 1998). However, differing finding was found by Oliveira et al. (2000). In China, 22 to 44% of adolescents reported brushing their teeth on a twice-daily basis (Petersen & Zhou, 1998; Zhu et al., 2003). In Thailand, 76% of 12-year-olds brushed their teeth twice daily (Petersen et al., 2001).

In the Middle East, twice-daily tooth brushing behaviour has been reported for 30-70% of adolescents (Al-Tamimi & Petersen, 1998; Vigild et al., 1999b; Rajab et al., 2002; Farsi et al., 2004; Al-Omiri et al., 2006). Most research on the oral health behaviour of Iranian children has not been at the national level and is not available internationally. In a nationwide survey, 13 to 99.7% of 9-year-old children in different provinces reported to brush their teeth at least once daily (MOHME, 2000). In the same study, 49% of 12-year-olds in the whole country reported brushing their teeth at least once daily, with higher percentages among the girls (60% vs. 40%).

Between countries, consumption of sweets and soft drinks also varies. Daily sugary snacking among 11-year-olds in Nordic countries was clearly less frequent than among their counterparts for example in Wales and Scotland (Honkala et al., 1990; Hausen et al., 2000). In the Middle East, consumption of sugary foods and drinks is very high (Vigild et al, 1999b; Sayegh et al., 2005) and is more frequently among boys (Ahmed et al., 2007). Ismail and colleagues (1997) in their review on the trends of sugar consumption in emerging economies confirmed that sugar use was increasing in China, India, and South Asia. In South and Central America, sugar use was either equivalent to or higher than that in most developed economies. In the Middle East, average sugar use was higher than that of other emerging economies. However, it was either lower than or equivalent to the levels reported by developed economies. Many central African countries consumed less than 15 kg of sugar/person/year. Ismail and colleagues (1997), however, pointed out that while average sugar consumption in developed economies is higher than safe levels and where prevention programmes are in place, sugar consumption is not associated with high or increasing caries prevalence. In

emerging economies, where sugar consumption is higher than safe levels, and there are no well-organised preventive programmes, caries prevalence is already high or is increasing.

In Iran, consumption of sugar showed increase during the last decades (Ghassemi et al., 2002). This is mostly due to subsidization on food, put in place during the Iraq's attack to Iran to secure minimum and equitable food supplies. The subsidies have been continued after war for some foods such as sugar. Increasing growth of urban population and cheap and easy availability of refined sugar could also be other reasons. An increasing in consumption of sugar was seen among urban families from 41 g/person/day in 1985 to 50 g/person/day in 1995 and among rural families from 40 to 60 g/person/day.

2.3. Determinants of oral health and oral health behaviour

Health and health behaviours are involved with social, economic, and environmental conditions (Graham, 1999; Sheiham & Watt, 2000). A complex range of factors, including individual and lifestyle factors, social and community support, and general socio-economic, cultural, and environmental conditions determine the health status of individuals and populations (Dahlgren & Whitehead, 1992; Dahlgren, 1995). These factors are distal causes of oral diseases (Petersen, 2005b) and are known as social determinants of health (Newton & Bower, 2005).

Understanding the factors influencing health – the determinants of health – is critical for health professionals to deliver effective treatment and prevention of diseases (Daly et al., 2002). Sustainable improvements in the health of the population and a reduction in health inequalities will never be achieved below the underlying causes of disease have been addressed (Watt, 2005). Focusing solely on changing lifestyle is ineffective, is very costly (Syme, 1996), and may widen health inequalities (Schou & Wight, 1994; Sanders et al., 2006). Concentration on individual health-related behaviour is an oversimplification and an evasion of responsibility (Sheiham & Watt, 2000). This criticism of the emphasis on individual behaviour change is particularly relevant to oral health policies (Terris, 1980).

Understanding the social determinants of health allows for an integrated approach to prevent a range of conditions; the common risk factor approach (CRFA) (Sheiham & Watt, 2000; WHO, 2000; Sanders et al., 2005). The CRFA tries to improve health by reducing risks and promoting individuals' health and empowerment by creating supportive environments and facilitating behaviour change. The major risk factors for chronic diseases such as diet, smoking, and hygiene are also the risk factors for dental caries and periodontal diseases (Reibel, 2003; Moynihan & Petersen, 2004). Promoting health by controlling a small number

of risk factors may have a major impact on a large number of diseases at lower cost, with greater efficiency and effectiveness than for disease specific approaches (Grabauskas, 1987; WHO, 2000; Petersen, 2003). The CRFA focuses on improving health conditions for the whole population, as well as for high-risk groups, by reducing social inequities (Sheiham & Watt, 2000).

As a consequence of the CRFA, oral health population-based data can serve as an indicator of general health status and as a marker for health inequalities (Watt, 2006). Many studies have highlighted the relationship between oral health behaviour and general health behaviour; therefore, performing preventive oral health behaviour helps toward better general health behaviours and reduction in risk behaviours (Payne & Locker, 1996; Tada & Matsukubo, 2003; Petersen et al., 2008). Among children and adolescents, the CRFA implemented through a population or a direct population approach is preferable for prevention of dental caries and periodontal diseases, because the majority of preventable causative factors for these diseases are environmental (such as tobacco and food policy) and interpersonal (such as family influence on self-care behaviour) (Sheiham & Watt, 2000; Kallio, 2001).

Biological and behavioural factors determine each individual's oral health. These factors are related to the social support offered by family, friends, and community (Dahlgren & Whitehead, 1992). Social support is created in the environment where children live - their home and school - and becomes essential for building their health (Moysés & Rodrigues, 2006). Parents are the most important resources for the social support of their children (Åstrøm & Jakobsen, 1996). To better understanding the different determinants of children's oral health, these could be categorised as child- and parent-related determinants of oral health and behaviour (Wickrama et al., 1999; Poutanen et al., 2007b).

2.3.1. Determinants of oral health

2.3.1.1. Child-related determinants of oral health

Several studies have shown a relationship between oral health status and oral health behaviour of children. Tooth brushing less than twice a day or frequent sugary snacking or both, are important predictors for developing children's caries lesion (Fabien et al., 1996; Flink et al., 1999; Vanobbergen et al. 2001a; Rajab et al., 2002; Almeida et al., 2003; David et al., 2005; Levine et al., 2007). Among young children, frequency of tooth brushing and dental caries are negatively associated, and frequency of sugar consumption and dental caries positively associated (Gibson & Williams, 1999). Cariogenic snacking and tooth brushing less than twice a day have been indicators of dental caries experience among children (Kalsbeek & Verrips, 1994; Bedos et al., 2005). Unfavourable oral health behaviours performed at age 3

were associated with dental caries at 10 years of age in Finnish children (Mattila et al., 2005b). However, some studies found no relationship between children's oral health behaviour and their dental caries (Okada et al., 2002; Bruno-Ambrosius et al., 2005). Harel-Raviv et al. (1996) has concluded that the exact relationship between sugar intake and caries incidence is unclear.

Other health-related behaviours also affect children's dental caries. Among female Swedish teenagers, Bruno-Ambrosius and colleagues (2005) found that the omission of breakfast and irregular main meals, as well as smoking were significantly associated with dental caries. Overweight and obesity among adolescents were associated with higher approximal caries prevalence (Alm, 2008; Cinar & Murtomaa, 2008).

Considering dental caries as an infectious disease (Caufield & Griffen, 2000), the risk for developing new caries is influenced by earlier experience of caries (Greenwell et al., 1990; Disney et al., 1992; Hausen, 1997; Källestål & Wall, 2002), and poor gingival health (Okada et al., 2000; Campus et al., 2001). Vanobbergen et al. (2001a) found that both past caries experience and oral cleanliness are important risk predictors for development of high caries rates in Flemish children. Dental caries in the primary teeth influence cavity formation in the permanent molars (Leroy et al., 2005), even in later life (Alm, 2008). Moreover, dental caries in the primary molars alters emergence order of permanent teeth, which determines the period at risk (Leroy et al., 2009). Visible plaque on teeth and gingival bleeding in childhood have been associated in Finnish children with the presence of caries lesions in later life (Mattila et al., 2005b). Good oral hygiene in childhood decreases risk for caries after tooth emergence (Leroy et al., 2005) and provides good dental health in adolescence (Alm, 2008).

School children's dental caries experience differs according to age and gender, and prevalence rates increase with age (Murtomaa et al., 1995; Alvarez-Arenal et al., 1998; Almeida et al., 2003). Controversial findings involve gender and dental caries experience in the permanent dentition: no difference between genders (Flinck et al., 1999; David et al., 2005), more caries among girls (Alvarez-Arenal et al., 1998; Saravanan et al., 2008), and more among boys (Hamissi et al., 2008; Karim et al., 2009).

Through an ecological study in emerging economies, Egri & Gunay (2004) found that completing the primary level of education may be considered a good predictor of their dental caries. Children's oral health-related knowledge is associated with their dental caries; third-grade schoolchildren with inadequate oral health knowledge were twice as likely to have caries as did children with adequate knowledge (Oliveira et al., 2000). Children's oral health

impacts on their quality of life: their self-reported bad state of teeth was associated with poor school performance among children in India (David et al., 2006).

2.3.1.2. Parent-related determinants of child's oral health

Parents' oral health-related knowledge, attitudes, and behaviour are associated with their children's oral health. A high level of dental caries among children is associated with a low level of oral health-related knowledge of their mothers (Szatko et al., 2004). Mothers' positive attitudes towards oral health were related to children's better dental health (Skeie et al., 2006; Mahejabeen et al., 2006) as well as their gingival health (Okada et al., 2001). Parental knowledge and behaviour were especially important among girls (Poutanen et al., 2007a).

Parents' own oral health as well as their oral health behaviour is related to the oral health of their children. Child's dental caries was associated with mother's irregular tooth brushing behaviour (Mattila et al., 2000). Parents' oral health behaviour can influence their children's behaviour and thus their gingival health and dental caries directly, indirectly, or both (Okada et al., 2002). Dental caries among fathers or mothers or both are related to caries experience among their children (Mattila et al., 2000, 2001). Children of edentulous mothers had significantly more caries lesions than did children of dentate mothers (Bedos et al., 2005).

Parental oral health knowledge and attitudes undoubtedly play a role in determining the oral health of their children; however, deprivation, ethnicity, family income, and educational status all emerged as significant factors influencing parents' oral health knowledge and attitudes (Petersen, 1992; Watt, 2002b). Parental level of education has been shown to be one of the most important determinants for children's oral health in many countries (Petersen et al., 1991; Petersen, 1992, 2005b). In addition, mother's education has been a better predictor for health inequalities among children than the father's education (Wamani et al., 2004; Darout et al., 2005).

Socio-economic determinants have significant influence on children's oral health (Hamp et al., 1984; Petersen, 2005b), with different indices for assessment of these determinants. Dental status has been associated with deprivation (Gift et al., 1997; Burt, 1998; Bedi et al., 2000; Williams et al., 2002); children living in deprived areas are more likely to have experienced decay than those from non-deprived areas (Monaghan & Heesterman, 1999). Ethnicity has also been associated with dental health status (Watson et al., 1999; Bedi et al., 2000; Williams et al., 2002; Sundby & Petersen, 2003), though a contradictory finding emerged in a study of Davidson and colleagues (1997). While some authors (Verrips et al., 1992; Chen, 1995) discussed ethnic differences in caries experience is decreasing or disappearing when adjustment is made for socio-economic variables, Prendergast and

colleagues (1997) found differences in caries experience between ethnic groups to be independent of deprivation score. Skeie and colleagues (2006) also suggested that immigrant status has an independent effect on caries experience.

The prevalence of caries-free children was higher among the highest socio-economic status (SES) families compared with the lowest (Vanobbergen et al., 2001b), while dental caries and treatment needs were considerably higher in children of low SES (Irigoyen et al, 1999). Through a life-course approach, Nicolau and colleagues (2003a & b) found that socio-economic factors in early life were associated with caries and gingival bleeding in adolescence. Caries reduction among children was also related to SES; non-privileged children showed less caries reduction than did their privileged counterparts (Van Nieuwenhuysen et al., 2002).

2.3.2. Determinants of oral health behaviour

2.3.2.1. Child-related determinants of oral health behaviour

Tooth brushing is strongly influenced by any individual's lifestyle and social behaviour. A positive association between tooth brushing behaviour and personal cleanliness appeared among Iranian adolescents (Dorri et al., 2009a). Tooth brushing frequency is influenced by time of arising, breakfast habits and bedtime (Macgregor et al., 1996). Tooth brushing frequency is also associated with such lifestyle behaviours as not smoking, not using alcohol, and having a regular bedtime (Macgregor et al., 1996; Koivusilta et al., 2003).

Life- and school-satisfaction and self-esteem indicators are associated among preadolescents with twice-daily tooth brushing. Feelings of happiness and acceptance by others, lack of loneliness, and ability to make friends are the strongest predictors for recommended tooth brushing frequency (Honkala et al., 2007). Self-efficacy beliefs are associated with oral health behaviour among preadolescents (Basak et al., 2005), with positive oral health-related attitudes associated with positive oral health-related behaviours among adolescents (Freeman et al., 1993). Gender differences have appeared in oral health-related attitudes; girls often have more favourable attitudes than boys (Freeman et al., 1993; Östberg et al., 1999). High knowledge of oral health was associated with twice-daily tooth brushing among 12- to 22-year-old students in Sudan (Darout et al., 2005), but such an association was poor among British adolescents (Freeman et al., 1993). Gender differences also existed for oral health-related knowledge (Freeman et al., 1993; Östberg et al., 1999). Källestål et al. (2006) found that the motives for oral health behaviours change as Swedish children reach adolescence. They explored emotional factors such as aesthetic values that seem to increase in importance, whereas cognitive factors such as knowledge become less important. A sense of coherence –

"a global orientation that expresses the extent to which one has a pervasive, enduring, though dynamic feeling of confidence that is comprehensible, manageable, and meaningful" (Antonovsky, 1987) – was associated with tooth brushing frequency among Iranian adolescents: the higher the sense of coherence among adolescents the more frequent the tooth brushing behaviour (Dorri et al., 2009b). The sense of coherence, nonetheless, did not fully explain the gender difference in tooth brushing behaviour.

A combination of oral health-related behaviours has been suggested to form an oral health-related lifestyle (Aleksejuniene et al., 2002). Tooth-brushing frequency and use of sugary snacks were associated: more frequent use of sugary snacks was related to less frequent tooth brushing (Rajala et al., 1980). Twice-daily tooth brushing is related to regular use of dental floss among adolescents (Macgregor et al., 1998; Honkala et al., 2007). Tooth brushing may also be a predictor of future lifestyle; adolescents with a low tooth-brushing frequency tend to reach only the lowest education levels, and these adolescents tend to smoke and use alcohol regularly (Koivusilta et al., 2003).

Tooth brushing varies considerably by age and gender. Older children brush their teeth more often than do younger children (Currie et al., 2000; Almeida et al., 2003; Maes et al., 2006). In a longitudinal study, Kuusela and colleagues (1996) reported that adolescents of 18 brush their teeth more often than at 12. Tooth brushing is more frequent among girls than among boys. The better tooth-brushing behaviour of girls seems to be universal (Honkala et al., 1981; Murtomaa & Metsäniitty, 1994; Kuusela et al., 1996, 1997a; Currie et al., 2000; Rajab et al., 2002; Almeida et al., 2003; Farsi et al., 2004; Maes et al., 2006). Iranian girls have also practiced more favourable oral hygiene and general hygiene behaviours (Dorri et al., 2009a). Amongst Swedish adolescents, the strongest predictor of tooth brushing less than twice per day was male gender (Källestål et al., 2006). Nonetheless, gender equality in oral hygiene behaviour was found among Sudanese students (Darout et al., 2005).

Differences between genders also exist regarding consumption of sugary items; girls have reported using sugary snacks and soft drinks less frequently (Honkala et al., 1982; Freeman et al., 1993; Ahmed et al., 2007); nonetheless, it seems that the gender disparities regarding sugar consumption observed earlier among Norwegian adolescents levelled off later on (Åstrøm & Samdal, 2001). Unfavourable oral hygiene and eating habits were more common among Swedish and Finnish boys (Källestål et al., 2000; Poutanen et al., 2005). In contrast, in the African countries, sugar consumption is more frequent among girls (Okullo et al., 2003). As this finding was in urban areas, Blay and colleagues (2000) suggested an economic explanation due to urbanization in these countries.

Rise and Hølund (1990) showed that environmental variables are more important than personal variables for prediction of sugar-use behaviour. Degree of peer orientation is closely linked to sugar consumption, as consumption seems to be a way of for adolescents to demonstrate adherence to and identification with peer group norms. Television and radio advertising are the major sources of information in all societies (Ismail et al., 1997), and about 40% of the products requested by children were advertised in the prior 6 months (Donkin et al., 1992). Television advertising reaches almost all of the population in Middle Eastern countries (Musaiger, 1993). Significantly different sugar-consumption levels are therefore seen between mothers and their children; the mothers reported less frequent sugar consumption (Petersen et al., 1990).

2.3.2.2. Parent-related determinants of child's oral health behaviour

Scottish parents with positive beliefs about their child's tooth-brushing behaviour tend to have children who brush their teeth twice a day (Pine et al., 2000). An international study showed that children whose parents had positive attitudes towards controlling their oral hygiene habits had more favourable oral health behaviours (Adair et al., 2004). Self-efficacy – the parents' belief that they can effectively implement the guidelines of good oral care for their children – is another relevant factor that determines positive oral behaviours among children (Syrjala et al., 2001). Åstrøm & Kiwanuka (2006), using the Theory of Planned Behaviour (Ajzen, 1991) studied the association of parental intention with control of sugar snacking and whether that behaviour occurs in preschool Ugandan children. Parents who had children with caries perceived themselves to have less control over their child's sugar snacking and perceived them to be more susceptible to tooth decay compared to parents of children without caries.

Concordance of parental and adolescent health behaviours such as smoking is known (Rossow & Rise, 1994; Ausems et al., 2003), and this sort of positive association also applies to other oral health behaviours. Tooth brushing and inter-dental cleaning by children are positively correlated with the corresponding behaviours of their parents, especially of their mothers (Rossow, 1992; Åstrøm & Jakobsen, 1996; Åstrøm, 1998; Okada et al., 2002). Twice-daily tooth brushing by children was highly influenced by the dental visits of their parents (Rajab et al., 2002), particularly of their mothers (Wierzbicka et al., 2002). In terms of intergenerational transmission of health-risk behaviours, Wickrama and colleagues (1999) revealed that fathers' lifestyle affected mainly the boys' lifestyle, and mothers' lifestyle affected mainly the girls' lifestyle.

Family socio-economic status is associated with the child's oral health behaviour (Kuusela et al., 1997b). Frequency of tooth brushing and sugary snacking among children were related to their mothers' occupation level (Poutanen et al., 2005), and educational level (Verrips et al.,

1993; Rajab et al., 2002; Wierzbicka et al., 2002) and to the occupational level of their fathers (Vanobbergen et al., 2001b). Maes and colleagues (2006) in their cross-national survey showed that the highest parental occupation status was indicative of a high prevalence of tooth brushing in most countries. Oral health behaviours of children were also associated with their ethnicity (Verrips et al., 1993; Källestål et al., 2000; Adair et al., 2004; Skeie et al., 2006). However, financial and structural barriers to dental care may explain the wide variation between privileged and unprivileged groups (Sanders et al., 2006).

The WHO (2001b) suggested five factors important to young people's health. These include: "meaningful relationships with adults and peers; parental structure and boundaries for behaviours; encouragement of self-expression; opportunities for participation with children's contributions being valued; educational, economic, and social opportunities and minimal risk of injury, exploitation, or disease".

3. AIM OF THE STUDY

3.1. General aim

The general aim of the study was to assess oral health and its determinants among Iranian preadolescents, and to test a school-based health education programme to promote their oral health.

3.2. Specific objectives

To achieve the aim, the specific objectives were to examine:

1. What is the oral health status of 9-year-old Iranian children? (I)
2. What is the oral self-care behaviour of 9-year-old Iranian children? (II)
3. Does the parents' education have any effect on the child's oral health status and oral self-care behaviour? (I, II)
4. Do the mother's own oral self-care behaviour and her supervision of the child's tooth brushing have any effect on the child's oral health status and oral self-care behaviour? (II, III)
5. Do the mother's oral health-related knowledge and attitudes have any effect on the child's oral health status and oral self-care behaviour? (IV)
6. Can a specially designed school-based oral health educational programme improve children's oral hygiene and gingival health? (V)

3.3. Working hypotheses

1. Preadolescents' better oral health status and oral self-care behaviour are positively associated with higher level of parental education.
2. Mothers with higher level of knowledge of and positive attitudes towards oral health, mothers with their own favourable oral self-care behaviour as well as mothers undertaking active supervision of their children's tooth brushing facilitate better oral health for their preadolescents.
3. A school-based oral health educational programme improves oral health in preadolescents.

4. SUBJECTS AND METHODS

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

4.1. Study background

The school-age children have been defined as target group for oral health promotion programmes in Iran (MOHME, 2000). Tehran city, the capital of Iran, has 8 million inhabitants (Statistical Centre of Iran, 2010). Research has shown that in Tehran, at age 9, the mean caries experience is 1.1 for the permanent teeth and 3.3 for the primary teeth, and that only 69% of children brush their teeth at least daily (MOHME, 2000). The DMFT of 12-year-olds was 2.4 in 1998, with a D-component of 80% (Pakshir, 2004). Furthermore, 30% of 12-year-olds experienced gingival bleeding (MOHME, 2000).

4.2. Study population

The target population of this study comprised the third-grade school children of all public primary schools in 19 areas of Tehran city. Almost all of the 6- to 11-year-old children (n = 500,000) in Tehran city attend primary schools (MOE, 2007). Of those, 92% attend the public primary schools that comprised the sample set of this study.

4.3. General description of the study

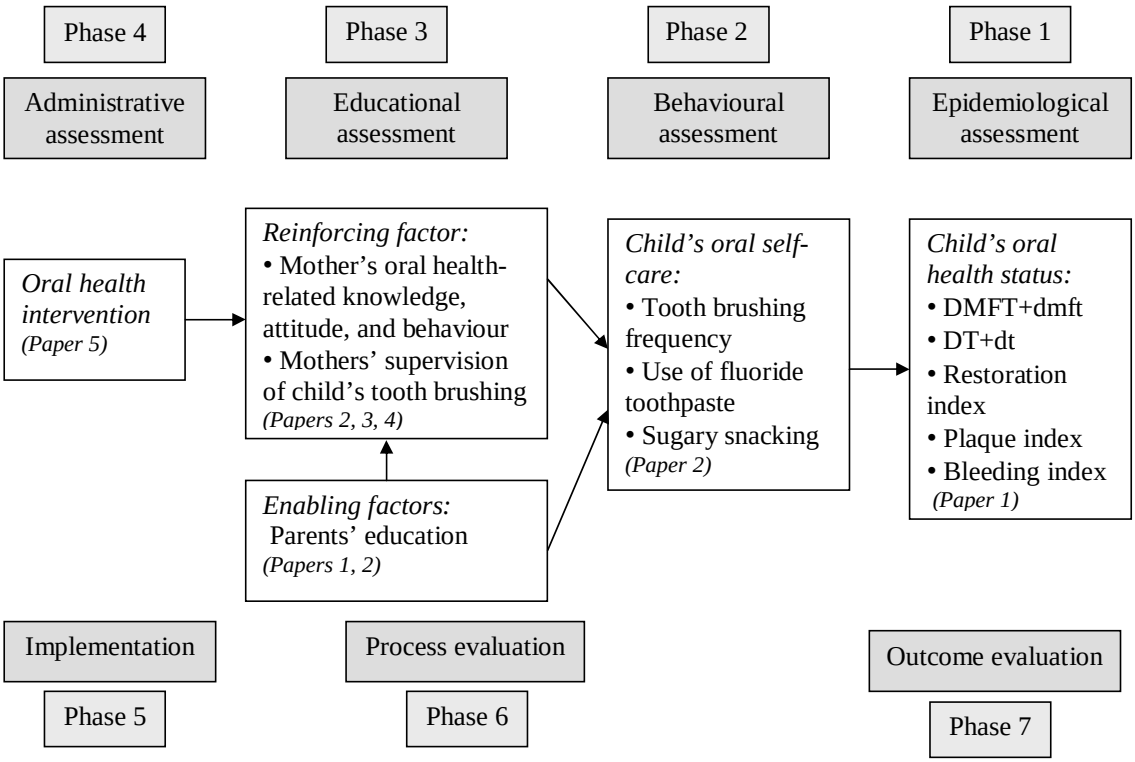
This study was designed to be cross-sectional with a 3-month intervention trial involving a representative sample of 9-year-olds in Tehran. The data included the children's clinical dental examinations at baseline and at study end, as well as a self-administered questionnaire for the children and their mothers at baseline. The sample came from all public primary schools in the city by means of multi-stage sampling. Firstly, from a list of primary schools, taking the children's gender into account, 16 schools (8 for boys, 8 for girls) were randomly selected. The randomization was applied separately for boys' and girls' schools by means of systematic random allocation. Then, from each school, one third-grade class as a cluster was randomly chosen, with all its children included. For the intervention trial, separately for boys' and girls' schools, the clusters were randomly assigned to three intervention groups and one control group, each group comprising two girls' and two boys' schools.

4.4. Theoretical model of the study

Design and planning of this study was based on the PRECEDE-PROCEED model (Green & Kreuter, 1991). Planning an intervention according to this theoretical model can provide a comprehensive understanding for facilitating preadolescents' oral health. The model is a useful guide to characterize the resources, barriers, and organizational factors, a feasible method for building upon existing local resources and addressing oral health concerns. Furthermore, as children were the target group, using the PRECEDE-PROCEED model helps to find the role of "important others" in children's oral health, while many behavioural theories focus only on the person's own characteristics.

The PRECEDE-PROCEED model was modified for the present oral health study according to the background situation of the study population **(Figure 4.1)**. The assumption of this study was that socio-demographic factors and mothers' oral health-related factors are of the utmost importance in maintaining and improving of preadolescents' oral health behaviour and status.

Figure 4.1. Modified PRECEDE-PROCEED model (Green & Kreuter, 1991) describing factors influencing children's oral health



4.5. Pilot study

In December 2004, a separate pilot study was conducted in one girl's school in Tehran in order to test the reliability and feasibility of the methods. The protocol was then revised slightly, and the main project was carried out in February-March 2005.

4.6. Cross-sectional part of the study

A representative sample of 9-year-old primary school children were selected by multi-stage sampling from all the public primary schools in Tehran. Firstly, from a list of primary schools provided by the Ministry of Education, taking the gender of their pupils into account, 16 schools (8 boys' schools and 8 girls' schools) were randomly selected. Thereafter, from each school one third-year class was randomly chosen. In total, 459 subjects (225 boys and 234 girls) and their mothers voluntarily participated in the study.

4.6.1. Data collection

The data came from a clinical examination of the children and two self-administered questionnaires: one for children, and one for mothers. All of the children completed their questionnaires in class under supervision before the clinical examination. Each child was then asked to take home a cover letter and the mother's questionnaire, to be completed and returned to school within 2 days; 416 (91%) of the mothers responded. The response rate for every question varied, but was no less than 86%. The clinical dental examination was then performed for recording children's oral health. Only two of the children were excluded from the clinical examination, one refusing to participate and one having a cleft lip and palate.

4.6.1.1. Questionnaires

The questionnaires (Appendices) utilized oral self-care behaviours and oral health-related knowledge and attitude statements from previous studies (Chen et al., 1997; Okada et al., 2001; Szatko et al., 2004) to assess the child's and mother's oral self-care and mother's knowledge of and attitudes towards oral health. To discover the reliability of these questionnaires, a separate group of children and their mothers (n = 27) answered the questionnaires twice, and kappa values of 0.77 to 1.0 for different questions were calculated.

Questions about the oral self-care (OSC) of both mother and child covered the frequency of tooth brushing, use of fluoride toothpaste, and consumption of sugary snacks between meals. The question "How often do you usually brush your teeth?" offered five alternatives: "irregularly or never", "once a week", "a few times a week", "once daily", or "twice daily or more". The question "Do you use a toothpaste containing fluoride while brushing?" had four alternatives: "never", "seldom", "rather often", or "always or almost always". The question

"How often do you have sugary snacks and drinks between your main meals?" offered five options for answers, "three times a day or more", "twice a day", "once a day", "occasionally, not every day", or "rarely or never".

According to the proposed recommendations for oral health maintenance (Moynihan, 2005; Sheiham, 2001), mothers' and children' OSC were dichotomised into favourable or unfavourable. Favourable OSC included tooth brushing twice daily, always or almost always using fluoride toothpaste, and eating sugary snacks between meals once daily or less. Unfavourable OSC was being rated unfavourable in one, two, or all three of these OSC behaviours. Previously, the child's and mother's OSC was also categorised into three groups (Study II). The criteria for favourable OSC were similar, while moderate OSC included two of the OSC behaviours reported for favourable OSC, and unfavourable OSC included no more than one of these favourable OSC behaviours.

The mother's role in maintaining the child's OSC was assessed as "supervision of the child's tooth brushing". The corresponding question was: "How often do you supervise your child's tooth brushing?" Alternatives for answering were as follows: a) always or almost always, b) rather often, c) seldom, or d) never. These were later categorized to indicate the mother's role as active (a+b) or inactive (c+d).

Eight statements on different aspects of oral health (microbial plaque, causes and prevention of oral diseases), on a five-point Likert scale from 'fully agree' to 'fully disagree', assessed the mothers' knowledge of oral health. Their responses were scored from 1 to 5; with the higher scores indicating higher degree of knowledge (the negative statements were rescored). The sum of these scores served as the final oral health knowledge score for each respondent. For further analyses, the sum scores were sub-grouped into quartiles, and the low (Q_1: 8 - 29) and the high (Q_4: 34 - 40) quartiles were compared.

Six statements about the importance of oral health and the seriousness of oral diseases, with the same scale as for the knowledge statements and the same scoring assessed the mothers' attitudes. The sum scores for the low (Q_1: 8 - 22) and the high (Q_4: 27 - 30) quartiles were compared.

Mothers were asked to give information on parental education as a socio-economic background factor. The questions, about levels of education for fathers and mothers separately, were assessed on a 7-point-scale ranging from illiterate to doctorate degree. For further analysis, parents' education (PE) was categorized into three levels; low (less than 9

yrs), medium (between 9-12 yrs), or high (more than 12 yrs). The parents' level of education was defined as the highest level of the better-educated parent.

4.6.1.2. Clinical examination

The children were examined in the health office at the school during school time, before lunch. All clinical examinations were conducted by the author using a disposable mirror, a sterile CPI probe, and a blue and white headlamp under natural light in the office. A research assistant recorded the clinical data on prepared data sheets. At the beginning of the survey, duplicate examinations of the children (n = 27) in one school were performed in order to assess intra-examiner agreement in the use of the diagnostic criteria, yielding 98% intra-examiner consistency for caries recordings and 91% for CPI and PI.

Clinical examinations were carried out based on the WHO criteria for recording dental status and bleeding (WHO, 1997), and on the Silness & Löe index (1964) for measuring plaque. Dental status was scored as the number of decayed, missing, and filled teeth in both primary (dmft) and permanent (DMFT) dentitions tooth by tooth. In Studies I to IV, dental status was analysed in primary and/or permanent teeth. In the final report, only sound dentition (DMFT+dmft = 0) and decay-free teeth (DT+dt = 0) were assessed as overall dental status of the children.

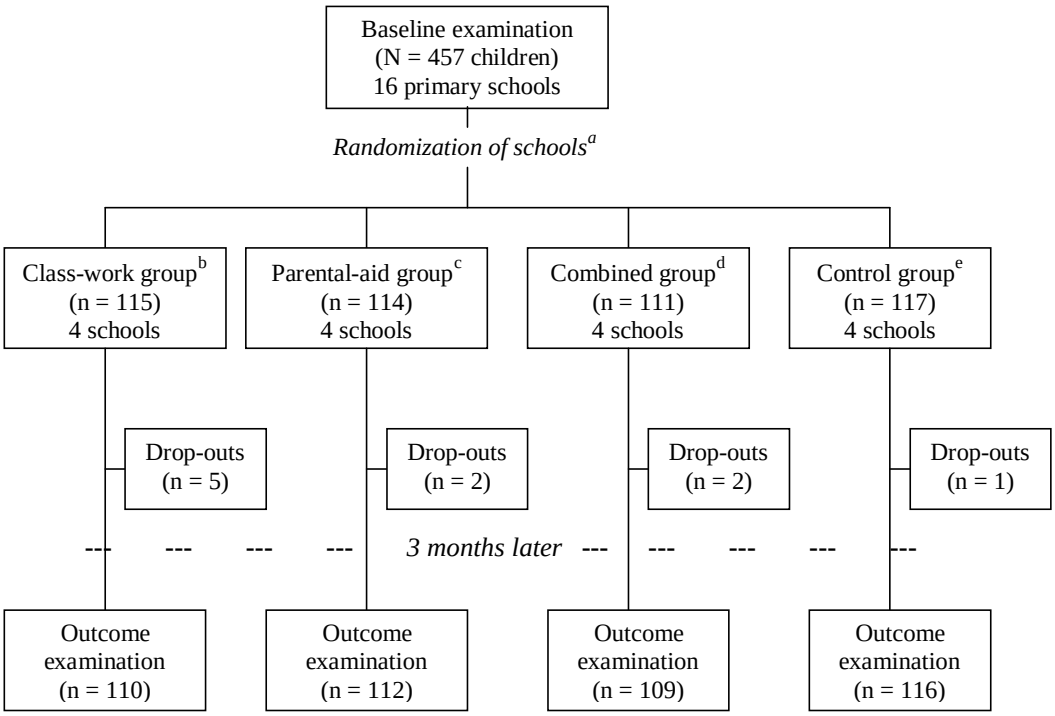
Subsequently, the restoration index (RI=FT/DT+FT) facilitated an assessment of the children's dental treatment (Vanobbergen et al., 2001b). Those who received full dental treatment were compared with those who had incomplete or were without dental treatment.

The children's oral hygiene was assessed by plaque measurement (modified PI) and recorded for each of the six index teeth (dd 16, 11, 26, 36, 31, and 46) as no plaque, plaque on gingival margin only, or plaque elsewhere, with scores correspondingly 0, 1, or 2. The sum of plaque recording calculated and, according to its distribution, the low (sum of plaque scores recording maximum 9) and high (12; maximum plaque on every index tooth) sub-groups were compared. The children's gingival health was assessed by bleeding index (BI) with the same criteria as described for the community periodontal index (CPI) for each of the six index teeth as healthy (0) or bleeding (1). The sum scores for the low (0 - 2) and the high (6; bleeding around every index tooth) extremes were compared. For the five cases with a missing index tooth, for the first permanent molar was substituted a primary tooth mesially to it. In the absence of the incisor, for the missing central incisor was substituted the one on the opposite side of the midline.

4.7. Interventional part of the study

The community trial was designed as a 3-month school-based intervention study. For the intervention trial, separately for boys' and girls' schools, the third-grade classes as the clusters were randomly assigned to three intervention groups and one control group, each group comprising two girls' and two boys' schools. The total numbers of 457 children (224 boys, 233 girls) were enrolled in the intervention study **(Figure 4.2)**.

Figure 4.2. The 3-month school-based intervention among Iranian 9-year-olds (**V**)



[a]Each group included two boys' and two girls' schools
[b]Class-work group: Puzzles with oral health messages and oral health instructions given by a health counsellor in class during 3-4 sessions
[c]Parental-aid group: Leaflet and a brushing diary sent to parents
[d]Combined group: Combination of both these interventions
[e]Control group: No intervention
(With the permission from the publisher)

4.7.1. Data collection

The data collection was performed by mean of a clinical dental examination of the children. All the children present at the day of examination participated in the clinical examination.

For all four groups, a similar clinical examination was conducted at baseline and at the end, recordings of plaque and bleeding measurements. To compare the results of both dental examinations, sums of plaque scores and bleeding scores were calculated for both baseline and outcome examinations.

For the outcome examinations, a dentist not involved in the study procedures and blind to group assignment was trained at a university dental clinic to achieve acceptable agreement with the baseline examiner. Subsequently, a calibration was carried out on a separate group of 27 children. Each was examined by one of the examiners and then re-examined by the other examiner within 1 hour. This procedure resulted in an inter-examiner reliability with a kappa value of 0.84 for PI and of 0.63 for BI, representing an excellent and a substantial agreement between examiners (Landis & Koch, 1977).

4.7.2. School-based interventions

Three kinds of intervention were implemented, one in class, one via the parents, and one as a combination of these. One group served as controls with no intervention. Approximately 2 weeks after data collection at baseline, interventions began, and the follow-up examinations occurred 3 months later. To avoid bias, the details of the interventions were not explained to the children. The execution of the intervention was monitored through visits at the schools and discussions with health counsellors.

Class-work group (n = 110). This intervention was applied in class by means of seven various illustrative puzzles, printed on A4 sheets, used as learning tools, including oral health messages guiding children to twice-daily tooth brushing and use of fluoride toothpaste. Each primary school has a health officer with at least 2 years' university studies in health science who provides first aid, screens for common diseases, and supplies detailed health education. For the trial, the health counsellors were advised individually and similarly about the puzzles and their use for instructing children in oral hygiene methods. During three to four sessions in one month, each session lasting for 30 to 45 minutes, the children solved the puzzles one by one. The health officer handed out the leaflets in class, and supervised the children in doing one or two puzzles at one time. This teaching was adjusted to the pace at which the children were able to complete the puzzles. After the completion of each puzzle, the health counsellor explained its oral health message. For example, if the message was about tooth brushing, the health counsellor explained with a dental model why and how children should brush their

teeth. Additionally, a poster to motivate children to avoid sugary snacks hung on the classroom wall during the trial period.

Parental-aid group (n = 112). This intervention was provided via the parents at home without giving the children any additional instructions on oral health at school. A two-page A4-size oral health education leaflet and a brushing diary prepared for the study were delivered by the health counsellors to the children to take home. This leaflet contained comprehensive well-known oral health information on the aetiology of common oral diseases – gingival disease and dental caries – and their associations with general diseases and quality of life. The leaflet emphasized the preventability of dental caries and ways to keep the mouth healthy by recommending twice-daily tooth brushing, use of fluoride toothpaste and restriction of sugary snacks. Furthermore, the modelling role of parents in their children's good oral health behaviours was underlined. The leaflet used simple language and explained scientific issues plainly and clearly to make this easy for the parents to read and understand. An image of a toothbrush preceded the most important topics as an additional motivation while reading them. In the cover letter, parents were advised to encourage the child and to keep a diary on the child's tooth brushing, to supervise the tooth brushing and help if needed, and to provide non-sugary snacks.

Combined group (n = 109). Intervention in this group was carried out both via class-work and via the parents according to the programmes described above.

Control group (n = 116). This group received no intervention at all, but each child had undergone the clinical examination.

4.7.3. Evaluation of the interventions

Almost all children (n = 447/457) attended the clinical examinations after 3 months. The outcome measures of the study were changes in plaque and bleeding scores, calculated as differences in the sum scores of plaque and bleeding from baseline to the outcome examination. A positive value indicated improvement in gingival health. All comparisons were made with the control group.

For further analysis, two positive outcomes were defined: 'acceptable oral hygiene' was defined as a change in at least half the index teeth which had plaque at baseline to clean teeth at the outcome examination. An outcome of 'healthy gingival' was defined as an improvement in all the index teeth which showed bleeding at baseline. Percentages of children demonstrating the final outcomes indicated the intervention's effectiveness.

4.8. Ethical aspects

The protocol was approved by the Ethics Committee of Shaheed Beheshti University, Tehran, Iran. Shaheed Beheshti University required permissions for the study from the Ministry of Health and the Ministry of Education. After their authorization, consent was asked from each regional Health Department in Tehran. Thereafter, the principals of each selected school were provided with the information of the present community-based trial. The consent of the study was obtained at the levels of state and community (Hutton, 2001) by providing the community with information on the research (Edwards et al., 1999; Hutton, 2001) which is acceptable by The WHO/CIOMS guidelines (2002) when individual consent in not feasible in community trials. As well as, at the beginning of the study a cover letter to the mothers explained the main aspects of the questionnaires and clinical examinations of the children. The letter guaranteed that participation in the study is voluntary for both the children and the parents, and parents were informed about any urgent need for dental care at any of the dental examinations.

4.9. Statistical methods

Evaluation of statistical significance between groups was made by ANOVA and Kruskal-Wallis tests for mean values and the Chi-square test for frequencies. P values less than 0.05 were considered statistically significant.

To uncover the latent dimensions of a set of variables, and not to assume that a dependent variable is specified, factor analysis is applied (Garson, 2010). To learn the interaction between the mother's oral health-related factors, a factor analysis with a principle component method and varimax rotation was performed. Each item that loaded at 0.60 or greater on only one factor was included as an item for a given factor. Two factors, explaining 65% of the common variance, were revealed. New variables concerning each factor were applied for further analyses.

Binary logistic regression models were applied and corresponding odds ratios (OR) and 95% confidence intervals (95% CI) determined. The child's oral health status and treatment, the child's tooth brushing, and the child's OSC were as dependent variables. The independent variables were gender of the child, parental education, and mother's oral health-related factors.

The odds ratio (OR) as a cross product and Number Needed to Treat (NNT) indicated the preliminary effectiveness of the interventions. To take into account the clustering of the children within schools, generalized estimating equations (GEE) were used with logit link and

an exchangeable correlation matrix to make the comparison between the intervention and control groups.

To detect a 25% reduction in the scores of dental plaque and gingival bleeding with $\alpha = 0.05$ (two sided), power = 80%, 1-3% attrition, means of 11.00 (SD = 1.4) for plaque and of 4.00 (SD = 1.3) for bleeding – the intra-cluster correlation coefficients being 0.08 and 0.12, respectively – required one school/arm with 29 children examined in each school. To allow the use of normal distribution critical values and possible effects by gender, 16 schools (4 schools/arm) were enrolled.

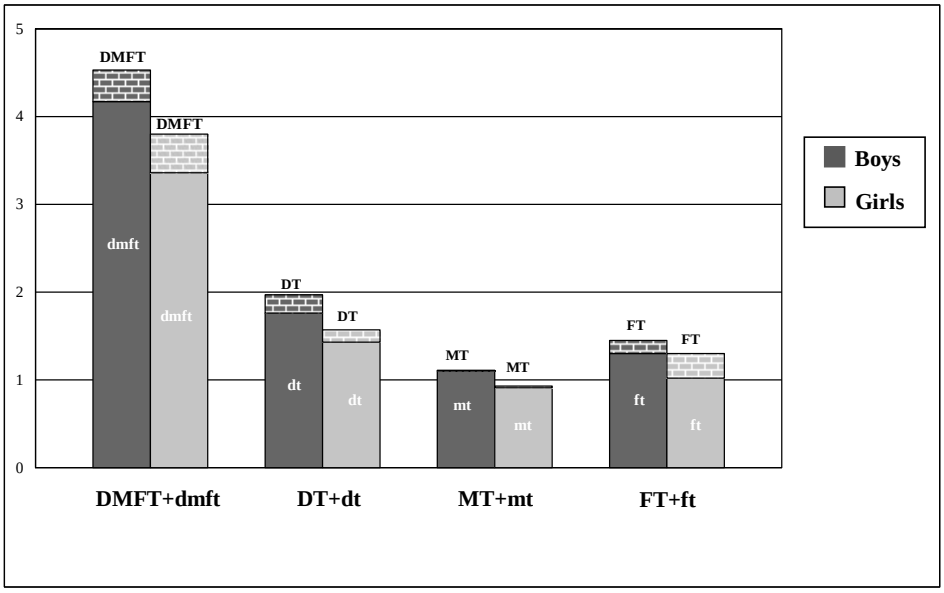
5. RESULTS

5.1. Epidemiological assessment of the 9-year-old children (I)

The mean DMFT+dmft value was 4.2 (SD = 3.0) for the whole study group. Separately for the primary and permanent teeth, mean dmft value was 3.8 (2.8), and mean DMFT was 0.4 (SD = 0.9). Dental caries (dt) was the dominant component of dmft with a mean value of 1.6 (SD = 1.8), while filled teeth (FT) constituted the greatest part of DMFT, with a mean of 0.2 (SD = 0.7). The percentage of children having sound dentition (DMFT+dmft = 0) was 14%. Girls more often had sound dentition than did the boys (16% vs. 11%); but this difference was not statistically significant.

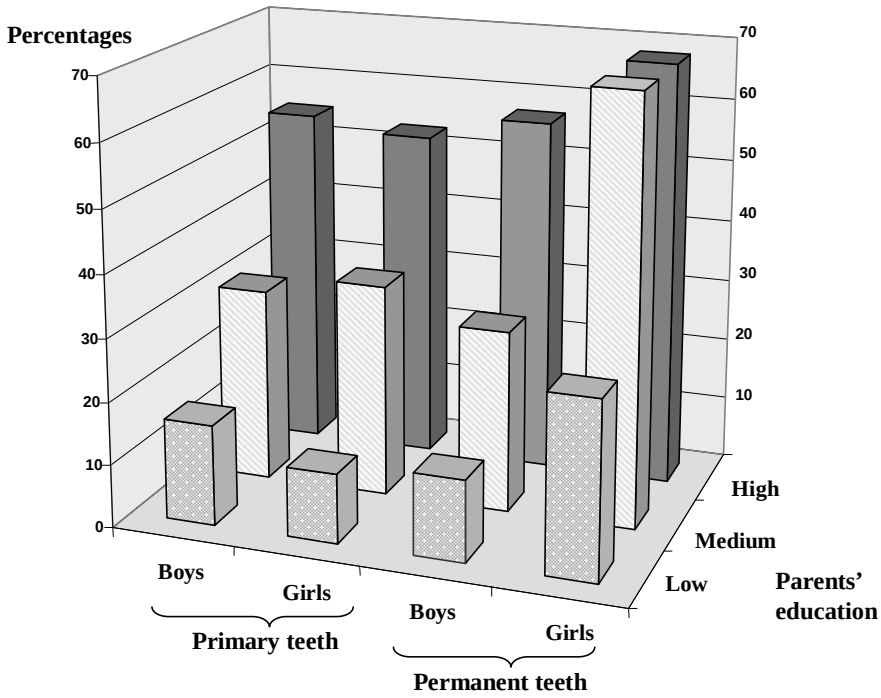
The mean DMFT+dmft value was 4.5 (SD = 3.2) for boys and 3.8 (SD = 2.9) for girls ($P < 0.05$, **Figure 5.1**). In the separate analyses, this gender difference was observed only for the primary but not for the permanent dentition. Regarding components of DMFT+dmft, a gender difference appeared only for DT+dt ($P < 0.05$, **Figure 5.1**), girls having more decay-free teeth than did the boys (38% vs. 28%).

Figure 5.1. Oral health status (mean values) of 9-year-old Iranian children (n = 457) in relation to their gender



No gender difference emerged regarding dental treatment received in the primary dentition, but more restorative dental treatment of permanent teeth had been given to the girls ($P < 0.05$, **Figure 5.2**). A strong association was found between high parental education and restoration index (RI) in primary teeth ($P < 0.001$), as well as in permanent teeth ($P < 0.05$, **Figure 5.2**). When RI was calculated for both primary and permanent dentitions, the mean (SD) was 0.4 (0.4) for the total study group.

Figure 5.2. Restoration index (RI) in primary and permanent teeth of 9-year-old children in relation to their gender and parents' education



All children had plaque on at least one index tooth. The mean (SD) of sum plaque scores was 11.1 (1.3) for boys and 10.7 (1.6) for girls ($P < 0.01$). Low plaque score (sum of plaque recording 5-9 of 12) was found for 15% of the children, with more girls than boys (30% vs. 17%, $P < 0.01$) showing a low plaque score.

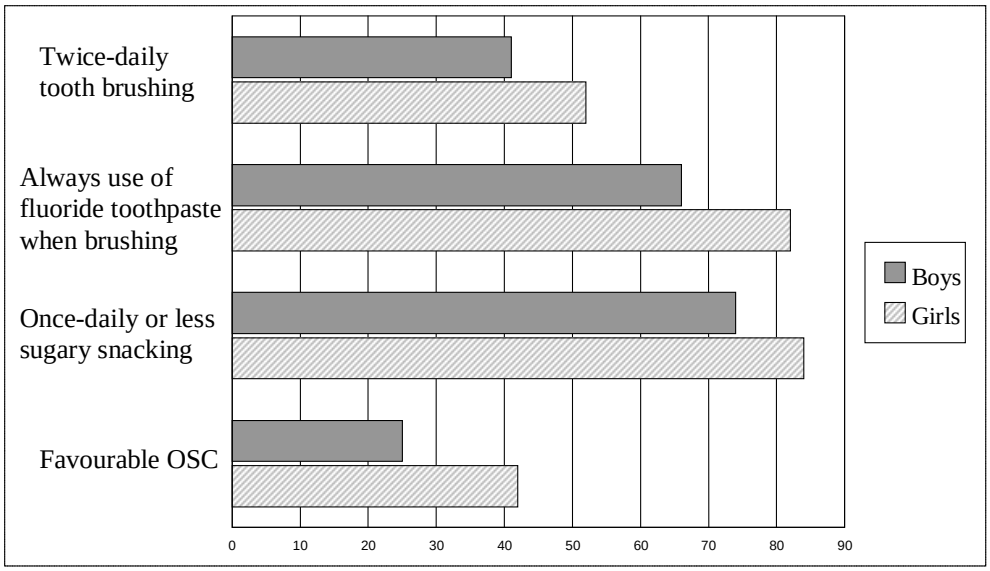
Plaque score was low among children with decay-free teeth more frequently than among those with active dental caries (34% vs. 19%, $P < 0.05$). Children with a low plaque score had more restored primary teeth more than did those with a high plaque score (31% vs. 16%, $P < 0.05$).

The mean (SD) of sum bleeding scores was 4.0 (1.4) for the boys and 4.2 (1.2) for the girls ($P < 0.05$). Of all children, 12% showed a low bleeding score (sum of bleeding recording 0-2 of 6). Boys more often had a lower bleeding score than did girls (53% vs. 32%, $P < 0.05$). Children with a low bleeding score had more filled primary teeth than children with high bleeding score (30% vs. 11%, $P < 0.05$). The bleeding score was low more often among boys and girls with a low plaque score than among those with a high plaque score (68% vs. 30%, $P < 0.01$).

5.2. Behavioural assessment of the 9-year-old children (II)

About one-third (34%) of the children reported favourable oral self-care (OSC). Less than half (46%) reported that they brushed their teeth at least twice a day. The figure for regular use of fluoridated toothpaste while brushing was 74% and for eating sugary snacks between meals less than once daily was 79%. Girls reported more favourable oral self-care behaviours than did boys ($P < 0.01$, **Figure 5.3**).

Figure 5.3. Oral self-care and its characteristics among 9-year-old Iranian boys and girls (n = 457)



Favourable OSC includes twice-daily tooth brushing, always use of fluoride toothpaste, and once-daily or less sugary snacking.

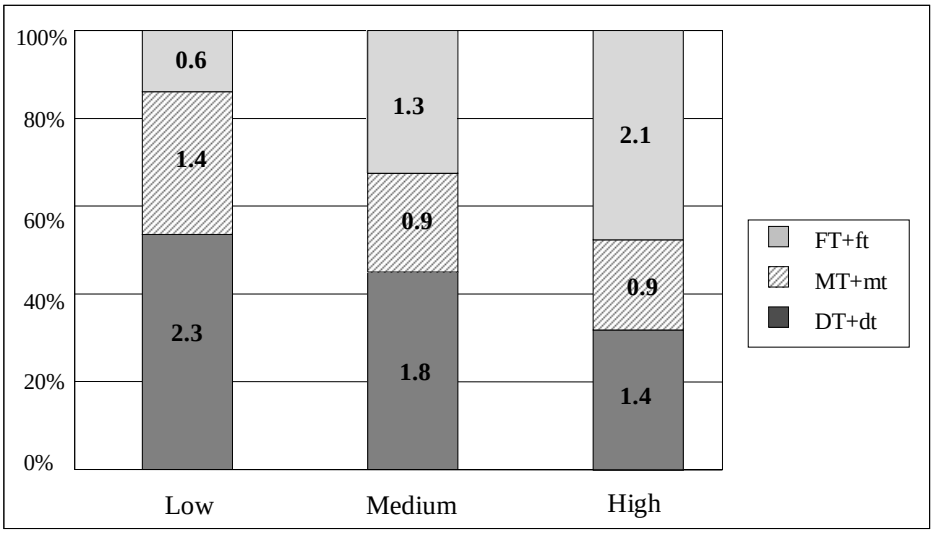
The children's oral health status showed no significant differences regarding their oral self-care (see later **Table 5.1**); however, a lower plaque score (sum of plaque recording 5-9 of 12) appeared among the children with favourable OSC than among their counterparts with unfavourable OSC (33% vs. 20%).

5.3. Parent-related factors affecting the children's oral health status and oral self-care (I – IV)

5.3.1. The effect of parental education on children's oral health and oral self-care (I, II)

No significant difference emerged between parental level of education and DMFT+dmft. However, for all the components of DMFT+dmft, significant differences existed between children of low-education and high-education parents **(Figure 5.4)**.

Figure 5.4. Mean DMFT+dmft of 9-year-old Iranian children (n = 457) in relation to parental education



In separate analyses (**I**) for the primary dentition, children of less-educated parents showed significantly more dental caries (2.0 ± 1.9) than did those of highly educated parents (1.3 ± 1.7). The children of less-educated parents also had more missing teeth than did their counterparts (1.3 ± 1.3 vs. 0.9 ± 1.3). Fewer filled teeth were also found among children of less-educated parents (0.4 ± 1.1) than among their counterparts with better-educated parents

(1.8 ± 2.0). Regarding the permanent dentition, children of less-educated parents had more dental caries than their counterparts (0.3 ± 0.7 vs. 0.1 ± 0.4).

As shown in **Figure 5.2**, a strong association existed between high parental education and RI in primary teeth ($P < 0.001$), as well as in permanent teeth ($P < 0.01$). In addition, bleeding scores were lower among the children of high parental education (22% in low, 47% in medium, and 59% in highly educated groups, $P < 0.05$).

The children of highly educated parents reported brushing their teeth (49% vs. 36%) and using toothpaste (82% vs. 62%) more frequently than did children of the less-educated parents ($P < 0.05$).

5.3.2. Influence of mothers' oral self-care on children's oral health and oral self-care (II)

Almost one-third (28%) of the mothers reported tooth brushing at least twice a day, and 60% of them reported regular use of fluoridated toothpaste. The majority (81%) reported eating sugary snacks between meals once daily or less. Fourteen percent of the studied mothers had favourable OSC behaviour.

Children having decay-free teeth (DT+dt = 0) showed no significant difference from their mothers' favourable behaviour **(Table 5.1)**. However, the decay-free teeth in their permanent dentition (DT = 0) was related to the favourable behaviour among their mothers ($P = 0.01$). Children of mothers with favourable behaviour had received more dental treatment of both their primary and permanent dentitions (**Table 5.1**). The oral hygiene and gingival health of children did not differ from their mothers' oral health behaviour.

Mothers' twice-daily tooth brushing was significantly associated with their children's twice-daily tooth brushing behaviour **(Table 5.2)**. Among the mothers who reported twice-daily tooth brushing, 64% of their daughters reported twice-daily tooth brushing, although 36% brushed their teeth less frequently ($P < 0.05$). This difference was not verified for the boys.

Use of fluoride toothpaste and sugary snacking of mothers showed no relationships with these same oral self-care behaviours of their children **(Table 5.2)**. When OSC behaviours were compared among the mothers and their children, mothers' unfavourable OSC was significantly related to children's unfavourable OSC ($P = 0.03$, **Table 5.2**).

Table 5.1. Oral health status of 9-year-old Iranian children (n = 457) in relation to their own oral self-care and mothers' oral self-care (OSC)

		Child's OSC[1]			Mother's OSC[1]		
	All	FB	UB	P[5]	FB	UB	P[5]
Dental status							
DMFT+dmft = 0	14	16	12	0.25	12	13	0.77
DT+dt = 0	33	38	31	0.10	41	30	0.11
Dental treatment[2]							
RI for permanent teeth = 1	44	51	40	0.27	92	36	0.001
RI for primary teeth = 1	19	25	16	0.06	31	16	0.02
Oral hygiene and gingival health							
Low plaque score[3]	15	33	20	0.01	24	25	0.87
Low bleeding score[4]	12	39	45	0.56	47	43	0.74

[1]Favourable behaviour (FB) includes tooth brushing at least twice daily, regular use of fluoride tooth-paste, and sugary snacking between meals once daily or less. Unfavourable behaviour (UB) is defined as being unfavourable in one, two, or all three behavioural aspects.
[2]Restoration Index computed as RI = FT / DT+FT
[3]Low plaque score is sum of plaque recording 5-9 of 12 for the six index teeth
[4]Low bleeding score is sum of the bleeding recording maximum 0-2 of 6 for the six index teeth
[5]Chi-square test

5.3.3. Influence of mothers' supervision of the child's tooth brushing on children's oral health and oral self-care (III)

Altogether 52% of the mothers reported actively supervising their children's tooth brushing, with no difference between boys and girls. Sound dentition (DMFT+dmft = 0) was more frequent among their girls than among the counterparts whose mothers were assessed as inactive (22% vs. 9%) **(Table 5.3)**; no such difference was established for the boys. The mothers' activity in the supervision of their children's tooth brushing resulted in no difference in the children's oral hygiene and gingival health.

Twice-daily tooth brushing was found among children whose mothers were assessed as active in the supervision of their children's tooth brushing more often than among those with mothers who were inactive (51% vs. 40%, **Table 5.3**). The highest rate (63%) of twice-daily tooth brushing was among girls whose mothers were assessed as active in the supervision of their children's tooth brushing; such a difference did not apply to the boys.

Table 5.2. Percentage distribution of 9-year-olds (n = 457) studied by their reported oral self-care behaviours in relation to their mothers' oral self-care behaviour (OSC)

Child's OSC and its aspects	Mother's OSC and its aspects								
	Tooth brushing		Use of fluoride toothpaste		Sugary Snacking between meals		OSC[1]		
	Twice daily	Less	Regularly	Less	Once-daily or less	More	FB	UB	P[2]
Child's tooth brushing									0.02
Twice daily	56	42							
Less	44	58							
Use of fluoride toothpaste									0.25
Regularly			75	70					
Less			25	30					
Sugary snacking between meals									0.95
Once-daily or less					80	80			
More					20	20			
Oral self-care[1]									0.03
Favourable (FB)							46	31	
Unfavourable (UB)							54	69	

[1]Favourable behaviour (FB) includes tooth brushing at least twice daily, regular use of fluoride toothpaste, and sugary snacking between meals once daily or less. Unfavourable behaviour (UB) is defined as being unfavourable in one, two, or all three behavioural aspects.
[2]Chi-square test

5.3.4. Influence of mothers' knowledge of and attitudes towards oral health on children's oral health and oral self-care (IV)

Oral health-related knowledge among the mothers was generally high. Almost all of the mothers (92-94%) acknowledged that restricting the consumption of sugary snacks can prevent dental decay and regular tooth brushing helps preventing gum diseases. They (97%) conceded the benefit of visiting a dentist for regular check-ups. A majority of them (79-84%) knew the preventive role of fluoride toothpaste and the destructive effect of sweet foods on teeth. Many of them (60%) admitted the role of microbial plaque to cause dental and gingival diseases.

Positive attitudes towards oral health was found among the mothers: 97% of them considered dental disease as serious, the disease being as important to be as other diseases for 75% of them, and almost all (90%) thought that dental decay is preventable. Primary teeth were

Table 5.3. Tooth brushing frequency and oral health status of 9-year-old Iranian children (n = 457) according to level of the mother's reported supervision of the child's tooth brushing

Child's tooth brushing and oral health	Supervision of the child's tooth brushing[1]								
	All			Boys			Girls		
	Active[1]	Inactive[2]	P[5]	Active[1]	Inactive[2]	P[5]	Active[1]	Inactive[2]	P[5]
Frequency of tooth brushing									
Twice-daily or more	51	40	0.046	38	42	0.61	63	39	0.001
Dental status									
DMFT+dmft = 0	18	9	0.005	14	8	0.20	22	9	0.008
DT+dt = 0	37	28	0.08	31	22	0.15	42	34	0.24
Dental treatment[2]									
RI for permanent teeth = 1	45	42	0.78	42	25	0.26	48	56	0.57
RI for primary teeth = 1	19	19	0.98	17	16	0.76	22	23	0.85
Oral hygiene and gingival health									
Low plaque score[3]	25	25	0.91	16	21	0.42	37	28	0.27
Low bleeding score[4]	44	44	0.99	52	54	0.88	36	32	0.77

[1]Active supervision: always or often; Inactive supervision: seldom or never
[2]Restoration Index computed as RI = FT / DT+FT
[3]Low plaque score is sum of plaque recording 5-9 of 12 for the six index teeth
[4]Low bleeding score is sum of the bleeding recording 0-2 of 6 for the six index teeth
[5]Chi-square test

considered as important by many of them (75%) as well as they agreed to the possibility of maintaining one's teeth for whole life.

Mothers' knowledge and attitudes was not found associated with the children's sound dentition (DMFT+dmft = 0) **(Table 5.4)**, however, mothers' high oral health attitude scores was related to sound dentition among the girls (P = 0.01). Mothers with high oral health knowledge and attitude scores (highest quartile) had more children who were defined as decay-free (DT+dt = 0) and restored their teeth (RI = 1). Mothers' knowledge of and attitudes towards oral health showed no differences with the oral hygiene and gingival health of their children **(Table 5.4)**.

Children of mothers with high oral health-attitude scores (highest quartile) reported twice-daily tooth brushing more frequently, but their mothers' knowledge of oral health showed no association with these children's tooth brushing **(Table 5.4)**.

Table 5.4. Tooth-brushing frequency and oral health status of Iranian 9-year-olds (n = 457) according to mothers' oral health-related knowledge and attitudes

	Mothers' knowledge			**Mothers' attitudes**		
	Q_1[1]	**Q_4**[2]	**P**[6]	**Q_1**[1]	**Q_4**[2]	**P**[6]
Tooth-brushing frequency						
Twice daily or more	46	46	0.94	38	54	0.01
Dental status						
DMFT+dmft = 0	13	14	0.79	14	12	0.59
DT+dt = 0	23	41	0.004	26	42	0.01
Dental treatment[3]						
RI for permanent teeth = 1	20	70	0.001	23	63	0.007
RI for primary teeth = 1	9	29	0.001	11	28	0.005
Oral hygiene and gingival health						
Low plaque score[4]	27	19	0.24	24	33	0.21
Low bleeding score[5]	45	56	0.42	39	48	0.49

[1]Q_1: mothers with lowest oral health knowledge and attitude scores
[2]Q_4: mothers with highest oral health knowledge and attitude scores
[3]Restoration Index computed as RI = FT / DT+FT
[4] Low plaque score is sum of plaque recording 5-9 of 12 for the six index teeth
[5]Low bleeding score is sum of the bleeding recording 0-2 of 6 for the six index teeth
[6]Chi-square test

5.3.5. Determinants of the children's oral health and oral self-care (including I - IV)

Factor analysis for mother's OSC, knowledge of and attitudes towards oral health, and supervision of the child's tooth brushing resulted in two factors which explained 65% of the total variance (**Table 5.5**). These factors were designated 'educational aspect' and 'behavioural aspect'.

Table 5.5. Factor loading for mother's oral health-related factors

	Factors[1]	
	Educational aspect	**Behavioural aspect**
Mother's knowledge of oral health	0.870	—
Mother's attitudes towards oral health	0.853	—
Mother's oral self-care	—	0.619
Mother's supervision of the child's tooth brushing	—	0.830
Percentage of variance explained	40	25

[1]Principle component analysis and Varimax rotation method with Kaiser Normalization, a rotation converged in 3 iterations.

To determine the factors influencing a child's oral health required application of logistic regression models (**Table 5.6**). Child's gender, parents' education, and mother's educational and behavioural aspects were entered in the models as explanatory factors for the child's tooth-brushing, OSC, dental status, and dental treatment.

As shown in **Table 5.6**, girls were more likely to practise twice-daily tooth-brushing (OR = 1.6), had more favourable OSC (OR = 2.0), had more often decay-free teeth (OR = 1.8), and full treatment in permanent teeth (OR = 3.3). Parents' education had an influence on the child's decay-free teeth (OR =1.2), child's full treatment for permanent (OR =1.6), and child's full treatment for primary teeth (OR =1.5), but it did not influence children's tooth brushing and OSC.

Mothers' behavioural and educational aspects had effect on all of the aspects of their children's oral health status and behaviours. For instance, the mother's behavioural aspect influenced, for her child, twice-daily tooth brushing (OR = 1.2), favourable OSC (OR = 1.1), decay-free teeth (OR = 1.3), sound dentition (OR = 1.5), full treatment for permanent teeth (OR = 1.5), and full treatment for primary teeth (OR = 1.1).

Table 5.6. Oral health of Iranian 9-year-olds as explained by their gender, parents' education, and mothers' educational and behavioural aspects by means of the separate logistic regression models

	Estimate	S.E.	P	OR	95% CI
Child's twice-daily tooth brushing					
Gender (0 = boy, 1 = girl)	0.475	0.206	0.02	1.6	1.1-2.4
Parents' education	0.006	0.078	0.94	1.0	0.8-1.2
Mother's educational aspect	0.166	0.111	0.14	1.2	1.0-1.5
Mother's behavioural aspect	0.326	0.106	0.002	1.4	1.1-1.7
Child's favourable OSC					
Gender (0 = boy, 1 = girl)	0.707	0.219	0.001	2.0	1.3-3.1
Parents' education	0.032	0.081	0.69	1.0	0.9-1.2
Mother's educational aspect	0.109	0.116	0.35	1.1	0.9-1.4
Mother's behavioural aspect	0.293	0.111	0.008	1.3	1.1-1.7
Child's decay-free teeth (DT+dt = 0)					
Gender (0 = boy, 1 = girl)	0.557	0.224	0.01	1.8	1.1-2.7
Parents' education	0.216	0.082	0.008	1.2	1.1-1.5
Mother's educational aspect	0.272	0.124	0.03	1.3	1.0-1.7
Mother's behavioural aspect	0.283	0.115	0.01	1.3	1.1-1.7
Child's sound dentition (DMFT+dmft = 0)					
Gender (0 = boy, 1 = girl)	0.439	0.306	0.15	1.6	0.9-2.8
Parents' education	-0.023	0.112	0.84	1.0	0.8-1.2
Mother's educational aspect	0.086	0.158	0.59	1.1	0.8-1.5
Mother's behavioural aspect	0.430	0.154	0.005	1.5	1.1-2.1
Child's full dental treatment for permanent teeth (RI = 1)					
Gender (0 = boy, 1 = girl)	1.188	0.542	0.03	3.3	1.1-9.5
Parents' education	0.460	0.225	0.04	1.6	1.0-2.5
Mother's educational aspect	0.507	0.293	0.08	1.7	0.9-3.0
Mother's behavioural aspect	0.637	0.280	0.02	1.9	1.1-3.3
Child's full dental treatment for primary teeth (RI = 1)					
Gender (0 = boy, 1 = girl)	0.370	0.301	0.22	1.5	0.8-2.6
Parents' education	0.417	0.108	0.000	1.5	1.2-1.9
Mother's educational aspect	0.407	0.180	0.02	1.5	1.1-2.1
Mother's behavioural aspect	0.064	0.159	0.69	1.1	0.8-1.5

Hosmer-Lemeshow goodness-of-fit test significance P> 0.05 for the models.

5.4. Effects of a school-based oral health education intervention based on the determinants of the child's oral health (V)

Girls showed greater improvement than did the boys, when comparing the changes in plaque and bleeding measurements by intervention group with changes in controls. The greatest positive changes in bleeding scores among the children was in the parental-aid group, with a mean (SD) of 4.17 (1.09) for boys and of 4.31 (1.23) for girls. The combined group showed a mean (SD) of 2.92 (1.71) for boys and of 3.55 (1.26) for girls for changes in bleeding scores.

Regarding positive intervention outcomes, percentages of children achieving acceptable oral hygiene was most frequent in children in the parental-aid ($P < 0.001$) and combined groups ($P < 0.05$), and healthy gingiva was more noticeable among these children ($P < 0.001$) than for the control group. The class-work group did not differ from the controls **(Table 5.7)**.

The strongest effects of intervention on achieving acceptable oral hygiene emerged among the children receiving parental aid (OR = 5.5, NNT = 3), and among those in the combined group (OR = 2.0, NNT = 8). The children doing class-work showed no positive outcome regarding oral hygiene. As regards healthy gingiva, strong intervention effects appeared among the children with parental aid (OR = 7.8, NNT = 2) and among those in the combined group (OR = 3.7, NNT = 3). The class-work group showed a weak intervention effect for healthy gingiva (OR = 1.5, NNT = 11).

The generalized estimating equations (GEE) models taking into account the clustering effect and controlling for the children's gender and parents' education confirmed a strong intervention effect on healthy gingiva in both groups where parents were involved: the parental-aid group (OR= 7.7, 95% CI 2.2-27.7) and combined group (OR = 6.6, 95% CI 2.0-22.1). While parents' education did not affect the outcome, girls achieved more healthy gingiva than did the boys in all intervention groups (OR = 2.5-2.6).

Table 5.7. Numbers (n) and percentages of children achieving acceptable oral hygiene and healthy gingiva during a 3-month school-based intervention among Iranian 9-year-olds (n = 447) (modified from **V**)

Intervention groups	Intervention outcomes					
	Acceptable oral hygiene[1]			Healthy gingiva[2]		
	Total n (%)	Boys n (%)	Girls n (%)	Total n (%)	Boys n (%)	Girls n (%)
Class-work group	110 (13)‡	53 (6)*	57 (19)‡	109 (41)‡	52 (37)‡	57 (46)**
Parental-aid group	112 (52)***	58 (33)‡	54 (72)***	112 (79)***	58 (85)***	54 (72)***
Combined group	109 (28)*	60 (30)‡	49 (27)‡	108 (64)***	59 (53)‡	49 (78)***
Control group	116 (16)	52 (21)	64 (13)	115 (32)	51 (43)	64 (23)

[1]Acceptable oral hygiene defined as being free of plaque on at least half the index teeth
[2]Healthy gingiva defined as changes to no bleeding from all the index teeth
Chi-square test for differences between each intervention group and control group
$^{*}P < 0.05$, $^{**}P = 0.01$, $^{***}P < 0.001$, ‡non-significant

6. DISCUSSION

6.1. General description

The present study assessed determinants of oral health status and behaviour of 9-year-old primary school children and evaluated the impacts of a school-based intervention programme on their oral hygiene. Data collection consisted of two self-administered questionnaires delivered to the children and their mothers, and clinical dental examination of the children at baseline and after a 3-month follow-up intervention programme.

The present study found the PRECEDE-PROCEED model (Green et al., 1980; Green & Kreuter, 1991) as a useful tool to identify the determinants influencing a child's oral health behaviour and status and as a feasible framework for empowering existing local resources in the community to ensure good oral health. This planning model has been shown to be both feasible and sustainable (Arbeit et al., 1992; Miilunpalo, 2001; Watson et al., 2001). When determining factors influencing the outcome program, a high priority in program planning could be to focus on more important and more changeable factors (Green & Kreuter, 1991; PPM, 2010). Oral health intervention in the present study benefited from mothers as the most important factor to reinforce the child's oral health.

The school-based oral health intervention programme was designed in the school as a suitable system already in place to promote oral health (WHO, 2003a). The WHO emphasizes that the school should be an important setting to reach and engage teachers, students, and their parents in oral health intervention programmes. The present study showed high engagement and participation in the programme of children, parents, and education officials. The school-based intervention was effective in the improving gingival health of the children with poor gingival health at baseline. Both intervention groups involving parents showed a marked improvement in the intervention outcomes among the children.

6.2. Methodological considerations

The target population of the study was 9-year-old school children attending public primary schools in Tehran city. Almost all of the 6- to 11-year-old children in Tehran attend primary schools (MOE, 2007), and public primary schools comprise 90% of all schools of the city, which lays a good base for the present sample selection. School provides a feasible and cost-beneficial approach to reach school-age children (WHO, 2003a); for most of the school-based surveys, therefore, the schools were selected as the unit sample (Frencken et al., 2001; Friel et al., 2002; Vanobbergen et al., 2004). To find a representative sample of schools required a multi-stage sampling approach. For intervention programmes, a randomized control trial

design is considered the best method of demonstrating a clear cause-and-effect relationship between an intervention and outcome (Sibbald & Roland, 1998). However, to prevent contamination of the programme within schools, the study design benefited from a cluster randomized control trial approach as recently suggested in the literature (Redmond et al., 1999; Worthington et al., 2001).

To reduce probable biases related to misconceptions and errors (Helöe, 1972) and to limit incorrect answers (Sjöström et al., 1999) that might arise with a self-administered questionnaire, the following efforts were made: all the children completed their self-administered questionnaires under supervision in the class. First, the questionnaire was delivered to the children and was read aloud in class by the author to facilitate understanding of the questions. The self-administered questionnaire for parents used simple language to be easily readable and understandable for all including the less-educated parents. Instructions for answering the questionnaire were clear to facilitate reliable answering. However, as in any other questionnaire survey, socially acceptable answering (Sjöström & Holst, 2002) is the tendency among participants. A desire to give the favoured responses might have affected the responses of both children and parents, and might have produced a too-optimistic picture of the present situation. An attempt was made to discover the actual situation of a child's tooth brushing behaviour by asking the similar question of their mothers.

To improve the validity of the questions and statements, the questions regarding oral health behaviour, as well as oral health-related knowledge and attitude statements were selected from previous validated questionnaires (Chen et al., 1997; Okada et al., 2001; Szatko et al., 2004). Some revisions were made in the contents of the questionnaire based on the discussions with experts in oral public health and health education. After a pilot study in one school, slight modifications were made in the statements. The answers had high reliability when the questions were asked twice.

Children's dental health and gingival bleeding were recorded based on the WHO criteria as recommended for epidemiological surveys (WHO, 1997), whereas dental plaque was recorded as a modification of Silness & Löe index (1964). Universal use of the WHO criteria would make it possible to compare different surveys, but a lack of distinct criteria for assessing dental plaque was observable. The plaque-free mouth has been considered a goal unrealistic (Sheiham, 1991b) and difficult to reach, therefore minor changes were made in recording of the amount of plaque, changes that remained undetectable due to the measurement's combining scores 2 and 3 of the original plaque index. Allowing for the prevalent formation of dental plaque, method used can be considered sufficient reliable for the

present programme. Because of the easily fluctuating presence of plaque, a better indication of the intervention's effects on oral health may therefore be gingival bleeding.

To eliminate examiner bias, baseline clinical examinations were performed by the author and then another dentist, one not involved in the study procedure and blind to the group assignment, conducted outcome clinical examinations. To achieve acceptable agreement between examiners, a training and calibration procedure was performed. Dental plaque and gingival bleeding have difficulty reaching to a high agreement; however, the study met an acceptable standard of inter-examiner reliability with excellent agreement between examiners for PI, and substantial agreement for BI (Landis & Koch, 1977).

Because of the curricula of the schools, the results of the intervention had to be completed in the same term. Thus the follow-up period was no longer than 3 months, which can be considered relatively short; the sustainability of the findings thus remains unknown. This limitation can be identified in several studies regarding oral health education (Watt & Marinho, 2005). Short-term clinical outcomes such as dental plaque and gingival bleeding were evaluated instead of dental caries to eliminate in part this limitation.

6.3. Results of the study

6.3.1. Oral health and oral self-care among preadolescents

The primary importance of collecting epidemiological data concerning dental health among various age groups has been stressed by the WHO (Petersen, 2005a), especially in populations where international comparisons are scarce. Some epidemiological studies have been conducted on the oral health status of 12-year-old children in Iran (Pakshir, 2004), but only a few of those took into account factors that affect oral health, particularly in the younger age groups.

The dental status of the children was rather good; the total mean DMFT value was 0.4 (SD = 0.9) and mostly comprised filled teeth (FT). The mean dmft value was 4.2 (SD = 2.9) in boys and 3.4 (SD = 2.6) in girls. The percentage of caries-free children for primary dentition was 15% and for permanent dentition was 78%. The children's oral hygiene was, however, unsatisfactory, as almost all children had plaque and bleeding on at least one index teeth.

A decline in the trend of dental caries prevalence in permanent teeth among children in Iran has been shown in the earlier studies, and the country has achieved the WHO goal for the year 2000 of DMFT < 3.0 at the age of 12 years (Moynihan & Petersen, 2004). The present

prevalence of dental caries in permanent teeth supports this finding, but caries experience in primary teeth at the age of 9 years remains about the same as reported in the national surveys in 1998 (Pakshir, 2004) and 2004 (MOHME, 2009). Since consumption of sugary snacks is on the rise among the Iranian children (Ghassemi et al., 2002), as well as children have inadequate fluoride intake due to low frequency of twice daily tooth brushing, the situation might change in the future. This is alarming and requires preventive activities. In any case, the high rates of gingival bleeding and dental plaque in the children studied clearly demonstrates the great need for oral hygiene instruction.

Almost one-third (28%) of the mothers and half (46%) of the children reported tooth brushing at least twice a day. The reported tooth brushing frequency among these children is higher than those reported for children in most Middle Eastern countries like Jordan (Rajab et al., 2002) and Saudi Arabia (Al-Tamini & Petersen, 1998) and falls within the range in European countries (Maes et al., 2006). A higher twice-daily tooth brushing frequency were found in Kuwait (Honkala et al., 2007), the US, and Canada (Maes et al., 2006). Recommended oral self-care was evident for 14% of the mothers and 34% of the children.

The present finding indicates a trend toward more frequent tooth brushing than seen to the previous survey among children living in Tehran (MOHME, 2000). However, among children living in other parts, especially in rural areas, evidence leads to an estimation of a worse situation as to the frequency of favourable tooth brushing behaviour. To improve children's tooth brushing habits to reach the recommended behaviour, therefore, a high priority should be given to the oral health intervention programmes. Frequent twice-daily tooth brushing is the most important aspect to be adopted; then efforts could be focussed on the technique and duration of brushing (Honkala, 1984). The alarming findings of high amounts of plaque among these children – in spite of the twice-daily tooth brushing behaviour – call for designing oral health interventions to improve children's tooth-brushing skills.

6.3.2. Child- and parent-related determinants of oral health and self-care

6.3.2.1. Gender differences in oral health and OSC

Better dental status, less dental plaque, more dental treatment, and more favourable OSC occurred more frequently among the girls. These gender differences regarding oral health and oral health behaviour were in line with abundant evidence in the literature (Addy et al., 1994; Kuusela et al., 1997a; Currie et al., 2000; Rajab et al., 2002; Farsi et al., 2004; Martens et al., 2004; Poutanen et al., 2005; Maes et al., 2006; Dorri et al., 2009a). Regardless of the society and culture, girls seem to demonstrate better oral self-care behaviour. Some authors have explained these gender behaviour differences according to social and psychological impacts

of oral health, finding that women perceived oral health as having a great impact on their quality of life in general (Mc Grath & Bedi, 2000).

The girls seemed to benefit from the mothers' favourable oral health behaviour more than did the boys, although the mothers reported supervising their children's tooth brushing similarly for both genders. Mothers' OSC showed higher correlations with the OSC of their daughters than with that of their sons. Parental influence has been shown to vary according to the child's gender (Poutanen et al, 2006); maternal modelling has a stronger impact on girls. Gender links in the relationship between the OSC of parents and children has been clear (Åstrøm, 1998; Wickrama et al., 1999). This may explain the more favourable oral health behaviour practices among girls in general; however, boys should also be fostered towards healthier behaviour (Poutanen et al., 2005). Their mothers' modelling should also facilitate the boys' learning. Mothers should, therefore, be empowered in their parenting and have more effective communication with their sons.

6.3.2.2. Parents' education and child's oral health

In the present study, the association was found between parents' education and children's dental caries and treatment, but with no statistical relationship between parents' education and tooth brushing behaviour and OSC of the children in the final regression models.

Socio-economic determinants have a significant influence on children's oral health (Petersen, 2005b). The prevalence of caries-free children has been higher among the highest socio-economic status (SES) families than among the lowest SES families (Vanobbergen et al., 2001b), while more dental caries and treatment needs were considerably higher in children of low SES (Irigoyen et al, 1999). Indices for assessment of the socio-economic determinants differ; nevertheless, educational background has been one of the most important predictors of oral health (Hobdell et al., 2003b). Parents' education served here as an important determinant for the socio-economic status of the children (Petersen, 2005b). The present finding of a strong inverse association between parental education and caries experience has also been evident in both economically developed (Bolin et al., 1997; Petersen, 2005b) and developing countries (Al-Tamimi & Petersen, 1998; Mascarenhas, 1999; Kiwanuka et al., 2004). Nonetheless, others found no such association (Ullah et al., 2002; David et al., 2005). Iraqi children with more highly educated mothers experienced more dental caries (Ahmed et al., 2007).

Higher SES has been related to a healthier periodontium in children (Taani, 1997; Christensen et al., 2003). Similarly, an association existed between children's periodontal condition and parents' education, with healthy periodontium more frequent among those with more highly

educated parents; gingival bleeding occurred more among children of poorly educated parents.

A positive relationship between socio-economic status and access to dental treatment services was shown in an international study by Hobdell et al. (2003b). High treatment levels have also been observed in children of better educated parents in several domestic studies (Irigoyen et al., 1999; Vanobbergen et al., 2001b). Among the children in the present study, a great discrepancy in dental treatment and unmet treatment needs appeared in relation to the parents' education. While more restorations have been reported for the children of highly educated parents, more extractions were performed on the children of poorly educated parents. This indicates that between these SES groups access to treatment as well as the treatment choices differed. This circumstance is probably due to the economic barriers to dental care confronting the low education group rather than to their lack of knowledge concerning the importance of good oral health, as has been discussed earlier (Roberts-Thomson et al., 1995; Sanders et al., 2006). Access to primary dental care should therefore be delivered to all children and adolescents regardless of economic backgrounds as is done in the Nordic countries (Honkala et al., 1991; Järvelin, 2002).

A family's socio-economic status has also been associated with a child's oral health behaviour (Kuusela et al., 1997b). Unfavourable oral health behaviour has been identified among children who had mothers with low-skill occupations (Poutanen et al., 2005) and a low level of education (Verrips et al., 1993; Rajab et al., 2002). Moreover, Maes and colleagues (2006) found that family affluence and parental occupation were significantly associated with children's tooth-brushing frequency. In the present study, bivariate analyses showed the children of highly educated parents reported brushing their teeth more frequently than did their counterparts. However, multivariate analyses failed to reveal any statistical relationship between parental education and children's tooth-brushing frequency. The effect of parental education on the child's behaviour seems to be overlooked in the presence of other important factors, such as mother's OSC and her supervision of the child's tooth brushing. The impact of parents' education on dental status and treatment of the children, not on their oral health behaviour, may show that parents' education plays an economic role in receiving both preventive and curative dental care, but not on shaping the child's behaviour. Sanders and colleagues (2006) also found that poorer adults make fewer dental visits than do more affluent ones, because of the cost and structural barriers to dental care, but people with different socioeconomic backgrounds equally practice recommended OSC behaviours.

6.3.2.3. Parents' role in child's oral health

The present findings showed children whose mothers had favourable OSC and were active in supervision of the child's tooth brushing were more likely to belong to the favourable OSC group, to have caries-free dentition, and to receive more restorative treatment in their permanent teeth. As well as, more sound dentitions occurred among children with mothers who had high knowledge of and more positive attitudes towards oral health.

Although research suggests the wide variations in children's health, parents have a central role in offering care and support and in transmitting to them models of healthy behaviour and knowledge. In a family, the influence of parents on their children's oral health, as a health-promoting environment is crucial (Christensen, 2004; Mattila et al, 2005a), with high significance to children's oral health and self-care (Åstrøm, 1998; Pine et al, 2000; Okada et al., 2002; Östberg et al., 2003). The main responsibility for providing care and support for the children falls on their mothers (Okada et al, 2001; Mahejabeen et al, 2006). In the present study, mothers' had a very important impact on their children's oral health and self-care. A mother's oral health-related factors such as her favourable OSC, her active supervision, and her positive attitudes towards oral health had a strong influence on the child's recommended tooth-brushing behaviour and good oral health.

This is in accordance with findings of Åstrøm (1998) and Okada and colleagues (2002). Mothers through their behaviour served as an important model for everyday life. Their role-modelling, guides children toward healthy behaviour, but parents who depend on explanation as the sole means of educating their children are unlikely to achieve the desired results (Mattila et al., 2005a). Socialization to oral health behaviours is considered a modelling process in which children learn the behaviour of their parents as the most available and valued role models (Bandura, 1986). Parents as the reinforcing factor (Green & Kreuter, 1991) could be the most important resources of social support for school-age children (Åstrøm & Jakobsen, 1996). Parents continue their important social modelling for their offspring regarding oral health behaviour, even when the children meet other socializing agents outside the home (Åstrøm & Jakobsen, 1998). In countries like Iran, mothers as the primary care givers who spend a great deal of time in close relationship with their children play a vital role in inculcating favourable behaviours. In respect of changing roles and areas of responsibility within the family (Rossow, 1992), fathers should be encouraged to find a more active role in their children's health as well. Considering gender linking for health behaviours (Åstrøm, 1998; Wickrama et al., 1999), the fathers particularly could assist their sons to healthier behaviour.

Parental support improves the oral health of children and adolescents and varies during one's lifetime. Parents of preschoolers should regularly check and assist with their children's tooth brushing; this has been shown to be effective in twice-daily tooth brushing and in reducing dental caries (Kuriakose & Joseph, 1999; Pine et al., 2000). Adolescents also benefited from a close and supportive relationship with their parents for development of their oral hygiene performance (Åstrøm, 1998). The present results revealed that for preadolescents to take advantages of twice-daily tooth brushing and sound dentition, their parental supervision is essential.

Research have been shown that parents' own oral health behaviour, lifestyle, and routines influence the way they assist their children (Mattila et al., 2000). The present findings also showed that those mothers with a favourable OSC reported frequent supervision of their children's tooth brushing. By applying a factor analysis on mother's oral health-related factors, mother's OSC and her supervision of the children's tooth brushing resulted in a single factor, called the behavioural aspect. The mothers' own oral health behaviour may impact their sense of responsibility towards their children's oral health behaviour. The perceived benefits (HBM, 2009) of good oral health may for its part explain the mothers' supportive behaviour (Pine et al., 2000).

That mothers' positive attitudes towards oral health, in the present study, showed a significant effect on their children's twice-daily tooth-brushing behaviour and good oral health is in accordance with earlier research on the influence of mothers' positive oral health attitudes on oral health and oral self-care of the children (Pine et al., 2000; Okada et al, 2001; Adair et al., 2004; Skeie et al., 2006). Attitudes towards oral health impact on how parents care for the oral health of their children (Adair et al., 2004). In the present study, according to factor analysis, oral health-related knowledge and attitudes of the mothers resulted in a single factor as an educational factor. Then, in the separate analyses, knowledge did show an additive effect along with attitude on children's oral health. Behavioural theories (Noar, 2005-2006) explain the impact of attitudes in changing and maintaining behaviour (Freeman & Linden, 1995; Pine et al., 2000; Skeie et al., 2006). On the other hand, parental knowledge has been associated with children's oral health behaviour (Poutanen et al., 2006). It may explain the supportive role of knowledge in establishing attitudes.

In the final analyses, the mother's behavioural aspect showed significantly more influence on the child's oral health and self-care than did the mother's educational aspect. Mothers' behavioural aspect has impacted children's tooth brushing behaviour, OSC, decay-free teeth, sound dentition, and full dental treatment for permanent teeth. While mother's educational aspect showed a significant influence on the child's decay-free teeth and full dental treatment

for primary teeth, it failed to show a statistically significant impact on the child's other oral health-related outcomes. However, odds ratios from 1.1 to 1.7, and their explaining the good estimate of these outcomes, confirm the supporting role of knowledge and attitude in changing and maintaining behaviour (Noar, 2005-2006). It may suggest that improving the cognitive and affective domains among mothers, may lead to constructive behavioural changes.

A KAB model (acquisition of factual knowledge will alter attitudes and lead to a change in behaviour), however, has been criticised as a simplistic representation of human behaviour (Daly et al., 2002) and is not widely accepted. It has been emphasized that behaviour is largely determined by the prospects and circumstances in which individuals live (Sheiham, 2000).

6.3.3. Oral health promotion among preadolescents

The present community trial showed that a school-based intervention approach is, at least in the short term, effective in improving the gingival health of preadolescents with poor gingival health at baseline. This is in line with earlier findings (Hartono et al., 2002; Biesbrock et al., 2004; Watt & Marinho, 2005). Noticeably, in the interventions involving parents (parental-aid and combination groups) outcome improvement was evident. Employing the parental support resulted in desired outcomes in other oral health interventions (Redmond et al., 1999; Worthington et al., 2001).

To analyse and to find different strategies for youth health promotion in different countries is important to improve the capability of the younger generation to make healthy lifestyle choices (Nutbeam, 1997). School-based intervention has been suggested as a suitable approach for improving children's health and it can be efficient, effective, cost-effective, and beneficial to the entire community (WHO, 2003a; Moysés & Rodriques, 2006). The findings of the present trial suggest that the school is an appropriate structure in place, also in Iran, to implement oral health intervention programmes.

Furthermore, as health-care systems have limited resources, to select the best preventive strategy that requires the least resources is very important (Oscarson et al., 2003). To find a suitable educational programme not depending on costly professional input, is of great importance (Watt & Marinho, 2005), particularly in countries with a developing oral health care system like Iran. Using the school system to provide information to parents seems to be both efficient and cost-effective (Booth & Samdal, 1997; Kwan et al., 2005). UNESCO (2010) advised the parent-teacher meetings to collaborate and coordinate between home and

school. These meetings are frequent at schools in Iran and could facilitate the delivery of oral health-related information to parents.

The present results represent the important role of parents in improving and sustaining the oral health status and behaviour of their offspring. This finding is in agreement with evidence in the literature (Booth & Samdal, 1997; Pine et al., 2000). Family cohesiveness and structure are respected as important for children's well-being (Park, 2007). The establishment of public policies centred on support to the family and targeting families for intervention to promote and establish favourable oral health behaviours is suggested as an important strategy for children's health promotion (Pine et al., 2000; Moysés & Rodriques, 2006). The high effectiveness of the present intervention was confirmed by a small NNT for the two intervention groups involving parents. Parents in the communities with a similar cultural background such as Iran could therefore well be employed for intervention programmes.

Health and oral health education is one of the main responsibilities of health counsellors at schools in Iran. However, some findings of the present trial demonstrated that the intervention in class guided by health counsellors did not result in a marked improvement among children. It seems that in addition to the personal traits, attitudes, and commitments that influence the quality of health counsellors' work and consequently the success of school-based programmes (Moysés et al., 2003; Gill et al., 2009); health counsellors may have insufficient oral health information. It seems that health counsellors must receive advanced training and education on the subject of oral health. Due to a recent shortage in the number of health counsellors, they usually must cover two primary schools, which reduces the quality of their job along with many other duties at schools. Providing financial support to encourage health counsellors, as well as training an adequate number of them to cover primary schools is a necessity.

This study reveals that many of the children did not benefit from low-cost facilities and subsidised dental treatment delivered at public health centres. The link between schools and health centres seems to be unclear (Gill et al., 2009), and this barrier as well as other possible obstacles needs to be addressed by health-policy makers.

Because of the continuing perception that oral health is separate from general health, there is a risk of marginalising oral health promotion (Freeman, 2002). Considering the common risk factor approach, developing a more holistic approach to promoting oral and general health of the children is of great importance.

7. CONCLUSIONS AND RECOMMENDATIONS

Dental status of the children was rather good (DMFT = 0.4 ± 0.9, dmft = 3.8 ± 2.8). However, the children's oral hygiene was unsatisfactory, as almost all children had plaque and bleeding on at least one index teeth. Recommended oral self-care was evident for 34% of the children; about half of them (46%) reported a twice-daily tooth brushing behaviour.

Parents' education had significant effect on the child's oral health status. Mother's favourable OSC behaviour and her supervision of the child's tooth brushing showed positive effect on the child's oral health status and OSC behaviour. As well as, mother's oral health-related knowledge and attitudes had positive effect on the child's oral health status. The school-based oral health educational programme - especially when involving the parents - improved children's oral hygiene and gingival health.

Poor oral hygiene and high prevalence of dental caries in primary teeth among children call for decisive oral health promotion activities. In oral health educational programmes, children should have top priority due to their critical period for adopting favourable oral health behaviours. These programmes need to be implemented to cover comprehensively the determinants of oral health.

The role of parents, especially mothers, has been shown to be extremely important to promote and maintain the children's oral health and behaviour. In oral health promotion activities, the influential role of parents should be acknowledged. Since the mother and the father seem to play an important role in fostering good health behaviour in a child, particularly fathers should be encouraged to assume a more active role regarding oral health of their offspring.

Parents should be made aware how imperative is their modelling role in their children's oral health and behaviour. It is important to support parents to enhance their knowledge and to adopt healthy behaviours in regards to oral health. Firstly, parents should be empowered to improve their own oral health behaviour and then to transfer that healthy behaviour to their children. Oral health interventions should improve children's tooth-brushing skills as well as parents' ability to perform plaque-assessment for their children.

Community school-based oral health educational programmes should be established to include all primary schools. It should be borne in mind that the school forms the main setting to implement oral health promotion, and is one of the first and the most important secondary socializing agencies for children. The importance of this system to transfer not only oral

health-related knowledge, but also healthy behaviours and skills to the children should be realized, and the existing system should even be modified to better serve these aims.

The role of teachers, and especially health counsellors to help children to achieve a healthier oral status should be realized and strengthened. The health counsellors should be empowered for their duties regarding children's oral health as a vital part of general health.

The school-based oral health educational programmes should benefit from a multi-sectored approach in oral health promotion for children. The parent-school meetings could be one useful setting employed for communication between the community, the school, and the family. The oral health programmes should take advantage of the common risk factor approach to avoid marginalising oral health, as well as to optimise their benefits for both general and oral health.

To evaluate the long-term outcomes of an oral health intervention programme and to assess employment of other sectors of the school setting in improvement of the children's oral health calls for further research.

8. SUMMARY

Despite a relatively low caries prevalence in permanent teeth at present, unsatisfactory oral hygiene and tooth-brushing behaviour along with the high caries prevalence in primary teeth expose Iranian children to a potentially high rate of dental caries in the future. As preadolescents and adolescents make up over 30% of the population of Iran, planning oral health promotion programmes focusing on the determinants of oral health is a major challenge to health policy decision-makers.

The present study assessed oral health and its determinants among Iranian preadolescents, in order to test a school-based health education programme to promote their oral health. The working hypotheses were: 1) Preadolescents' better oral health status and OSC behaviour positively associate with higher level of parents' education. 2) Mothers with a higher level of knowledge of and positive attitudes towards oral health and mothers having their own favourable OSC behaviour, as well as mothers undertaking active supervision of their children's tooth brushing facilitate better oral health for their preadolescents. 3) A school-based oral health educational programme will improve oral health in the preadolescents.

A cross-sectional study and a 3-month school-based intervention trial involving a representative sample of 9-year-olds were designed in Tehran, Iran. The data came from children's clinical dental examinations at baseline and at study end, as well as from the self-administered questionnaires for the children and their mothers at baseline. By means of multi-stage sampling, firstly from a list of primary schools taking the children's gender into account, 16 schools (8 for boys, 8 for girls) were randomly selected. The randomization was applied separately for boys' and girls' schools by means of systematic random allocation. Subsequently, from each school one third-grade class as a cluster was randomly chosen and all its children included. Totally, 459 subjects (225 boys and 234 girls) and their mothers participated in the study. For the intervention trial, the clusters were randomly assigned to three intervention groups and one control group, each group comprising two girls' and two boys' schools.

After baseline data collection, three kinds of intervention were implemented, one in class, one via the parents, and one as a combination of these. One group served as controls with no intervention. The follow-up examinations occurred 3 months later. The outcome measures of the study were changes in plaque and bleeding scores recorded.

The results showed that the mean dmft and mean DMFT values for the primary and permanent teeth were 3.75 (SD = 2.8) and 0.4 (SD = 0.9), respectively. All children had

plaque on at least one index tooth. Bleeding on probing in at least one index tooth occurred in 81%. About one-third (34%) of the children reported favourable oral self-care (OSC). Less than half (46%) of the children reported brushing their teeth at least twice daily.

The final logistic regression analyses to determine the factors influencing children's oral health showed that the girls were more likely to report twice-daily tooth brushing (OR = 1.6) and to have favourable OSC (OR = 2.0), decay-free teeth (OR = 1.8) and treated permanent teeth (OR = 3.3). Higher parental education had a positive influence on the child's decay-free teeth (OR =1.2), child's treated permanent teeth (OR =1.6), and child's treated primary teeth (OR =1.5), but no influence on children's reported tooth brushing and OSC. Mother's oral health-related aspects, i.e., mother's favourable OSC, high knowledge levels of and positive attitudes towards oral health, and active supervision of the child's tooth brushing had a positive effect on all aspects of children's oral health status and behaviours (ORs from 1.3 to 1.9).

After the intervention, the positive outcomes regarding oral hygiene were most frequent in children in the parental-aid ($P < 0.001$) and combined groups ($P < 0.05$), and healthy gingiva was more prevalent among these same children ($P < 0.001$) than for the control group. The class-work group did not differ from the controls. The final GEE models showed a strong intervention effect on healthy gingiva in both groups where parents were involved: the parental-aid group (OR = 7.7, 95% CI 2.2-27.7) and combined group (OR = 6.6, 95% CI 2.0-22.1).

In conclusion, unsatisfactory oral hygiene and unfavourable tooth brushing behaviour were found among 9-year-old preadolescents in Tehran. Mother's OSC, knowledge of and attitudes towards oral health, and supervision of the child's tooth brushing showed an influential impact on the child's oral health and OSC. This short-term school-based intervention appeared to be successful in promoting gingival health of preadolescents and emphasized the significance of role of the parents in health education activities.

9. ACKNOWLEDGMENTS

The present study was performed under the auspices of the World Health Organization's pilot projects in Community Dental Health in the Department of Oral Public Health, Institute of Dentistry, University of Helsinki in Finland, and the Department of Community Oral Health, School of Dentistry, Shaheed Beheshti Medical University, Tehran, Iran, from 2003 to 2010. I am grateful to these institutes for all the facilities they provided to me for the completion of my studies. Study grants from the Iran Center for Dental Research, Shaheed Beheshti Medical University, and the University of Helsinki are greatly appreciated. I also acknowledge the Council for Dental Education, the Ministry of Health and Medical Education of Iran, and the WHO office in Tehran for their support.

I am profoundly grateful to my supervisor, Professor Heikki Murtomaa, DDS, PhD, MPH, Head of the Department of Oral Public Health, Institute of Dentistry, University of Helsinki, for his thorough supervision, expert guidance, constructive criticism, and continuous support throughout my studies. My warmest appreciation goes to him for his expertise and his experience in the oral public health field, which were of great help to me. Without him this study would never have been completed. I am enormously proud to have been his student.

I am deeply indebted to my other supervisor, Adjunct Professor Jorma Virtanen, DDS, PhD, Department of Public Health, University of Helsinki, for his professional guidance, helpful criticism, and valuable comments at all stages of my study. He deepened my understanding of systematic scientific research with his deep knowledge, critical view, and through deep discussions with him. Being his student has been a privilege for me.

I am sincerely indebted to Adjunct Professor Miira Vehkalahti, DDS, PhD, Department of Oral Public Health, Institute of Dentistry, University of Helsinki, for her professional guidance and continuous support during my study. Her profound scientific expertise and excellent sense of humor have been a constant source of encouragement. I am very grateful for the possibility to have her as a teacher and also as a good friend. I am also thankful to Professor Lauri Tarkkonen, PhD, Department of Mathematics and Statistics, University of Helsinki, for teaching me the principles of biostatistics.

I also express my sincere thanks to my Iranian supervisor, Associate Professor Azita Tehranchi, DDS, MSc, Department of Orthodontics, School of Dentistry, Shaheed Beheshti Medical University, for her friendly cooperation and support. Her efforts in facilitating my research work are of great value to me.

My warm thanks and gratitude also go to Carol Norris, PhD, University of Helsinki, for teaching me the principles of English scientific writing and for her excellent editing of my thesis. I am also sincerely grateful for the possibility to have her as a good friend.

I am deeply grateful to the official referees of my thesis, Professor Anne Nordrehaug Åström, DDS, PhD, Department of Clinical Dentistry, University of Bergen, Norway, and Associate Professor Sisko Honkala, DDS, PhD, MSc, Department of Developmental and Preventive Sciences, Kuwait University, Kuwait, for their constructive and valuable comments to improve my thesis.

I also wish to express my warm thanks to my friends and colleagues in Iran and Finland for their support and friendship during my study, especially Prof. Fazlollah Ghofranipour, Dr. Maarit Gockel, Azam, Sofia, and all others that made it easier and more pleasant for me to live here.

I also thank the staff and pupils of the schools for their cooperation; without their kind assistance this study would not have been carried out.

I can never thank my father and my sisters and my brothers enough for their patience, support, and encouragement throughout the study time. They always believed in me and enriched my life in countless ways. My dearest thanks go to all my family members. Finally, I owe my heartfelt thanks to my late mother, who was my first and my best teacher who taught me how to read, how to love people, and showed me in so many ways how best to live.

This thesis I dedicate to all the children of my country and all over the world for their healthier future life.

Zahra Saied-Moallemi
Helsinki
September 2010

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11. APPENDIX

Appendix 1:

Mother's questionnaire (Questions not used for the present study are excluded.)

1. Oral self-care behaviour:

Please choose the appropriate option which best describe you.

1.1. How often do you usually brush your teeth?

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

1.2. Do you use toothpaste containing fluoride, while brushing?

1. Always or almost always
2. Quite often
3. Seldom
4. Not at all

1.3. How often do you have sugary snacks and drinks between your main meals?

1. About three times a day or more
2. About twice a day
3. About once a day
4. Occasionally, not every day
5. Rarely or never eat between meals

2. The child's oral self-care:

How do you take care of your child's teeth? Please choose one option which you usually do.

2.1. Does your child brush his/her teeth?

1. Always or almost always
2. Quite often
3. Seldom
4. Not at all

2.2. How often do you supervise your child's tooth brushing?

1. Always or almost always
2. Quite often
3. Seldom
4. Not at all

2.3. How often do you restrict your child's frequency of consumption of sugary snacks and soft drinks?

1. Always or almost always
2. Quite often
3. Seldom
4. Not at all

3. Knowledge of and attitudes towards oral health:

How do you think about taking care of your teeth? Do you "fully agree", "agree", "disagree", "fully disagree", "no opinion" with the following statements?

<u>Attitudes towards oral health:</u>

3.1. Dental problems can cause other health problems.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.2. Dental problem can be serious.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.3. Dental disease is less important than other health problems.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.4. It is natural for people to lose all their teeth in old age.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.5. Milk teeth are not important because they fall out soon.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.6. I am able to prevent my teeth from decaying.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

Knowledge on oral health:

3.7. Gum disease is caused by microbial plaque.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.8. Eating sweet food does not cause tooth decay.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.9. Cavities are caused by microbial plaque.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.10. Brushing without toothpaste is enough for preventing dental caries.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.11. It is beneficial to visit a dentist for regular check-ups.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.12. Rinsing with salt water or other kinds of mouth rinses is sufficient to clean teeth.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.13. Restricting consumption of cookies, chocolate, candies, and other sugary snacks helps prevent dental caries.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

3.14. Regular teeth brushing helps prevent gum problems.

1. Fully agree 2. Agree 3. Disagree 4. Fully disagree 5. No opinion

4. Socio-economic status:

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

1. Illiterate
2. Primary or secondary school
3. High school (vocational school) or diploma
4. Associate degree
5. Bachelor's degree
6. Master's degree
7. Doctorate

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

1. Illiterate
2. Primary or secondary school
3. High school (vocational school) or diploma
4. Associate degree
5. Bachelor's degree
6. Master's degree
7. Doctorate

Appendix 2:

Child's questionnaire (other questions not used for the present study are excluded.)

1. Oral self-care behaviour:

Please choose the appropriate option which best describe you.

1.1. How often do you usually brush your teeth?

6. Irregularly or never
7. Once in a week
8. A few (2-3) times in a week
9. Once a day
10. More than once a day

1.2. Do you use toothpaste containing fluoride, while brushing?

4. Always or almost always
5. Quite often
6. Seldom
7. Not at all

1.3. How often do you have sugary snacks and drinks between your main meals?

6. About three times a day or more
7. About twice a day
8. About once a day
9. Occasionally, not every day
10. Rarely or never eat between meals

Appendix 3:

Clinical oral examination form

Child name: **School name:** **Date of exam:** **dd mm yy**

Identification number: **Gender:** **1- Boy, 2- Girl** **Date of birth:**

Periodontal status:

16	11	26
46	**31**	**36**

0- Healthy
1- Bleeding
2- Calculus

Oral hygiene status:

16	11	26
46	**31**	**36**

0-No plaque
1- Plaque on gingival margin only
2- Elsewhere

Dental status:

		E	D	C	B	A	A	B	C	D	E		
17	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
47	**46**	**45** E	**44** D	**43** C	**42** B	**41** A	**31** A	**32** B	**33** C	**34** D	**35** E	**36**	**37**

s- Sound, **d**- Decayed, **df**- Filled and decayed, **f**- Filled, **m**- Missing, **U**- Unerupted (for permanent tooth only), **9**- Excluded tooth

DT		**dt**	
MT		**mt**	
FT		**ft**	
DMFT		**dmft**	