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ORIGINAL ARTICLE

An early oral health care program starting during pregnancy—a long-term study—phase V

Karen Meyer · Mansoureh Khorshidi-Böhm · Werner Geurtsen · Hüsamettin Günay

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Abstract
Objectives Objective was to analyze the effects of a long-term prevention program on dental and oral health of adolescents.
Materials and methods The entire study was subdivided into five phases. Phase I comprised an individual preventive care during pregnancy, phase II assessed mothers and their children until the age of 3, and in phase III until the age of 6. In phase IV, 13- to 14-year-old teenagers were investigated. In phase V, 18–19-year-old adolescents were examined (18.4±0.4 years, n=26). All phases consisted of an examination, education, and treatment based on the concept of an "early oral health care promotion." The control group consisted of randomly selected adolescents of the same age (n=35). The following clinical parameters were assessed: DMF-T/DMF-S, HI, PBI, PSI, and *Streptococcus mutans*/lactobacilli concentration in saliva.
Results The adolescents of the prevention group revealed a share of 92.3 % caries-free dentition. Mean DMF-T was 1.4±2.6. The control group showed a significantly higher mean DMF-T of 3.8±3.2 (p<0.05) and revealed 71.4 % of caries-free dentition. The prevention group showed a significant lower PSI of 1.2±0.8 compared to the control group (2.1±0.4) (p<0.05).
Conclusion An "early oral health care promotion" starting during pregnancy may cause a sustained and long-term improvement of the oral health of young adults.
Clinical Relevance Prevention programs starting during pregnancy may establish an improved health behavior. Caries, periodontitis, and dietary complications in mother and child can be avoided by improving maternal oral health and by a tooth-friendly diet.

K. Meyer (✉) · M. Khorshidi-Böhm · W. Geurtsen · H. Günay
Department of Conservative Dentistry, Periodontology and Preventive Dentistry, Hannover Medical School, Carl-Neuberg-Str. 1, 30625 Hannover, Germany
e-mail: Meyer.Karen@mh-hannover.de

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Introduction

Oral diseases (e.g., caries and periodontitis) are caused by a great variety of different factors and therefore require the application of different preventive strategies. Besides the four main factors, i.e., microorganisms, substrate, host and time, and additional secondary factors (e.g., dental morphology and position, quantity and buffering capacity of saliva, frequency of food uptake, and consistency and composition of diet) contribute to initiation and progression of caries.

Early childhood caries (ECC) constitutes a serious and unresolved "public health problem" in the lower social strata of the western industrial countries including Germany [1, 23]. A clear polarization of the caries load was observed. Children from low socioeconomic groups and children with immigrant background show a higher caries prevalence and a lower degree of rehabilitation than children from higher social strata [5, 7, 9, 24, 25, 28, 37, 43, 44, 46, 47]. The higher caries risk of children with immigrant background is primarily due to a lack of information and education of their parents. The parents of children with immigrant background make rarely use of preventive checkups and have poorer oral health awareness [43].

In the literature, there are numerous strategies for the prevention of ECC [50]. Based on the type of intervention, these strategies can be divided into four groups, which can also be used in combination: knowledge and behavior, fluoride, antibacterial agents, and primary–primary prevention. Twetman analyzed the literature published 1998–2007 regarding the effectiveness of methods used for the prevention of ECC [50]. There was a body of evidence for the use of fluoride but the evidence concerning the preventive effect of knowledge and behavior, antibacterial agents, and primary–primary

prevention were inconclusive [50]. However, all studies emphasized the importance of an early start and motivational interviewing. Dental health education is part of the domain "knowledge and behavior." Kowash et al. and Feldens et al. evaluated a home visit program in families with low socioeconomic status and documented a significant reduction of ECC [13, 26]. Another study, in which toothbrushes and fluoridated toothpaste were given to the participants in addition to a dental health promotion program showed no significant reduction of ECC, but a lower caries experience in the study group [12]. Most studies that addressed the intervention "fluoride" showed a significant reduction of caries. Fluoride was applied in various forms (e.g., fluoride-containing toothpaste, fluoride pills, and fluoride varnish) [11, 52, 53]. Several studies that investigated antibacterial agents (e.g., chlorhexidine) showed a reduction of mutans streptococci, but could not determine any significant reduction of ECC [49]. Studies documented that a long-term dental care ("early dental care") of pregnant women in sense of a primary–primary prevention results in an improvement of the child's oral and general health [3, 10, 15–17, 19, 32]. The early oral health care concept ideally includes measures of dental prevention, both pre- and postnatal for mother and child until the age of 3 ("primary–primary prevention" and "primary prevention") [20]. This concept can be also started postnatally if no prenatal dental care takes place. The main aims of this approach are to strengthen the health behavior of the parent or parents. Thus, caries, periodontal disease, and nutrition-related complications should be prevented in the child [20]. The main tasks are a comprehensive clinical examination (dental, periodontal, and mucosal examination), information and education (e.g., caries, periodontal disease, mechanisms of transmission/infection, and supplementary nutrition counseling), and treatment (e.g., bacteria reduction in terms of "whole mouth therapy" concept) of the pregnant woman and the father [20].

The efficiency of this "early oral health care" concept has been shown in a long-term study that has been divided into five phases [18, 21, 32] (Table 3). Phase I included the individual preventive care of pregnant women (primary–primary prevention), and phase II comprised the preventive care of mothers and their children until the age of three (primary prevention). In phase III, mothers and children until the age of 6 were examined and re-informed/re-educated in prevention. In phase IV, teenagers at the age of 13 to 14 who participated in phases I–III were examined. All participating mothers revealed a significant improvement of their oral health at the end of phase I. All children in the prevention group were caries free without any filling at the age of 3 years (sound) (phase II), no oral colonization with SM could be detected. However, only 81.5 % of the children of the control group were caries free without fillings (mean dmf-s, 4.5). In phase III, 75 % of the children of the prevention group were caries free without any fillings (mean dmf-s, 3.7), whereas only 50 % of the control group were caries free and revealed no restoration (mean dmf-s, 6.5). In phase IV, 65.5 % of the teenager of the prevention group were caries free without any fillings (mean dmf-s, 0.6), whereas only 30 % of the control group were caries free and revealed no restoration (mean dmf-s, 1.8) (Table 1).

The objective of this clinical investigation was to analyze the effects of a long-term prevention program starting during pregnancy on the dental and oral health of young adults at the age of 18 to 19 years. The hypothesis that was set forth was that persons who were included in the primary prevention program showed a significantly better oral health compared to young adults without intense primary prevention.

Material and Methods

Subjects

In May 1991, pregnant women visiting 13 gynecologists in Hannover were offered an individual preventive program which was carried out at the Department of Conservative Dentistry, Periodontology and Preventive Dentistry. A total of 86 pregnant women from various social backgrounds in Hannover at the age between 20 and 37 years (mean age, 28.5±3.5 years) were referred from the gynecologists and participated in phase I. In the second phase, there were 54 and in the third phase 40 of the mother–child couples were still available. All participating mothers and their children were examined, instructed, and supervised in 6 months intervals regarding dental prevention until the age of 3 years. Until the age of 6, the children and their mothers were examined, preventively supervised, and re-instructed/re-informed each 12 months. The following clinical parameters were assessed at each examination for mother and child: DMF-S or dmf-s, proximal plaque index, and the salivary level of *Streptococcus mutans* (tested by a dip slide technique using the commercial test kit Dentocult® SM (Vivadent, Ellwangen, Germany). The mothers were informed about their own dental and periodontal findings as well as about the goals of primary–primary prevention. Each mother received an individual oral hygiene instruction and a dietary counseling. Furthermore, the women were informed about the etiology of caries and periodontitis as well as the importance of a low cariogenic diet and the use of fluorides. Emphasis was given on teaching mothers how to avoid or minimize the possibility of infecting their children with their own mutans streptococci. They were although taught about how to establish the habit of daily tooth cleaning combined with dentifrice containing a low concentration of fluoride as soon as the first deciduous tooth erupted. The numerically equal control group comprised children of the same age who were randomly selected from various kindergartens in Hannover. New controls were recruited for each phase.

Table 1 Results of phases II–V

	Prevention group (at 3 years of age)[a]	Control group (at 3 years of age)[a]	Prevention group (at 4 years of age)[b]	Control group (at 4 years of age)[b]	Prevention group (at 6 years of age)[c]	Control group (at 6 years of age)[c]	Prevention group(at 13–14 years of age)[d]	Control group (at 13–14 years of age)[d]	Prevention group (at 18–19 years of age)[c]	Control group (at 18–19 years of age)[c]
Number and gender of participants	54: 27♀ and 27♂	65: 32♀ and 33♂	47: 27♀ and 20♂	45: 22♀ and 23♂	40: 24♀ and 16♂	40: 18♀ and 22♂	29: 15♀ and 14♂	30: 15♀ and 15♂	26: 14♀ and 12♂	35: 27♀ and 8♂
Participants with naturally healthy dentition	54 (100 %)	53 (81.5 %)	43 (91.5 %)	26 (57.7 %)	30 (75 %)	29 (50 %)	19 (65.5 %)	9 (30 %)	17 (65.4 %)	8 (22.6 %)
Participants with untreated caries	–	12 (18.5 %) 5♀ and 7♂	4 (18.5 %) 5♀ and ♂3	19 (42.3 %) 8♀ and 11♂	4 (10 %) 2♀ and 2♂	15 (37.5 %) 4♀ and 11♂	3 (10.3 %) 3♀	13 (43.3 %)6♀ and 7♂	2 (7.7 %) 1♀ and 1♂	10 (28.6 %) 8♀ and 2♂
dmf-s/DMF-S	–	4.5	1.5	7.0	3.7	6.5	0.6	1.8	1.4	5.4

[a] Günay et al. [18]

[b] Günay et al. [19]

[c] Haker et al. [21]

[d] Meyer et al. [32]

Between phase III and IV, mothers and children were preventively supervised and treated, if necessary, by their family dentists. Twenty-nine adolescents (15 female and 14 male) aged between 13 and 14 years (mean age, 13.4±0.5 years) participated in phase IV. Phase IV comprised one examination, education, and professional tooth cleaning. The control group of phase IV consisted of randomly selected adolescents at the same age and similar educational level (30 adolescents: 15 female and 15 male; mean age, 13.6±0.5 years).

Twenty-six young adults (14 female and 12 male) at the age between 18 and 19 years (mean age, 18.4±0.4 years) remained in phase V. Phase V comprised one examination, education, and professional oral hygiene treatment. The randomly selected control group revealed the same age and a similar education level (35 adolescents: 27 female and 8 male; mean age, 18.6±3.6 years).

The study was approved by the ethical committee of Hannover Medical School.

Clinical examination

All participants were examined in the same way according to WHO criteria [54] in the Department of Conservative Dentistry, Periodontology and Preventive Dentistry (Hannover Medical School), using magnifying glasses (2.3-fold magnification).

The following data were collected:

- Oral assessment (teeth, periodontia, and mucosa)
- *Streptococcus mutans* (SM) and *Lactobacillus* (LB) concentration in saliva (CRT®bacteria, Vivadent, Ellwangen, Germany)
- Hygiene index (HI) [36]
- Papilla bleeding index (PBI) [42]
- Decay missing filling-teeth (DMF-T)/decay missing filling-surfaces (DMF-S) [54]
- Periodontal Screening Index (PSI) [33]
- Numbers of pit and fissure sealings

Education

Because there is a direct correlation between oral health and oral hygiene behavior as well as between oral health, general health and social status, the participants of filled out a questionnaire to analyze their knowledge about oral health. The self-designed questionnaire consisted of 50 multiple choice questions about dental visits (e.g., frequency and potential treatments), oral hygiene habits (technique and systematics of tooth brushing, use of oral hygiene articles, etc.), application of fluorides, diet habits, and knowledge about etiology of caries and periodontitis and their prevention. Subsequently, based on the results of the questionnaire, the participants of the study were individually re-motivated and re-instructed. The

education included oral hygiene instructions, dietary counseling, information about the etiology of caries and periodontitis, and the use of fluorides.

Since parents play a crucial role in the development of health behavior of children, the mothers of the young adults were also asked to complete a questionnaire. This questionnaire was self-designed too and consisted of 48 multiple choice questions about dental visits (e.g., frequency and potential treatments), oral hygiene habits (e.g., technique and systematics of tooth brushing, applied oral hygiene articles), use of fluorides, dietary habits, and knowledge about the etiology of caries and periodontitis and their prevention.

Statistical analysis

DMF-T/DMF-S, HI, PBI, and PSI were statistically analyzed using the *t* test, SPSS version 19 ($p<0.05$). SM and LB concentration, number of pit and fissure sealings, and the questionnaire were statistically evaluated by means of the chi-square test, SPSS version 19 ($p<0.05$).

Results

In the "prevention" group, there were 92.3 % of the participants and 71.4 % of the 35 participants of the control group of phase V showed caries-free dentitions. Seventeen (65.4 %) of the prevention group and eight (22.9 %) of the control group were sound. Seven (26.9 %) adolescents of the prevention and 17 (48.5 %) of the control group showed a dentition with restorations. Two of the adolescents (7.7 %) of the prevention and ten (28.6 %) of the control group suffered from caries (Table 2). Mean DMF-T in the prevention group was 1.4±2.6 (DMF-S=1.4±3.4), and mean DMF-T in the control group was 3.8±3.2 (DMF-S=5.4±5.4). Mean HI was 67.4±10.2 %, and mean PBI was 0.2±0.2 in the prevention group. The adolescents of the control group showed a mean HI of 43.3±13.7 % and a mean PBI of 0.5±0.2. The mean PSI was 1.2±0.8 (prevention group) and 2.1±0.4 (control group) based on the worst value of all sextants (Table 3). In the prevention group, 19.2 % showed a PSI of 0, 50.0 % of 1, and 30.8 % of more than 1. None of the participants of the control group revealed a PSI of 0. A 2.9 % showed a PSI of 1 and 97.1 % of more than 1. In the prevention group, 24 (92.3 %) of adolescents had a low SM and 25 (96.2 %) with low LB concentration ($<10^5$ KFE/ml saliva). Two participants (7.7 %), however, showed high SM concentrations and one participant (3.8 %) a high LB concentration ($>10^5$ KFE/ml saliva). In the control group, 28 (80.0 %) had a low oral concentration of SM and 30 (85.7 %) had a low colonization with LB ($<10^5$ KFE/ml saliva). But seven adolescents (20.0 %) showed a high SM and five (14.3 %) with high LB concentration ($>10^5$ KFE/ml saliva). All young adults of the prevention group were treated with pit and fissure sealants. In the control group, pit and fissure sealants were observed on 29 participants (82.9 %).

Table 2 Mean age and dental findings in both examined groups in phase V

	Prevention group	Control group
Number of participants	26 (14♀ and 12♂)	35 (27♀ and 8♂)
Mean age	18.4±0.4	18.6±3.6
Naturally healthy dentitions	17 (65.4 %)	8 (22.9 %)
Dentitions with restorations	7 (26.9 %)	17 (48.5 %)
Untreated caries	2 (7.7 %)	10 (28.6 %)

Table 3 Results of phase V

	Group	*n*	Mean	Standard deviation	Significance ($p<0.05$)
DMF-T	Prevention group	26	1.4	2.6	0.041
	Control group	35	3.8	3.2	
DMF-S	Prevention group	26	1.4	3.4	0.004
	Control group	35	5.4	5.4	
HI (%)	Prevention group	26	67.4	10.2	0.057
	Control group	35	43.3	13.7	
PBI	Prevention group	26	0.2	0.2	0.572
	Control group	35	0.5	0.2	
PSI	Prevention group	26	1.2	0.8	0.001
	Control group	35	2.1	0.4	

The prevention group showed a significantly lower DMF, DMF-S, and PSI than the control group ($p<0.05$). Furthermore, significantly more pit and fissure sealing were documented in the prevention group compared to the control group ($p<0.05$). Regarding the results on PBI and SM and LB colonization, there was a tendency to lower values in the prevention group compared to the control group, whereas a tendency to a higher (better) HI was documented in the prevention group. But, these tendencies were not significantly different ($p>0.05$).

The standard of knowledge about oral health and health behavior (e.g., brushing teeth) was similar in the prevention and the control group. There were no statistical differences. All participants of the prevention and control group answered the questionnaire. The evaluation of the questionnaires showed that the young adults of the prevention and control group saw their family dentist on a regular basis (Fig. 1). The participants in the prevention and control group mainly

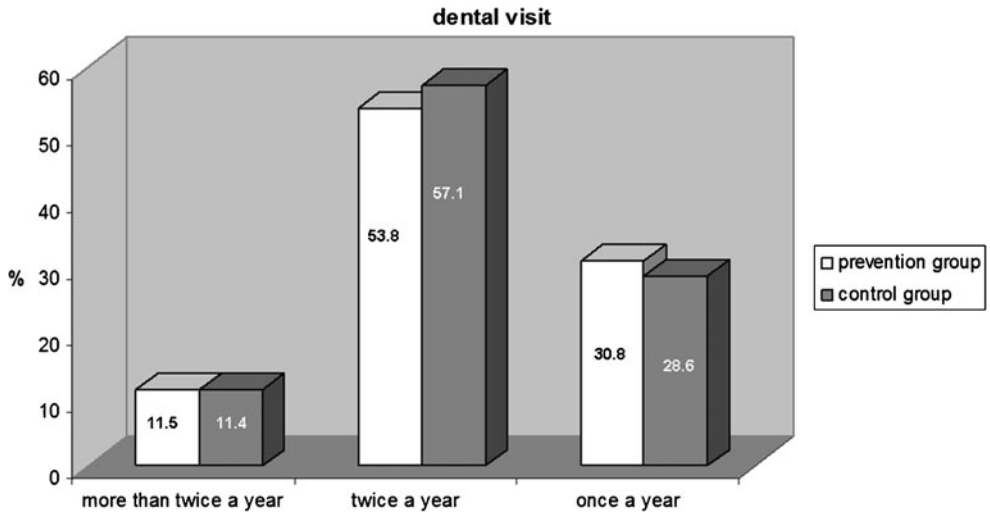

Fig. 1 Dental visits in both examined groups in phase V

received a routine dental examination (prevention group, 96.2 %; control group, 94.3 %). In the prevention group, 69.2 % were instructed regularly and 88.5 % felt well informed by their dentist regarding oral hygiene measures, whereas only 37.1 % of the control group was instructed regularly, although 77.1 % felt well informed.

The young adolescents of the control and prevention group have a similar socioeconomic status regarding the educational level (Fig. 2).

The mothers' health behavior and the level of knowledge about oral health were similar in the prevention and control group. Twenty-four mothers of the prevention and 25 mothers of the control group answered the questionnaire. The majority of the mothers of the prevention and control group saw their family dentist on a regular basis mainly for a routine dental checkup. Significantly, more mothers of the prevention group indicated that they received a professional tooth cleaning by their family dentists (prevention group, 91.7 %; control group, 68.0 %) ($p<0.05$). Only 32.0 % of the mothers in the control group were aware of dental preventive measures during pregnancy, whereas all women of the prevention group were familiar with this concept. All mothers of the prevention and significant less women of the control group had seen a dentist during pregnancy (prevention group, 100 %; control group, 76.0 %) ($p<0.05$). The mothers of the control group introduced their child usually at the age of 3 years for the first time to a dentist (mean age, 3.2 years±1.9), whereas all mothers of the prevention group introduced their child to a dentist before the age of 1 year. In the prevention group, 91.7 % of the mothers and 79.2 % of the control group considered a dental visit of the child before the age of 3 years, important or very important. Significantly, more mothers of the prevention group believe that their dental status can affect their child's dental status (prevention group, 79.2 %; control group, 44.0 %) ($p<0.05$).

The mothers of the control and prevention group have a similar socioeconomic background regarding the educational level (Fig. 3). The majority of the mothers in the control and

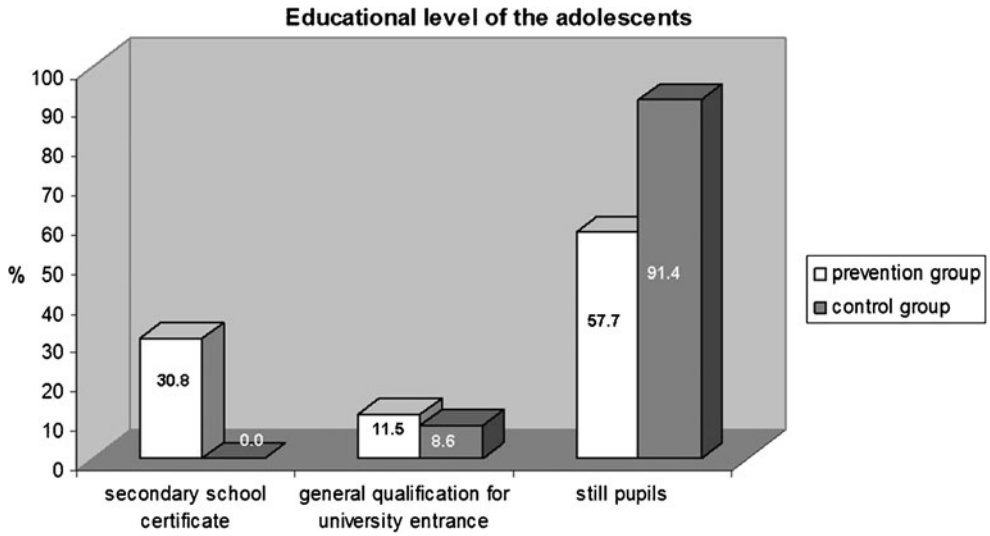

Fig. 2 Educational level of the adolescents examined in both groups

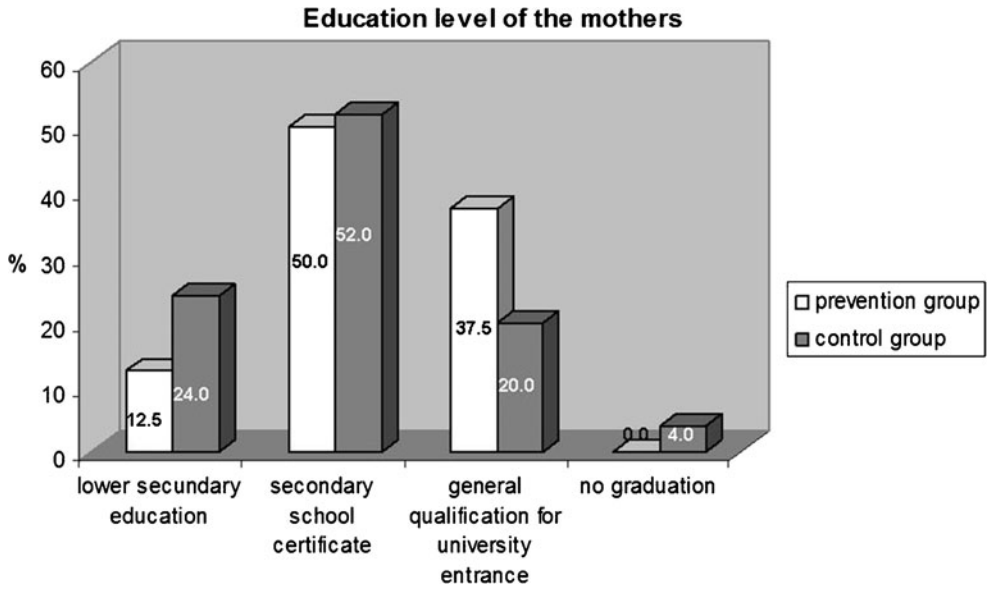

Fig. 3 Educational level of the mothers in both groups

prevention group have completed an apprenticeship (prevention group, 95.8 %; control group, 84.0 %). All mothers of the prevention group and 84.0 % of the control group that have responded to the questionnaire are working. The majority of mothers in the control and prevention group are married or in a stable relationship (prevention group, 95.8 %; control group, 89.0 %). The mean age of the mothers of the prevention group was 48.4±3.0 years and of the control group 48.0±5.2 years.

Discussion

An effective early intervention in terms of health promotion and disease prevention can improve the health for a long time. This applies also to the quality of life, mobility, and capability of the population and thereby will reduce health care costs [2]. The basis of many oral and systemic diseases is already set in early childhood, frequently due to a lack of knowledge of the parents. Severe health problems, which may persist in adulthood, may develop early in life without intervention [14, 30]. Early intervention programs beginning during pregnancy are an effective strategy for prevention of mental and physical problems [35]. The "Nurse-Family Partnership Program" is one of the few programs which begins already on prenatal. This program showed a positive impact in many areas. There was an improvement of maternal and fetal health during pregnancy (especially an increase of the average birth weight), a significant improvement in children's development, and a reduction of abuse and neglect by 48 % [35].

A comprehensive early dental intervention using preventive strategies or programs starting during pregnancy proofed to be efficient with respect to the prevention of oral diseases, specifically caries [3, 10, 15–17, 19, 32].

In Sweden, the dental "prenatal prevention" of pregnant women is used successfully since 1978 in the sense of a primary–primary prevention. From 1979 to 1991, the caries incidence and prevalence decreased by 75 to 90 % [4].

Brambilla et al. [10] were able to delay the colonization of toddlers and young children with caries pathogens by 4 months with a minimal preventive dental program limited to the period of pregnancy. In phase II of our study, we could delay the colonization of the children's oral cavities with caries pathogens for an even longer period of time. No child of the prevention group showed detectable SM levels at the age of 3 years [18]. These different results are very likely due to the length of the preventive care.

Gomez et al. [15–17] documented that a dental treatment starting during pregnancy until the age of 6 years of the children contributes to a significantly reduced caries experience of the infants. The structure of their program was similar to our study design. After 6 years, 87 % of the 5-year-old children and 89 % of the 6-year-old individuals of the prevention group were free of caries compared to only 50 % (5-year-old) or 62 % (6-year-old) of the controls. Similar data were found in our previous studies. At the age of 6, 75 % of the prevention group was caries free vs. 50 % of the control group [21]. Four years after the end of their study, *Gomez* et al. [17] re-examined the children. The children of the prevention group had a significantly lower caries incidence (mean DMF-S, 0.51±0.9) compared to the children of the control group (mean DMF-S, 1.57±1.4). These data support our results. Dental care for mother and child starting during pregnancy does not only influence the health of deciduous teeth, but has also a positive effect on permanent teeth even in case of an extended period of time between re-examinations. This

correlates with studies that documented a correlation between caries experience in deciduous and permanent teeth [27, 41].

The literature about caries in 18-year-old subjects worldwide is limited. Therefore, it is difficult to compare our results with other studies or to determine whether our data are representative. In Germany, there were no representative data regarding the DMF-T for 18–19-year-old persons. One study describes the DMF-T, obtained from the WHO database, for 18-year-old subjects in 12 different countries. The DMF-T ranges between 0.7 and 7.0 [34]. A German study documents long-term results of systematic caries prevention. The preventive care comprised a period of 5 to 15 years. A mean DMF-T between 4.3–2.18 was observed in the 18–25-year-old persons. The authors concluded that a regular ongoing preventive care over a long period maintained the dentition and improved dental health [6]. A Swedish study described the caries prevalence in Swedish 20-year-olds in relation to their previous caries experience [22]. Nearly 500 individuals beginning at the age of 1 year until the age of 20 years were examined. From the age of 1 year, the children had been enrolled in a regular dental care program including dental checkups and special preventive care for children at risk. The authors reported that 26 % of the 20-year-olds were caries free. The mean number of initial and cavitated lesions and restorations (DF-S) was 5.8. These results are comparable with our results regarding the control group. In the control group, 22.9 % of the adolescents were sound (caries free without restorations). The mean DMF-S was 5.4±5.4.

The participants of the prevention and control group were coincidentally chosen. The dropout rate was the result of the very long study period of the study. Main reasons were a change of residence and other nonspecified private reasons. This needs to be taken into consideration when interpreting the result of this study. Despite of the high dropout rate within the 18-year period of this study, clear tendencies could be observed. Voluntary participation in a preventive care results in a selection of the patient population. Due to the voluntary participation both in the prevention as well as in the control group, the patient pool consisted of participants who have appreciated the importance of the preventive measures. Persons belonging to caries risk group were not recruited. The examiners were not blinded for the group affiliation, but they were not aware of the results from the previous examinations. This must be taken into consideration when interpreting the data.

Socioeconomic status is correlated with oral health. People with a low socioeconomic status have a significantly worse oral and general health compared to people with higher socioeconomic status [29]. The subjects in the control and prevention group have a similar socioeconomic status. The mean age in the prevention group was 18.4±0.4 years and in the control group 18.6±3.6 years. According to the Federal Statistics Office, 60.7 % of the 15 to 20-year-old adolescents in Germany were nationwide still pupils in 2011. An 11.6 % have a lower secondary education. A 17.9 % reveal a secondary school certificate and 5.7 % have the general qualification for university admission [45]. A 57.7 % of the prevention and 91.4 % of the control group were still pupils at the time of the clinical examination with the aim to graduate with a general qualification for university admission. A 30.8 % of the adolescents of the prevention group have the secondary school certificate. An 11.5 % of the prevention and 8.6 % of the control group have the general qualification for university admission. The mean age of the mothers of the prevention group was 48.4±3.0 years and of the control group 48.0±-5.2 years. According to the German Federal Statistics Office, 24.9 % of the 45 to 50-year-old women in Germany have a lower secondary education, 42.6 % have a secondary education, and 28.2 % have the general qualification for university admission. Four percent of the women in Germany do not graduate from school [45]. In the prevention group, 12.5 % of the mothers and 24.0 % of the control group have a lower secondary education. In the prevention group, 50.0 % of the mothers and 52.0 % of the control group graduated from a secondary education. A 37.5 % of the prevention and 20.0 % of the control group earned the general qualification for university admission. These data show that the young adults of both groups as well as the mothers reveal a similar level of education. Furthermore, the adolescents of both groups live in "orderly circumstances". The majority lives with their parents in a stable family. Based on these results, the socioeconomic status of the prevention as well as the control group can be classified as representative for the German population.

In·phases I through II, the prevention group received a continuous dental care, and in phase III, the children and their mothers were examined and preventively supervised each 12 months. During this time, the mothers and their children were repeatedly (re-)motivated and (re-)instructed. Therefore, the better results regarding oral health cannot be attributed solely to the intervention during pregnancy. *Brambilla* et al. [10] observed a delay of the colonization of toddlers and young children with caries pathogens only by 4 months based on a minimal preventive dental program, which was limited to the period of pregnancy. This shows that a prevention strategy limited to pregnancy is not sufficient. Thus, a continuous dental care has to be implemented in order to achieve successful and sustainable caries prevention.

The standard of knowledge about oral health was similar in the prevention and control group. There were no statistical differences. The control group, in comparison to the prevention group, shows higher values of DMF-T/S, PBI, and PSI and lower values of HI. This illustrates that knowledge is available, but which is not sufficiently implemented [31].

In this study, the mothers of the control group introduced their child to the dentist usually at the age of 3 years, although 79.2 % of these mothers think that an earlier dental visit would

be important. All children of the prevention group were presented at the age of 6 month. Numerous studies have demonstrated that a dental preventive care during pregnancy or shortly after birth is effective in reducing the incidence of caries in children. But, the German statutory dental checkups especially for young children ("FU" examinations), which are valid since January 7, 1999, do not comprise children younger than 30 months and are thus deficient. However, there is evidence that the oral cavity is much earlier colonized with cariogenic bacteria [40, 51]. Borutta et al. [8] demonstrated that at the time at which the dental statutory checkups began, 17 % of children already suffered from early childhood caries. Therefore, preventive measures including education must begin much earlier.

The maternity guidelines of the German Federal Committee of Physicians and health insurances from 1999 request that "the doctor should only inform in the last trimester of pregnancy about the importance of oral health for mother and child" and "the correlation between diet and caries risk should be pointed out" if necessary. However, based on this recommendation, gynecologists provide only scarce and poor information about dental care during pregnancy. This is primarily due to the fact that gynecologists do not perform oral examinations and therefore do not have any information about the oral health of the pregnant women. Rahman and Günay [39] found in a survey of 602 pregnant women that 86 % of respondents were not informed about dental and oral health during pregnancy, but 82 % of these women would like to have more information on how their own dental status may influence the oral health of their children. Pistorius et al. [38] demonstrated that more than a third (38 %) of women was poorly informed about possible risks for oral/dental health as well as the positive effects of prevention during pregnancy. Spanier et al. [43] surveyed 442 mothers. Only 29.9 % of these women reported that they had received individual dental prophylactic measures during pregnancy. Only 8.8 % were provided with information about the transmission of oral pathogenic microorganism from mother to child. In the present study, most mothers of the control group did not know anything about dental prevention during pregnancy. Furthermore, they were not aware that their dental status may affect their child's dental status. This emphasizes the urgent need for more detailed information about oral diseases and their prevention during pregnancy [38, 39]. However, a close interdisciplinary cooperation between gynecologists, pediatricians, dentists, and midwives is required to educate pregnant women about the need for an early dental intervention.

No significant differences were found in our study regarding the general and oral health behavior of mothers in the control and prevention group. However, it must be considered that the questionnaires may have been answered based on "social desirability" [48].

On the other side, our results also clearly demonstrate that an early health care program during pregnancy increased the knowledge of mothers about options to prevent caries and periodontitis. All women of the "prevention group" were informed about the possibility of a dental prevention during pregnancy. This is reflected by the DMF-T/DMF-S scores of the young adults who participated in the present study. Taken together, a long-term dental care of pregnant women based on an "early health care" program results in a significantly better oral health until young adulthood.

Conclusions

Our data clearly document that an "early oral health care program" starting during pregnancy may cause a sustained and long-term improvement of the oral health of adolescents and young adults.

It seems that the dental early prevention concept has not been implemented adequately in private dental practices until now. To make pregnant women aware about this early oral health care concept, an optimization of the cooperation between pediatricians, family doctors, gynecologists, midwives, and dentists is necessary.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Adair PM, Pine CM, Burnside G, Nicoll AD, Gillett A, Anwar S, Broukal Z, Chestnutt IG, Declerck D, Ping FX, Ferro R, Freeman R, Grant-Mills D, Gugushe T, Hunsrisakhun J, Irigoyen-Camacho M, Lo EC, Moola MH, Naidoo S, Nyandindi U, Poulsen VJ, Ramos-Gomez F, Razanamihaja N, Shahid S, Skeie MS, Skur OP, Splieth C, Soo TC, Whelton H, Young DW (2004) Familial and cultural perceptions and beliefs of oral hygiene and dietary practices among ethnically and socioeconomical diverse groups. Community Dent Health 21:102–111
2. Apitz R, Winter SF (2004) Potenziale und Ansätze der Prävention–aktuelle Entwicklung in Deutschland. Der Internist 45:139–147
3. Axelsson P (1989) Präventivzahnmedizinische Programme. Schweiz Monatsschr Zahnmed 99:1045–1048
4. Axelsson P, Paulander J, Svärdström G, Tollskog G, Nordenstern S (1993) Integrated caries prevention: effect of a needs-related preventive program on dental caries in children. County of Värmland, Sweden: results after 12 years. Caries Res 27:83–94
5. Baden A, Schiffner U (2008) Milchzahnkaries bei 3- bis 6-jährigen Kindern im Landkreis Steinburg. Oralprophylaxe 30:70–74
6. Bastendorf KL, Laurisch L (2009) Langzeiterfolge der systematischen Kariesprophylaxe. Dtsch Zahnärztl Z 64:548–557
7. Bissar M, Koch J, Mouhjazi G, Schulte AG (2006) Kariesprävalenz bei 11-14-jährigen Kindern aus Migrantenfamilien. Autoreferate-Band, Wissenschaftliches Programm der 13. Jahrestagung der Deutschen Gesellschaft für Kinderzahnheilkunde 2006. Quintessenz, Berlin

8. Borutta A, Kneist S, Kischka P, Eherler D, Chemnitius P, Stösser L (2002) Die Mundgesundheit von Kleinkindern in Beziehung zu relevanten Einflussfaktoren. Dtsch Zahnärztl Z 57:682–687
9. Borutta A, Hufnagel S, Möbius S, Reuscher G (2006) Kariesinhibierende Wirkung von Fluoridlacken bei Vorschulkindern mit erhöhtem Kariesrisiko. Oralprophylaxe Kinderzahnheilkd 28:8–14
10. Brambilla E, Felloni A, Gagliani M, Malerba A, Garcia-Godoy F, Stohmenger L (1998) Caries prevention during pregnancy: Results of a 30-month study. J Am Dent Assoc 129:871–877
11. Davies GM, Worthington HV, Ellwood RP, Bentley EM, Blinkhorn AS, Taylor GO, Davies RM (2002) A randomised controlled trial of the effectiveness of providing free fluoride toothpaste from the age of 12 months on reducing caries in 5–6-year-old children. Community Dent Health 19:131–136
12. Davies GM, Duxbury JT, Boothman NJ, Davies RM, Blinkhorn AS (2005) A staged intervention dental health promotion programme to reduce early childhood caries. Community Dent Health 19:118–122
13. Feldens CA, Vitolo MR, Drachler ML (2007) A randomized trial of the effectiveness of home visits in preventing early childhood caries. Community Dent Oral Epidemiol 35:215–223
14. Felitti VJ (2002) Belastungen in der Kindheit und Gesundheit im Erwachsenenalter: Die Verwandlung von Gold in Blei. Z Psychosom Med Psychother 48:359–369
15. Gomez SS, Weber AA (2001) Effectiveness of a caries preventive program in pregnant women and new mothers on their offspring. Int J Paediatr Dent 11:117–122
16. Gomez SS, Weber AA, Emilson CG (2001) A prospective study of a caries prevention program in pregnant women and their children 5 and 6 years of age. ASDC J Dent Child 68:191–195
17. Gomez SS, Emilson CG, Weber AA, Uribe S (2007) Prolonged effect of a mother-child caries preventive program on a dental caries in the permanent 1st molars in 9 to 10-years-old children. Acta Odontol Scand 65:271–274
18. Günay H, Jürgens B, Geurtsen W (1996) "Primär-Primär-Prophylaxe" und Mundgesundheit von Kleinkindern. Dtsch Zahnärztl Z 51:223–226
19. Günay H, Dmoch-Bockhorn K, Günay Y, Geurtsen W (1998) Effect on caries experience of a long-term preventive program for mothers and children starting during pregnancy. Clin Oral Investig 2:137–142
20. Günay H, Meyer K, Rahman A (2007) Gesundheitsfrühförderung in der Schwangerschaft—ein Frühpräventionskonzept. Zahnärztl Mitt 97:2348–2358
21. Haker A, Günay H, Geurtsen W (1999) Langzeitprävention und Kariesprävalenz bei Mutter und Kind. Dtsch Zahnärztl Z 54:12
22. Isaksson H, Alm A, Koch G, Birkhed D, Wendt LK (2013) Caries prevalence in Swedish 20-year-olds in relation to their previous caries experience. Caries Res 47:234–242
23. Kneist S, Grimmer S, Harzendorf A, Udhardt A, Senf K, Borutta A (2008) Mundgesundheit von Patienten mit frühkindlicher Karies: Eine klinisch-mikrobiologische Studie. Das deutsche Zahnärzteblatt 117:74–82
24. Kühnisch J, Heinrich-Weltzien R (1998) Mundgesundheit und Inanspruchnahme zahnärztlicher Betreuungsleistungen 8jähriger Migranten und deutschen Schülern des Ennepe-Ruhr-Kreises. Gesundheitswesen 60:500–504
25. Kühnisch J, Senkel H, Heinrich-Weltzien R (2003) Vergleichende Untersuchung zur Zahngesundheit von deutschen und ausländischen 8- bis 10-Jährigen des westfälischen Ennepe-Ruhr-Kreises. Gesundheitswesen 65:96–101
26. Kowash MB, Pinfield A, Smith J, Curzon MEJ (2000) Effectiveness on oral health of a long-term health education programme for mothers with young children. Br Dent J 188:201–205
27. Li Y, Wang W (2002) Predicting caries in permanent teeth from caries in primary teeth: an 8-year cohort study. J Dent Res 81:561–566
28. Lindner L, Brunner-Strepp B, Pieper K (1999) Kariesprävalenz von deutschen und russischen Kindern. Oralprophylaxe 21:131–135
29. Locker D (2000) Deprivation and oral health: a review. Community Dent Oral Epidemiol 28:161–169
30. Lösel F, Beelman A, Jaursch S, Stemmler M (2004) Soziale Kompetenz für Kinder und Familien: Ergebnisse der Erlangen-Nürnberger Entwicklungs- und Präventionsstudie. Pressebericht des Bundesministeriums für Familie, Senioren, Frauen und Jugend (Hrsg.), Berlin
31. Makuch A (1990) Stomatologische Gesundheitserziehung im Vorschulalter (Theoretische und empirische Studien aus medizin-psychologischer Sicht). Habilitation, Leipzig, 1990
32. Meyer K, Geurtsen W, Günay H (2010) An early oral health care program starting during pregnancy: results of a prospective clinical long-term study. Clin Oral Investig 14:257–264
33. Meyle J, Jepsen S (2000) Der parodontale Screening-Index (PSI). Parodontologie 11:17–21
34. Namal N, Vehid S (2005) Ranking countries by dental status using the DMFT and FS-T indices. Int Dent J 55:373–376
35. Olds D, Kitzman H, Robinson J, Sidora K, Kitzman H, Eckenrode J, Cole R, Lucky D, Henderson CR, Hanks C, Bondy J, Holmber J (2004) Effects of nurse home-visiting on maternal life course and child development: Age 6 follow-up results of randomized trial. Pediatrics 114:1550–1559
36. O'Leary TJ, Drake RB, Naylor JE (1972) The plaque control record. J Periodontol 43:38
37. Pieper K, Jablonski-Momeni A (2008) Prävalenz der Milchzahnkaries in Deutschland. Oralprophylaxe 30:6–10
38. Pistorius J, Kraft J, Willershausen B (2005) Umfrage zum Mundgesundheitsverhalten von Schwangeren Frauen unter besonderer Berücksichtigung psychosozialer Aspekte. Dtsch Zahnärztl Z 60:628–633
39. Rahman A, Günay H (2005) Stand des Bewusstseins der Zahn- und Mundgesundheit während der Schwangerschaft. Dtsch Zahnärztl Z Abstractheft p277, Berlin
40. Ramos-Gomez FJ, Weintraub JA, Gansky SA, Hoover CI, Featherstone JD (2002) Bacterial behavioral and environmental factors associated with early childhood caries. J Clin Pediatr Dent 26:165–173
41. Raadal M, Espelid I (1992) Caries prevalence in primary teeth as a predictor of early fissure caries in permanent first molars. Community Dent Oral Epidemiol 20:30–34
42. Saxer UP, Mühlemann HR (1975) Motivation und Aufklärung. Schweiz Monatsschr Zahnheilkd 85:905–919
43. Spanier T, Rahman A, Meyer K, Günay H (2008) Kenntnisstand von Eltern 3-jähriger Kinder über die zahnärztliche Gesundheitsfrühförderung–eine klinische und empirische Studie. Oralprophylaxe 30:A21
44. Splieth C, Heyduck C, Alkilzy M, Meller C (2006) Dental-Pisa: Zusammenhang von oraler Gesundheit und Bildungsstatus–eine 10 Jahres-follow-up-Studie. Autoreferate-Band, Wissenschaftliches Programm der 13. Jahrestagung der Deutschen Gesellschaft für Kinderzahnheilkunde 2006, Quintessenz Verlag
45. Statistisches Bundesamt (2012) Bildungsstand der Bevölkerung. Wiesbaden 2012
46. Steegmann C, Pratsch P, Effenberger S, Schiffner U (2008) Caries in 3- to 6-year-old pre-school children in Hamburg. Caries Res 42:199
47. van Steenkiste M, Becher A, Banschbach R, Gaa S, Kreckel S, Pocanschi C (2004) Prävalenz von Karies, Fissurenversiegelung und Füllungsmaterial bei deutschen Kindern und Kindern von Migranten. Gesundheitswesen 66:754–758
48. Stocké V (2004) Entstehungsbedingungen von Antwortverzerrungen durch soziale Erwünschtheit. Z Soziol 4:303–320
49. Twetman S (2004) Antimicrobials in future caries control? A review with specific reference to chlorhexidine treatment. Caries Res 38:223–229
50. Twetman S (2008) Prevention of Early childhood Caries (ECC)—review of literature published 1998–2007. Eur Arch Paediatr Dent 9:12–18

51. Wan AK, Seow WK, Purdie DM, Bird PS, Walsh LJ, Tudehope DI (2001) Oral colonization of *Streptococcus mutans* in 6-month-old predentate infants. J Dent Res 80:2060–2065
52. Weintraub JA, Ramos-Gomez F, Jue B, Shain S, Hoover CI, Featherstone JD, Gansky SA (2006) Fluoride varnish efficacy in preventing early childhood caries. J Dent Res 85:172–176
53. Wennhall I, Mårtensson EM, Sjunnesson I, Matsson L, Schröder U, Twetman S (2005) Caries-preventive effect of an oral health program for preschool children in a low socio-economic, multicultural area in Sweden: results after 1 year. Acta Odontol Scand 63:163–167
54. WHO Oral health survey Basic Method (1997) 4th ed. Geneva