

Oral health in 13-15-year-old schoolchildren in Palmyra, Syrian Arab Republic

*An epidemiological study on the prevalence of dental fluorosis, dental caries
and orthodontic disorders, the impact of fluorosis on children's well being
and feeding factors possibly associated with dental fluorosis*

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Summary

Dental fluorosis is a disease which is characterised by discoloration of the teeth, firstly white and later on brown or black. Pits in the enamel may develop and in the most severe cases the enamel is broken down totally. In Palmyra, a municipality in Syria, the people are known to suffer from dental fluorosis, probably as a result of a too high fluoride content of the drinking water (0.76-1.81 ppm F). Based on the results of a pilot study, one year earlier, in 2002, which shows no other fluoride sources than the prevailing tap water, the present study was performed. This study aimed to answer the question how far dental fluorosis affects children's well being and to get a clue for the prevention by assessing the possible association between the occurrence of fluorosis and the drinks consumed by children during the first five years of life.

251 children aged 13-15 years from two schools for secondary education, participated in a clinical study. Variables registered were the prevalence and severity of fluorosis, the position of the front teeth, the caries experience of the permanent dentition and the prevalence of fractured teeth. In an interview the children were asked to report perceived problems with their oral health. The mothers of 181 children were interviewed at home or by telephone about the nursing and drinking habits in the first 5 years of their clinically examined child.

The clinical study showed that about 25% of the children were free of clearly visible fluorosis, whereas about 30% had moderate to severe fluorosis. The mean DMFT number was 0.6. Of all children 70% was free of clearly visible dentine caries lesions or fillings. The caries experience of the children was lower than that of children in other cities of the country, which may be the result of the caries preventive effect of fluoride.

Bleeding of the gums, malposition of the teeth, pain and caries were the most important problems mentioned by the children. Only one child spontaneously mentioned problems with respect to the colour of the teeth. On the explicit question whether the children perceived problems with respect to the colour of their teeth, 89% of the them answered positively. It is assumed that this result is biased as children probably had influenced each other on answering this question.

According to the mothers nearly all children drank tea or other drinks containing mainly tap water during the breast or bottle feeding period. After that period all children consumed drinks containing tap water.

As bleeding gums, tooth pain and untreated caries are prevalent oral health problems in Palmyra, possibilities should be explored to introduce a school based oral health program, which includes the promotion of oral hygiene and preventive and curative measures against caries. 'Atraumatic Restorative Treatment' (ART) can counter pain and prevent loss of teeth by preventing the enlargement of existing caries lesions. Despite the finding that discoloured teeth are not considered as an important oral health problem by the interviewed children, it is nevertheless advisable to prevent dental fluorosis. Therefore, the use of tap water up to the age of 5 years should be avoided as much as possible. Instead, low fluoride containing bottled water had to be used. As no experience exist whether such an advice is realistic, an experimental study on the feasibility, compliance of mothers and the effects on dental fluorosis is warranted.

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1 Introduction

Palmyra is a municipality with a population of about 40,000 inhabitants, located in an oasis in a desert, approximately 250 km north east of Damascus. The people in Palmyra are known to suffer from dental fluorosis, a disease which is characterised by discoloration of the teeth, firstly white and later on brown or black. Pits in the enamel may develop and in the most severe cases the enamel is broken down totally. The prevalence and severity of dental fluorosis has been reported previously by the WHO Regional Demonstration, Training and Research Centre for Oral Health in Damascus in 1983 and 1998. The results of their studies are shown in Table 1. Whether these data reflect single teeth or all visible teeth is unknown.

Table 1. Dental fluorosis in Palmyra reported by the WHO Regional Demonstration, Training and Research Centre for Oral Health in Damascus

	1986 Age 12-15 yr. n=170	1998 Age 11-14 yr. n=227
Dean's score	%	%
Normal	28	12
Questionable	18	15
Very mild	33	17
Mild	16	26
Moderate	5	25
Severe	0	3

Dental fluorosis occurs when the teeth are being formed in the presence of too much fluoride. Fluorosis in the front teeth can form an aesthetic problem. Permanent front teeth are formed before the age of 6 years.

The fluoride content of drinking water in several wells in Palmyra has previously been determined between 0.93-1.88 ppm F (Cooper et al., 1987) and between 0.56-1.30 ppm F (University of Zurich, 1998). Taking into account the hot and dry climate in Palmyra, these concentrations in the drinking water are believed to be the main cause of the observed dental fluorosis.

The data shown in table 1 indicate that the fluorosis experience among the children varied considerably, ranging from not observable to severe. The question is raised whether associated factors may have played a role in this large variation. Another question is which level of fluorosis bears significance to children's perception of well being in Palmyra.

In 2001, a pilot survey was conducted aiming to collect information on possible associated factors for a working hypothesis and to serve as a guidance for a more elaborative study. A second aim was to get insight into the impact of dental fluorosis on children's perception of well being and on their treatment wants. The pilot survey consisted of an oral examination and a structured interview with the aid of a questionnaire. The four left upper front teeth of 47 children aged 12-14 years were examined for the assessment of fluorosis. Depending on the index teeth

chosen (the 21 and the 22 only or the 21 up to the 24), 9-13% of the children exhibited severe fluorosis in at least one tooth and 20-30% of the children had moderate or severe fluorosis in at least one tooth. 53% of the children answered 'yes' on the question 'Do you have any problem with your teeth'. The main perceived oral health problem was pain, followed by orthodontic disorders. Only four percent mentioned to have aesthetic problems due to disfiguring dental fluorosis. When a more specific question was addressed regarding the appearance of their teeth by asking 'Has the way your teeth look hindered you in smiling freely in the last month?', 9% of the children responded with 'yes' and 9% with 'a little'. When the children were asked, 'Do you want your teeth to be treated', 40% responded with 'yes', but mainly for pain or an orthodontic disorder. Only 11% wanted treatment to improve the colour of their teeth. The complains regarding bad coloured teeth (9%) and demands for treatment to improve the colour (11%) was restricted to those children who exhibited severe or moderate fluorosis (30%) of their incisors. Thus only a minority of the children with severe or moderate fluorosis perceived an aesthetic problem. Children with very mild and mild fluorosis in this small sample did not perceive aesthetic problems.

Tea samples were collected from children's home. Fluoride concentrations in these samples ranged from 0.76-1.81 ppm F. These concentrations are within the range of previously reported F concentrations in drinking water. Thus, whether children drink tea or not is only relevant if tea is replaced by something low in fluoride content. Fluoride concentrations in household salt and dust samples collected from children's home ranged from 0.18-7.36 ppm F and 0.34-8.24 ppm F, respectively. These F concentrations are insignificant in relation to dental fluorosis.

Mothers were asked about the duration of breast feeding and the frequency of drinking milk. These variables tended to be negatively correlated ($p < 0.10$) with dental fluorosis, whereas frequency of tea drinking tended to be positively correlated ($p < 0.10$) with dental fluorosis. If these preliminary results would reflect the reality, it would afford the possibility to counsel mothers on appropriate nursing and drinking habits of their young child to decrease the prevalence of disfiguring fluorosis.

It was decided to perform a study on a larger group of children in order to confirm or reject the hypothesis that prolonged breast feeding and limited tea drinking are associated with less severe forms of dental fluorosis, which do not pose an aesthetical problem to the children. As caries lesions, fractured teeth and orthodontic disorders also affect the appearance of teeth, recording of these conditions were part of the study. The following research questions were formulated:

- What is the prevalence and severity of dental fluorosis in schoolchildren aged 13-15 years.
- To which extent does dental fluorosis affect the children's well being.
- What are the oral health complaints of the children.
- What is the prevalence of caries, fractured teeth and orthodontic disorders.
- What did the child drink in the first five years of life.
- Is there a statistically significant relationship between what the child drank in the first five years of life and the prevalence and severity of dental fluorosis at the age of 13-15 years.

The study was performed in October 2002.

2 Materials and Methods

The study consisted of a clinical examination of the dental status of children, an interview among children about their opinion regarding their teeth and an interview of the children's mother about the nursing and drinking habits of their child during the first years of life. In this chapter the selection of the participants, the methods used in the clinical part of the study and the questions posed in the interviews are described.

2.1 Participants

Children

The study was performed in Palmyra in two schools for secondary education: one boy's school and one girl's school. In these schools all children aged 13-15 years and born in Palmyra were enrolled. The number of children interviewed and clinically examined was 251.

Mothers

The interviewed mothers were mothers whom children were clinically examined. Mothers were interviewed at home or through telephone. Some mothers were not approached since their address and telephone number were unknown. A few were not willing to participate. Finally, 185 mothers were interviewed, which is 74% of all mothers with a clinically examined child.

2.2 Clinical study

The clinical study was carried out by two experienced examiners and one inexperienced examiner who was trained during the study. Performance of the last one was checked by an experienced colleague and, if necessary, corrected.

The clinical study consisted in a registration of

- the presence and severity of fluorosis;
- the position of the front teeth;
- the prevalence of decayed, missing, restored and fractured teeth.

The children were examined in the open air, without artificial light. Instruments used were plane dental mirrors, dental probes with a ½ mm diameter ball at the end and small spatulas with marks at 3, 6 and 9 mm from the edge. The form for clinical registrations, is presented in annex 1.

2.2.1 Dental fluorosis

The presence and severity of fluorosis was registered in the labial or buccal surfaces of all upper incisors, canine teeth and premolars using the scores of the Thylstrup Fejerskov Index (TFI) (Fejerskov et al, 1988; Fejerskov en Kidd, 2003). These are:

- 0 Normal translucency of the enamel.
- 1 Thin white lines running across the tooth surface.
- 2 The opaque white lines are more pronounced and frequently merge to form small cloudy areas.
- 3 Merging of the white lines occurs, and cloudy areas of opacity occur spread over many parts of the surface. In between the cloudy areas, white lines can also be seen.
- 4 The entire surface exhibits opacity, or appears chalky white. Parts of the surface exposed to attrition or wear appear to be less affected.
- 5 The entire surface is opaque, and there are round pits that are less than 2 mm in diameter.
- 6 The small pits may frequently be seen merging in the opaque enamel to form bands that are less than 2 mm in vertical height.
- 7 There is a loss of the outermost enamel in irregular areas, and less than half the surface is so involved. The remaining intact enamel is opaque.
- 8 The loss of the outermost enamel involves more than half of the enamel. The remaining intact enamel is opaque.
- 9 The loss of the major part of the outer enamel results in a change of the anatomical shape of the surface/tooth. A cervical rim of opaque enamel is often noted.

With the aim to improve the reliability of the data, scores 0 and 1, 2 and 3, 4 and 5, 6 and 7, 8 and 9 were taken together.

2.2.2 Position of front teeth

The following aspects of tooth position were registered:

- The vertical relationship between the upper and lower incisors (overbite and open bite)
- 0 incisal edges 11 and 41 at the same height (end to end relationship)
 - 1 incisal edge 11 between incisal edge and the middle of 41
 - 2 incisal edge 11 between the middle and the gingival margin of 41
 - 3 incisal edge 11 at or beyond the gingival margin of 41
 - 4 this score is not used
 - 5 open bite, distance between incisal edges 11 and 41 up to half of the length of 41
 - 6 open bite, distance between incisal edges 11 and 41 between the half and the total length of 41
 - 7 open bite, distance between incisal edges 11 and 41 more than total length of 41
 - 8 this score is not used
 - 9 no assessment possible, not applicable

- The horizontal relationship between the upper and lower incisors (overjet)
 - 0 'end to end' relationship
 - 1 distance between incisal ridge 11 and labial surface 41 > 0 and ≤ 3 mm
 - 2 distance between incisal ridge 11 and labial surface 41 > 3 and ≤ 6 mm
 - 3 distance between incisal ridge 11 and labial surface 41 > 6 and ≤ 9 mm
 - 4 distance between incisal ridge 11 and labial surface 41 > 9 and ≤ 12 mm
 - 5 distance between incisal ridge 11 and labial surface 41 > 12 mm
 - 6 this score is not used
 - 7 mandibular overjet
 - 8 this score is not used
 - 9 no assessment possible, not applicable
- Crowding or spacing of the upper and lower front teeth
 - 0 no crowding or spacing
 - 1 crowding, shortage of space ≤ 2 mm
 - 2 crowding, shortage of space > 2 and ≤ 5 mm
 - 3 crowding, shortage of space > 5 mm
 - 4 this score is not used
 - 5 spacing, surplus of space ≤ 2 mm
 - 6 spacing, surplus of space > 2 mm
 - 7 this score is not used
 - 8 this score is not used
 - 9 no assessment possible, not applicable.

2.2.3 Caries and tooth fractures

To each permanent tooth one of the following scores was assigned:

- s sound, a caries lesion restricted to the enamel may be present
- d decayed, tooth with a cavity or dentinal caries lesion
- m missing due to caries
 - missing due to an other reason
- f filled, no dentinal caries lesion present
- b broken or fractured, no dentinal caries lesion present.

The sum of the numbers decayed, missing, restored teeth (DMFT) was computed as a measure of the caries experience of the permanent dentition.

2.2.4 Reliability clinical methods

In 38 children, the clinical examination was repeated by a second examiner, who did not know the results of the first examination. Table 2 shows the reproducibility of the measurements, expressed in the Kappa coefficient (Cohen, 1968)

Table 2. Reliability of the registration of the clinical variables

Variable	Cohen's Kappa (se) ^b	
Dental fluorosis		
Highest score per child ^a	0.44	(0.12)
TFI ≥ 2	0.53	(0.16)
Position of front teeth		
Vertical relationship upper and lower front teeth	0.69	(0.11)
Horizontal relationship upper and lower front teeth	0.62	(0.11)
Crowding or spacing upper front teeth	0.44	(0.11)
Crowding or spacing lower front teeth	0.60	(0.10)
Caries and tooth fractures		
DT	0.71	(0.12)
FT	1.00	(0.00)
DMFT	0.71	(0.12)
Fractured teeth	0.64	(0.20)
DMFT ≥ 1	0.84	(0.11)

^a Codes combined two by two, see figure 1, page 12^b Standard error

The kappa coefficients for the different variables varied between 0.44 and 1.00. The reliability of measurements with a Kappa between 0.40 and 0.75 is mentioned as 'reasonable to good' and ≥ 75 as 'very good' (Hunt, 1986). Therefore it can be concluded that the reliability of the registrations of all clinical variables was sufficient.

2.3 Interview children

The children were interviewed by a Syrian nurse, who was familiar with the children. Firstly, the children were asked if they had any problems with their teeth. Secondly, specific questions were asked about possible problems they might perceive with the colour and the position of their teeth. If such problems existed, the children were asked if they want treatment for the problem mentioned. The questionnaire used, translated in English, is presented in annex 2. One question, not part of the questionnaire, was added after when 50% of the children had been interviewed. This question concerned the problem children may have with smiling when they feel themselves uncomfortable because of the appearance of their teeth.

2.4 Interview mothers

The mothers were visited at home or contacted by telephone by a female interviewer who gave information about the study and asked if the mother was willing to participate. The questions concerned the way the child was nursed (breast feeding or bottle feeding) and the beverages used during the first 5 years. The questionnaire used, translated in English, is presented in annex 3. The answers to the question about the duration of bottle feeding were not analysed, since during the interpretation phase it was not clear whether the answers referred to the number of months that a bottle was used, or to the age that bottle use was terminated.

2.5 Statistical analysis

The data collected in the different parts of the study were entered in data files and analysed with SPSS. Differences between categories were tested statistically with the Chi-square test.

3 Results

In this chapter, the clinical results and the results of the interviews are presented, followed by analysis on the relationship between clinical data and the interview data.

3.1 Clinical study

Of the 251 children examined, 50% (N=126) was boy and 50% (N=125) girl. 61% of the children were 13 years, 32% 14 years and 8% were 15 years old.

3.1.1 Dental fluorosis

In figure 1, the TFI scores are presented per type of tooth. In the central incisors fluorosis appeared to be the most prevalent.

Figure 1. TFI scores per type of tooth

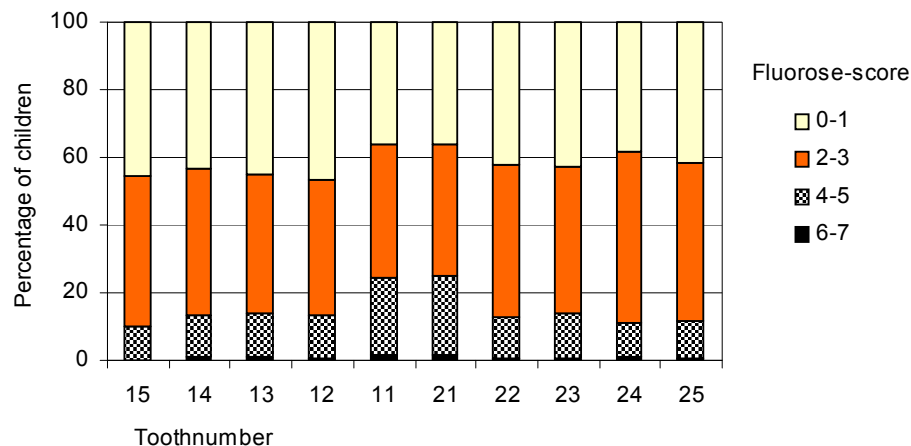


Table 3 shows the distribution of the children according to the highest fluorosis score in all teeth examined and to the highest score in the incisors and canine teeth. In 22% of the children no or only questionable fluorosis was registered (TFI = 0 or 1), in 47% of the children, fluorosis was found in a mild form (TFI = 2 or 3) and in 31% of the children in a moderate or severe form (TFI > 3). If only incisors or canine teeth were considered, the percentage of children without clear fluorosis (TFI < 1) was 27%.

Table 3. Frequency distribution of the children (N=251) with respect to the highest TFI scored in all teeth examined and in the incisors and canine teeth only

TFI score	All teeth examined %	Incisors and canine teeth %
0-1	22	27
2-3	47	44
4-5	29	27
6-7	2	2

3.1.2 Position of front teeth

In table 4, results are presented for the variables related to the position of the front teeth.

Table 4. Frequency distribution of the children (N=251) with respect to the position of the front teeth

	%
Vertical relationship upper and lower incisors	
end to end relationship or overlap up to half the length of the lower incisors	69
overlap > half the length of the lower incisors	30
open bite	1
Horizontal relationship upper and lower incisors	
end to end relationship or maxillary overjet ≤ 3 mm	63
maxillary overjet > 3 and ≤ 6 mm	34
maxillary overjet > 6 mm	3
mandibular overjet	1
Crowding/spacing upper incisors	
no shortage or surplus of space > 2 mm	62
crowding, shortage of space > 2 mm	17
spacing, surplus of space > 2 mm	21
Crowding/spacing lower incisors	
no shortage or surplus of space > 2 mm	51
crowding, shortage of space > 2 mm	42
spacing, surplus of space > 2 mm	6

3.1.3 Caries and tooth fractures

The children had a mean of 26.8 present teeth of which 26.0 were sound. Per child 0.2 teeth were fractured or lost by a trauma. In table 5 the mean DT, MT, FT and DMFT values are presented. Table 6 shows the frequency distribution of the children with respect to the number of DMFT. The prevalence of caries (DMFT > 0) was 30%.

Table 5. Mean number ($\bar{x}$) and standard deviation (sd) of DT, MT, FT and DMFT

	$\bar{x}$	sd
DT	0.5	0,1
MT	0.0	0.0
FT	0.1	0.0
DMFT	0.6	0.1

Table 6. Frequency distribution of the children (N=251) with respect to DMFT

DMFT	%	95% CI ^a
0	70	64%-76%
1	14	
2	8	
3	4	
4	3	
≥ 5	1	

^a 95% confidence interval of the percentage children with DMFT = 0

3.2 Interview children

On the question whether they had problems with their teeth, 73% of the children answered 'yes'. In table 7, a summary is given of the different problems mentioned. Bleeding of the gums, malposition of the teeth and pain were the most frequent mentioned problems. Only one child (0.4% of all children) answered to have a problem with respect to the colour of the teeth. All children except one answered positively on the question whether they wanted to be treated for the perceived problem.

Table 7. Percentage of children who mentioned tooth problems spontaneously or after an explicit question (N=251)

	Problem mentioned spontaneously % ^a	Problem mentioned after an explicit question % ^a
No problems	27	
Pain	20	
Caries	9	
Bleeding	24	
Malposition of the teeth	24	47
Broken teeth	1	
Abscess	1	
Colour of the teeth	0	89
Smiling ^b	0	62

^a As some children mentioned different problems the percentages count up to more than 100%

^b A question about possible problems with smiling was asked to the boys only (N=126)

On the explicit question whether they perceived problems with respect to the colour of the teeth, 89% of the children answered 'yes'. All children concerned answered that they wished to be treated to improve the tooth colour. 47% of the children gave a positive answer on the explicit question whether they had problems with the position of the teeth. All of them wished to be treated to solve this problem. On the question whether the children had problems with smiling, only posed to the boys, 62% said that this was true.

In children reporting problems with respect to the position of the teeth, more spacing between the front teeth was registered than in children who did not have such complaints (see annex 4, table 16). Children reporting caries as a problem had more carious teeth than children not mentioning this problems (see annex 4, table 17). The association between fluorosis and problems with respect to the colour of the teeth is described in paragraph 3.4.

3.3 Interview mothers

Of all mothers interviewed (N=185), 97% answered positively on the question whether the child got breast feeding some time after birth. In table 8 the frequency distribution of the children is shown according to the duration of the breast feeding. Of all children 22% got breast feeding for more than 23 months.

Table 8. Frequency distribution of the children (N=185) according to the duration of breast feeding

Duration of breast feeding	%
No breast feeding	3
< 6 months	7
6-11 months	12
12-17 months	24
18-23 months	32
24 months or longer	22

Of all mothers, 38% used (also) a bottle to feed the child. In table 9 the frequency distribution of the children is shown with respect to the child's age that bottle feeding was started.

Table 9. Frequency distribution of the children (N=185) according to the starting time of bottle feeding

Start bottle feeding	%
< 6 months	21
6-11 months	11
12-17 months	5
18-23 months	2
No bottle feeding	62

For 85% of the children the content of the bottle was powder milk. Other drinks mentioned were cow milk, cow milk diluted with water, powder rice or grain water and tea. 58% of the children drank tea during the first two years of life. The frequency distribution of the children with respect to the child's age that tea drinking was started, is presented in table 10.

Table 10. Frequency distribution of the children (N=176) according to starting time of tea drinking

Start use of tea	%
< 6 months	25
6-11 months	16
12-17 months	12
18-23 months	5
Not before 24 months	42

The number of daily tea drinks by the child up to the age of 5 years is shown in table 11.

Table 11. Frequency distribution of the children (N=171) according to the number of daily tea drinks up to the age of 5 years

Daily number of tea drinks	%
0 times a day	3
1-2 times a day	18
2-3 times a day	39
3-4 times a day	24
4-5 times a day	13
5-6 times a day	2

In table 12, the percentage of children is presented who consumed other drinks than tea during the breast or bottle feeding period and after that period up to the age of 5 years. There was a large variation in drinks. Most drinks consisted mainly of tap-water. Up to the age of 5, 16% of the children drank one drink without tap-water (cow milk, yoghurt, fruit juice or cola), but in all cases in combination with water, tea or another a tap-water containing drink.

Table 12. The percentage of children using drinks (other than tea) during the breast or bottle feeding period and after that period up to the age of 5 years

	During breast or bottle feeding period % ^a	After breast or bottle feeding period up to the age of 5 years % ^a
Water	15	28
Powder milk	6	23
Cow milk	1	9
Yoghurt	2	5
Powder rice or grain water	8	1
Anise	3	0
Artificial juice	6	5
Fruit juice	8	12
Cola	1	2
Not applicable	65 ^b	40 ^c

^a The percentages in this table count up to more than 100% as some mothers mentioned more than one drink

^b Besides breast or bottle feeding no drinks used other than tea

^c Only tea used

3.4 Dental fluorosis and possible associated factors

In this paragraph firstly the problems that children perceived with respect to the colour of their teeth are related to the prevalence and severity of fluorosis. Secondly the association is explored between the presence of fluorosis and the drinking habits of the child up to the age of 5 years.

3.4.1 Dental fluorosis and problems with the colour of the teeth

In figure 2, the frequency distribution of children with and without perceived problems with the colour of their teeth is shown with respect to the highest TFI scores in their incisors and canine teeth. In those with perceived problems, the percentage of children with a TFI score > 3 was about twice as high as compared to the category without perceived problems, but the difference was statistically not significant ($p = 0.27$). In the category children with 0 or 1 as highest TFI score in the incisors and canine teeth, 90% of the children reported problems with the colour of the teeth, whereas in the category with a TFI > 3 as highest score, 93% reported problems (table 13).

Figure 2. Frequency distribution of children with and without perceived problems with the colour of their teeth according to the highest TFI score in their incisors and the canine teeth

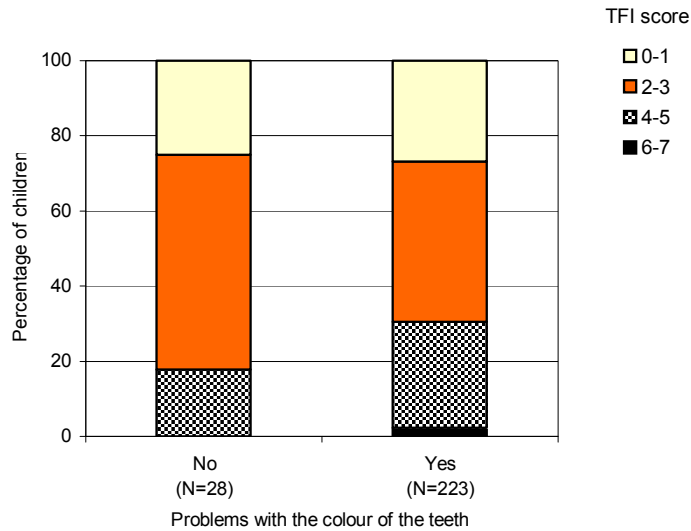


Table 13. Association between the highest TFI score in incisors and canine teeth and the percentage of children having problems with the colour of their teeth

Highest TFI score	Colour mentioned as problem			p = 0.27
	No %	Yes %	Total %	
0-1	10	90	100 (N=67)	
2-3	14	86	100 (N=111)	
> 3	7	93	100 (N=73)	

3.4.2 Dental fluorosis and drinking habits

In table 14, the association is shown between the prevalence and severity of fluorosis and the drinking habits of the children during the first years of life. No significant relationship between these variables existed.

Table 14. Association between the drinking habits of the child up to the age of 5 and the highest TFI score in incisors and canine teeth

	Highest TFI score				
	0-1	2-3	> 3	Total	
Duration of breast feeding					p = 0.54
6-11 months	30	50	20	100 (N=40)	
12-17 months	18	45	36	100 (N=44)	
18-23 months	32	42	25	100 (N=59)	
24 months or longer	32	46	22	100 (N=41)	
Bottle feeding before 12 months					p = 0.58
Yes	27	51	22	100 (N=59)	
No	28	43	28	100 (N=125)	
Start drinking tea					p = 0.56
< 12 months	25	50	25	100 (N=72)	
12-17 months	40	43	17	100 (N=30)	
≥ 18 months	27	45	27	100 (N=73)	
Number of tea drinks a day					p = 0.84
0-2	25	56	19	100 (N=36)	
2-4	27	45	28	100 (N=67)	
4-6	27	46	27	100 (N=67)	
Use of drinks without tap water					p = 0.96
No	28	46	26	100 (N=154)	
Yes	30	43	27	100 (N=30)	

4 Discussion

In this chapter, the validity of the data obtained and the results mentioned in the previous chapter are discussed.

4.1 Validity of the data

The validity of the obtained data depends on how representative the participants are for the whole community of all children in Palmyra and on the reliability of the methods used to obtain the data. Two secondary schools were selected out of the secondary schools present in Palmyra. Since, nothing is known about the oral health status of children in the different schools, the two selected schools do not necessarily accommodate children whom oral health status was representative for all children in Palmyra. However, conditions of living in a community like Palmyra are probably quite similar for all children. Therefore, the probability that result would significantly differ if other schools were selected is considered to be small. The present study focussed on the relationship between the prevalence of fluorosis and the drinking habits of a child during the first years of life. There is no reason to expect different results if the distribution of the participants with respect to the dependent and independent variables would be somewhat different.

As shown in table 2, the duplicate measurements revealed a sufficient reliability of the methods used in the clinical part of the study. Doubt exist about the independence of the answers the children gave on the questions about oral health problems perceived. It cannot be excluded that there was interchange of information between those who had been interviewed and those who still had to be interviewed. This was surely the case with the added question 'has the way the colour of your teeth look hindered you in smiling freely' Almost all children responded with 'yes'. In an extra survey among 56 girls, aged 13-15 years, who were separated from each other during the interview, only 34% of them answered 'yes' on this question. This implies that the answers obtained with respect to oral health problems in this study may reflect the group's view, rather than the individual view of the child. This seems particularly the case for answers to specific questions regarding problems about the colour of teeth and answers to questions about desired treatment.

The questions asked to the mothers were related to a period of time about ten years ago. Therefore, a memory bias has likely occurred, but not necessarily a more serious selective 'recall bias'.

4.2 Clinical study

Dependent on the teeth included, upper incisors and canine teeth only or all teeth, 29% or 22% of the children were free of clearly visible fluorosis, whereas 29% or 31% of the children, respectively, had moderate to severe fluorosis. These results correspond to the results of the study of Taifour (1998) which are presented in table 1. It can be concluded that the variation in severity

of fluorosis was relatively large.

With regard to the position of their front teeth, the about 2/3 of the Palmyra children were free of orthodontic disorders. As practically no children were treated, the data actually reflect a stage of 'natural' development of children's dentition. Some years ago, the position of front teeth was assessed with similar methods among 14-year-old Dutch children for whom orthodontic treatment was available. Table 15 present the data of both the Dutch children and the Palmyra children for comparison. The differences found between these two populations of children may partly be ascribed to orthodontic intervention, but genetic factors may have played a role as well.

Table 15. Frequency distribution of children in Palmyra (this study) and The Netherlands (source: Kalsbeek et al. 1997) with respect to the position of the front teeth

	Palmyra (Syria) N=251 %	The Netherlands N=486 %
Vertical relationship upper and lower incisors		
end to end relationship or		
overlap up to half the length of the lower incisors	69	72
overlap > half the length of the lower incisors	30	26
open bite	1	2
Horizontal relationship upper and lower incisors		
end to end relationship or maxillary overjet ≤ 3 mm	63	54
maxillary overjet > 3 and ≤ 6 mm	34	40
maxillary overjet > 6 mm	3	6
mandibular overjet	1	0
Crowding/spacing upper incisors		*
no shortage or surplus of space > 2 mm	62	77
crowding, shortage of space > 2 mm	17	17
spacing, surplus of space > 2 mm	21	6
Crowding/spacing lower incisors		*
no shortage or surplus of space > 2 mm	51	77
crowding, shortage of space > 2 mm	42	21
spacing, surplus of space > 2 mm	6	2

* Significant difference between Syrian and Dutch children, $p < 0.001$

Of all children examined, 70% were free of clearly visible dentine caries lesions or fillings. The mean DMFT number was 0.6. Supposing a linear increase between the age of 6 and the age of 13 years, the mean DMFT number at the age of 12 years can be estimated to be 0.5 DMFT. This number is much lower than the DMFT value of 1.9-2.3 for 12-year-old Syrian children (Beiruti *et al.*, 2001). As the cited data obtained in other cities of the country where the fluoride content of

drinking water is low (0.1 ppm F), the difference may reflect the caries preventive effect of fluoride.

4.3 Interview children

Problems frequently mentioned by the children in response to the introductory question 'Do you have any problems with your teeth?', were bleeding of the gums, malposition of the teeth, pain and caries. Orthodontic disorders in the front teeth as well as caries were clinically assessed, but not the condition of the gums. Perceived problems regarding malposition of teeth and caries were statistically significantly associated with clinical assessed spacing between the front teeth (Annex 4, table 16) and clinically detectable caries (Annex 4, table 17), respectively. As oral pain, caries and bleeding gums are important oral health problems among these schoolchildren, possibilities should be explored to introduce school based oral health programmes on oral hygiene and prevention and early treatment of caries. The Atraumatic Restorative Treatment (ART), a method to treat caries with hand instruments, without a dental drill and compressor, would be an appropriate technology for school based oral health services. ART has proven to be effective in an experimental setting in schools in Damascus (Taifour, 2002).

A notable result was that, in spite of the high prevalence of fluorosis, only one child spontaneously reported to have problems with respect to the colour of teeth. In contrast, 89% of the children responded to have problems with the colour of their teeth on the explicit question 'Do you have any problems with the colour of your teeth'. As discussed earlier, the answer to the latter question is probably biased due to interchange of information between the children.

A conservative conclusion may be that the children were more concerned about bleeding of the gums, malposition of teeth, caries and pain than about the discoloration of their teeth.

4.4 Interview mothers

Of all children, 90% got breast feeding for at least 6 months and 78% for at least 12 months. Nearly all children drank tea or other drinks which consisted mainly of water. After the breast or bottle feeding period, 14% of the children got cow milk or yoghurt, but these children used also drinks containing tap water. The low consumption of natural milk and yoghurt may be due to the relative high cost of these products.

4.5 Prevention of dental fluorosis

Fluorosis in Palmyra, does not cause problems with chewing and biting and it does not induce a higher risk of dental caries. The need for prevention depends chiefly on the extend that fluorosis affects peoples' feeling of well being. Only one child mentioned spontaneously the discoloration of the teeth as a problem after the introductory question 'do you have any problems with your teeth'. Since the answer to the question 'do you have any problems with the colour of your teeth' is likely biased as discussed before, we do not know how exactly children perceive their discoloured teeth. Even if children do not bother about their discoloured teeth at this moment,

their view can change in the future. Firstly, because the white lines or spots at the age of 13-15 years may discolour to brown and black at later age due to food pigments entering the porous fluorotic enamel. Secondly, because children's views may change under the influence of peer persons or by moving to environments where fluorosis is not a common phenomenon.

If a person perceives fluorosis as a problem, the dentist can solve it to some extent by placing synthetic veneers on the labial surfaces of the front teeth. However, this solution is expensive and therefore not available for all people. This means that prevention is preferable. The results of the study indicate that children under the age of 5 years consumed drinks which mainly consisted of tap water. As the fluoride content of tap water in Palmyra is the cause of fluorosis, prevention of fluorosis has to be achieved by decreasing the consumption of tap water by children under the age of 5 years. At this age, permanent incisors are formed and fluorosis can no longer develop. An advice to de-fluoridate the drinking water in Palmyra is not desirable, because the present fluoride content is effective in preventing the development of caries for all ages and it does not pose any health risk besides dental fluorosis. An advice to promote the use of cow milk and fruit juices seems impossible under the current prevailing economical situation, the use of bottled water containing a low fluoride content could be an alternative.

As no experience exist whether such an advice is realistic, a study on the feasibility, compliance of mothers and the effects on dental fluorosis is warranted. As the implementation of such a study is complicated, it should preferably be conducted in a relatively small community with a prevalence of fluorosis which is similar to that in Palmyra.

5 Conclusions and recommendations

The results presented lead to the following conclusions:

Clinical study

- The variation in the severity of dental fluorosis in 13-15-year-old children in Palmyra is relatively large.
- 70% of the children were free of clearly visible dentine caries lesions or fillings. The mean DMFT number was 0.6. The caries experience of the children was lower than that of children in other cities of the country. The difference may reflect the caries preventive effect of fluoride.

Interview children

- Bleeding of the gums, malposition of the teeth, and pain and caries were the most important problems mentioned by the children.
- Only one child spontaneously reported problems with respect to the colour of the teeth.
- On the explicit question about perceived problems with the colour of the teeth, 89% of the children answered positively. This result may be biased since as children possibly influenced each other on answering this question.

Interview mothers

- During the breast or bottle feeding period nearly all children drank tea or other drinks which consisted mainly of tap water.
- After the nursing period all children consumed drinks containing tap water.

Fluorosis and associated factors

- Momentarily, almost all drinks consumed by children under the age of 5 years contain tap water, which is the cause of dental fluorosis.
- No variables were found which could explain the large variation in severity of fluorosis among children in Palmyra.

Prevention of fluorosis

- Despite the finding that discoloured teeth are not considered as an important oral health problem by the 13-15-year-old children in Palmyra, it is nevertheless advisable to prevent dental fluorosis because the looks of fluorotic teeth will get worse later in life. Moreover, the present aesthetical norms may change in the future, especially when Palmyra people move to other parts of Syria where fluorosis is non-existent.
- To prevent fluorosis, the use of tap water by children up to the age of 5 should be avoided as much as possible.

The following recommendations can be given:

- As bleeding gums, pain and untreated caries has to be regarded as important oral health problems, promotion of oral hygiene and preventive and curative measures against caries should be taken in Palmyra.
- Possibilities should be explored to introduce a school based oral health program aiming to improve the oral hygiene status and the caries status of the children. 'Atraumatic Restorative Treatment' (ART) should be introduced as an appropriate alternative for the accepted but expensive treatment of caries lesions. Prevention and early treatment of caries with ART can prevent pain and later loss of teeth.
- To prevent fluorosis, mothers with young children should be counselled on replacing tap water by low fluoride containing bottled water in the drinks of their children under the age of 5 years.
- We recommend to perform an experimental study to get answers on the following questions:
 - What is the practicability of a program with the above advice to mothers ?
 - What is the effect of such a program on the behaviour of the mothers with respect to the content of drinks of their children?
 - What is the effect of the program on the prevalence and severity of fluorosis in the permanent teeth of children who were reared after the introduction of the program?
- To simplify the implementation of such a study, it is advised to perform it in a relatively small community where the prevalence of fluorosis is similar to that in Palmyra.

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Annex 1 Clinical examination form

1. Name, number school

2. Name, number child

3. Sex ☐ boy ☐ girl

4. Age years

5-14. TFI

15	14	13	12	11	21	22	23	24	25
...	...	...	...	...	...	...	...	...	...

15. Overbite

16. Overjet

17. Crowding/spacing upper front

18. Crowding/spacing lower front

19-46 Caries status*

17	16	15	14	13	12	11	21	22	23	24	25	26	27
...	...	...	...	...	...	...	...	...	...	...	...	...	...
47	46	45	44	43	42	41	31	32	33	34	45	36	37
...	...	...	...	...	...	...	...	...	...	...	...	...	...

* Caries status

s sound tooth

m missing tooth due to caries

• missing tooth due to an other reason

b broken or fractured tooth (if with a cavity or dentinal caries lesion, the score is 'd')

d decayed tooth (tooth with a cavity or dentinal lesion)

f restored tooth (restored with a cavity or dentinal lesion is scored 'd')

Annex 2 Questionnaire child

1. Name, number school
2. Name, number child
3. Sex ☐ boy ☐ girl
4. Age years
5. Do you have any problems with your teeth? ☐ no ☐ yes
What kind of problem?
6. Do you want treatment for that problem? ☐ no ☐ yes
7. Do you have any problems with the colour of your teeth? ☐ no ☐ yes
What is the exact colour problem?
8. Do you want treatment to improve the colour of your teeth? ☐ no ☐ yes
9. Do you have any problems with the position of your teeth? ☐ no ☐ yes
What is the exact position problem?
10. Do you want treatment to improve the position of your teeth? ☐ no ☐ yes

Annex 3 Questionnaire mother

1. Name, number school
2. Name, number child
3. Sex ☐ boy ☐ girl
4. Age years
5. Did you breast feed your baby directly after birth? ☐ no ☐ yes
How long?
6. Did you bottle feed your baby? ☐ no ☐ yes
From which age? How long?
7. What was the content of the feeding bottle?
8. Did your child drink tea during the breast feeding or bottle feeding period?
☐ no ☐ yes
From which age?
9. How frequent did your child drink tea up to the age of 5 years?
10. Did your child drink anything else during the breast feeding or bottle feeding period?
☐ no ☐ yes
What did she/he drink From which age?
11. Did your child drink anything else up to the age of 5 years? ☐ no ☐ yes
What did she/he drink
How frequent did your child drink this beverage up to the age of 5 years?

Annex 4 Oral health status and reported oral health problems

Table 16. Position of the front teeth of children reporting and not reporting malposition of teeth as a problem

	Position of teeth reported as problem		
	No	Yes ^a	Yes ^b
	N=128	N=56	N=59
	%	%	%
Vertical relationship upper and lower incisors			p = 0.26
end to end relationship or			
overlap up to half the length of the lower incisors	73	66	63
overlap > half the length of the lower incisors	27	32	37
open bite	0	2	0
Horizontal relationship upper and lower incisors			p = 0.06
end to end relationship or maxillary overjet ≤ 3 mm	63	70	54
maxillary overjet > 3 and ≤ 6 mm	36	27	37
maxillary overjet > 6 mm	1	4	5
mandibular overjet	0	0	3
Crowding/spacing upper incisors			p < 0.001
no shortage or surplus of space > 2 mm	75	57	30
crowding, shortage of space > 2 mm	16	18	17
spacing, surplus of space > 2 mm	8	25	53
Crowding/spacing lower incisors			p < 0.01
no shortage or surplus of space > 2 mm	51	54	48
crowding, shortage of space > 2 mm	47	39	36
spacing, surplus of space > 2 mm	2	7	16

^a Position of teeth reported as a problem after an explicit question only

^b Position of teeth spontaneously reported as a problem

Table 17. Number of DMFT in children reporting and not reporting pain and caries as a problem

DMFT	Pain mentioned as problem			Caries mentioned as problem		
	No	Yes		No	Yes	
	N=200 %	N=51 %		N=229 %	N=22 %	
0	71	67	p = 0.10	73	36	p < 0.001
1-2	23	18		21	32	
> 2	6	16		6	32	