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# A review of fluorosis in the European Union: prevalence, risk factors and aesthetic issues

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Abstract – Fluoride has played a key role in caries prevention for the past 50 years but excessive ingestion of fluoride during tooth development may lead to dental fluorosis. Throughout Europe many vehicles have been, and are currently, employed for optimal fluoride delivery including drinking water, toothpaste, fluoride supplements, salt and milk. Several indices, both descriptive and aetiological, have been developed and used for measuring fluorosis. This factor, combined with the lack of use of a standardized method for measurement of fluorosis, has made comparison between studies difficult and assessment of trends in fluorosis prevalence unreliable. Overall the evidence would appear to indicate, however, that diffuse enamel opacities are more prevalent in fluoridated than in nonfluoridated communities and that their prevalence at the very mild level may be increasing. In addition to fluoridated drinking water, risk factors for fluorosis include inadvertent ingestion of fluoride toothpaste and the inappropriate use of fluoride supplements. The risk is of aesthetic concern primarily during the period of enamel development of the permanent central incisors, although this largely appears to be a cosmetic rather than a public-health issue. It is concluded that there is a need to co-ordinate studies measuring fluorosis throughout Europe and that development of a standardized photographic method would be useful. Furthermore, the aesthetic importance of fluorosis needs to be determined in more detail in each country in the light of each country's respective risk factors and dental health policies.

Key words: aesthetics; Europe; fluorosis; indices; prevalence; risk factors

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Fluoride has played a central role in oral health promotion for the past 50 years but the ingestion of excessive fluoride during tooth development, particularly at the maturation stage, may result in dental fluorosis, which has an extensive range of clinical signs. Mildly fluorosed enamel is fully functional and may present as barely detectable whitish surface striations (1, 2) whereas severely fluorosed enamel is more prone to wear and fracture and may present as pitted, stained and porous enamel (3). Fluorosis may occur in either the primary or permanent dentition, this paper reviews studies of fluorosis of the permanent dentition.

Currently the various vehicles for and sources of fluoride include drinking water, toothpaste, fluoride supplements, fluoridated salt, fluoridated milk, processed drinks and foods. Optimal water fluoridation is that concentration which provides the maximum protection against caries with the least clinically observable fluorosis. Some areas have naturally optimally fluoridated water supplies (0.7–1.5 ppm F) including the Bordeaux region in France, Mouscron in Belgium and Hartlepool in the UK. Water fluoridation schemes are currently operating in Ireland, Spain, Switzerland and the UK (4). In Ireland fluoridation (0.8–1.0 ppm F) began in 1964, serves approximately 74% of the population and is mandatory by law (5). Spain began fluoridation in 1986 and it now serves in excess of 3.3 million people (4). Under the UK Water Fluoridation Act of 1985 the decision to fluoridate is made locally and currently 10% of the UK population receives fluoridated water

(6). In addition, approximately 20 000 children receive fluoridated milk through the school system in the UK (7). The use of fluoridated salt as an alternative to water fluoridation is an option in countries where there is a strong antiwater fluoridation lobby or where the water distribution systems are numerous or fragmented; countries involved include Germany, Switzerland, France, Belgium and the Czech Republic (8, 9). Fluoridation began in Holland in 1953 with the Tiel-Culembourg study but ended in 1973 because of problems with the legislation and subsequent antifluoridation activity (10). The oral-health preventive measures adopted within individual European countries vary considerably with substantially more overall spending on treatment rather than prevention, dental services costing between 5 and 10% of national health budgets (9).

Early studies in the late 1930s, 1950s and 1960s estimated that 7–16% of children reared in an optimally fluoridated area showed signs of mild or very mild fluorosis in the permanent dentition (11–13) (Table 1). A review in 1990 suggested that the prevalence of fluorosis in fluoridated communities has remained stable since then (14). Conversely other authors refer to an increase in fluorosis in the USA over the previous 30 years, both in fluoridated and nonfluoridated communities (15). The aim of this paper is to determine, by review, recent trends in the prevalence of fluorosis in Europe and the associated aesthetic concerns.

## Measurement indices

Dental fluorosis is but one of a number of developmental defects of enamel and the indices used to categorize enamel defects can be subdivided into descriptive and fluorosis-specific indices. The descriptive indices, including the Developmental Defects of Enamel (DDE) Index (16), Jackson-Al-Alousi (J-A) Index (17) and Murray-Shaw (M-S) Index (18), classify defects on the basis of their appearance and do not facilitate an estimate of the prevalence of fluorosis. The DDE index is currently the most commonly used descriptive index. It was developed by the Federation Dentaire Internationale as a suitable international epidemiological index for recording developmental defects of enamel and categorizes three types of defect: diffuse opacities, demarcated opacities and hypoplasia, with the measurement of diffuse opacities considered a close approximation of fluorosis. The fluorosis-specific indices, including those of Dean (11), Thylstrup and Fejerskov (TF) (19), the Tooth Surface Index of Fluorosis (TSIF) (20) and the Fluorosis Risk Index (FRI) (21), assume a diagnosis of fluorosis and do not record the range of defects that may be present. Neither type of index addresses the aesthetic acceptability of the defects. In essence the selection of a specific index for an epidemiological study is dependent on the purpose of the study itself.

The fluorosis-specific Dean's Index is of historical significance, has been, and continues to be, used extensively and is the standard for comparison for other indices. The index is a six-point ordinal measurement scale identifying fluorotic appearances ranging from 'normal' to 'severe'. It is, however, considered to have limitations in that the scale is not considered to be sufficiently sensitive, being vague at the 'questionable' end and lacking discrimination at the 'severe' end. Additionally, it is person-based and does not give information regarding the number or nature of the teeth affected. The TF index was developed by Thylstrup and Fejerskov in a bid to 'refine, modify and extend the original concepts developed by Dean' (19, 22). The classification scale

Table 1. Prevalence of fluorosis reported in early studies on children in the United States of America, 1939–61

| County | Year of examination | Index | Lighting | Age group | Fluoride | Fluorosis prevalence (%)[a] | Comments |
|---|---|---|---|---|---|---|---|
| Kewanee, IL (11) | 1939–40 | Dean's | Natural | 12–14 $n = 123$ cr[b] | Natural water (0.9 ppm) | 12.2 | |
| Newburgh, NY (12) | 1954–55 | Dean's | Natural | 7–14 $n = 438$ cr[b] | Water (1.0–1.2 ppm) | 7.3 | Fluoridated since 1945, children older than 10 years did not have exposure since birth |
| Grand Rapids, MI (13) | 1961 | Dean's | Artificial | 11–17 $n = 358$ cr[b] | Water (1.0 ppm) | 7.1–15.9 | Fluoridated since 1945, prevalence of fluorosis greater among black children |

[a]Fluorosis at the very mild or greater levels, does not include fluorosis at the questionable level.
[b]cr, continuous residents since birth.

corresponds closely to histological changes that occur in dental fluorosis and consists of a 10-point ordinal scale. In contrast to Dean's Index the teeth are cleaned and dried before examination, facilitating diagnosis. The TSIF (20) was also developed to improve upon the shortcoming of Dean's Index. Grades on an eight-point ordinal scale are assigned to individual tooth surfaces, examined wet, making the index advantageous from an aesthetic viewpoint.

Irrespective of the index used the examination for fluorosis can be affected by many factors. For example, examiner bias, intra- and interexaminer reliability, examiner drift, index validity and varying methodology, such as whether the teeth are dried, method and duration of drying, cleaning of the teeth and type of lighting used. When assessing trends in fluorosis prevalence and severity it is difficult to compare fluorosis scores recorded using different indices without introducing assumptions as to the comparability of grades across six-, eight- and 10-point ordinal scales. Added to this difficulty is the fact that when recording Dean's Index, the examiner identifies the two worst teeth and records only the condition of the second most severely affected tooth, the condition of the most severely affected tooth and the other teeth is not captured. In contrast, for the TF and TSIF indices the condition of all teeth, including the most severely affected tooth, is recorded. The use of a standard photographic technique may be helpful in controlling potential discrepancies (23). A technique employing standardized film, handling procedures, camera equipment, exposure time, lighting conditions, drying time of the teeth, camera angulation, lip retraction and processing procedures has been developed and employed successfully in seven EU countries and in the National Survey of Children's Oral Health in Ireland. The method has a number of advantages including allowing the scoring of the incisor teeth by a single trained and calibrated examiner under standardized, blind conditions. Examiner consistency and validity can also be monitored using the technique developed. Photographs also provide a permanent record of the appearance of the tooth and when standardized allow longitudinal monitoring.

## Prevalence of fluorosis in countries of the European Union

This review was undertaken to look at the levels of fluorosis in EU countries, it is not a systematic review, but studies from geographically and culturally disparate countries have been included to provide an overview of the pattern of fluorosis prevalence.

Fluoridation of public water supplies has been carried out in Ireland since the mid-1960s. Currently, 73% of the population are served with fluoridated supplies. The National Survey of Children's Dental Health in Ireland in 1984 examined representative samples of 8- and 15-year-olds for fluorosis using Dean's Index to provide a baseline reference for future comparisons. The overall results showed that in fluoridated areas 5% of 8-year-olds and 4% of 15 years-olds had fluorosis at the questionable level, 1% and 1.3%, respectively, had fluorosis at the very mild or mild levels. There were no cases with fluorosis at higher levels. In nonfluoridated areas 1.9% and 0.6% of 8- and 15-year-olds, respectively, had fluorosis at the questionable level, with no reports of higher levels of fluorosis in either group (24, 25). The various regional Health Boards subsequently carried out follow-up studies; the studies were carried out by examiners trained and calibrated to the same level as the examiners in the earlier studies (Table 2). In the Eastern Health Board (EHB) (26) for 8- and 15-year-olds in fluoridated areas in 1993 the prevalence of questionable fluorosis had increased to 19.5 and 21%, respectively, and fluorosis at the very mild or greater level had increased to 3% and 4%, respectively. In the Southern Health Board (SHB) in 1995 (27) there was little change in the prevalence of fluorosis for 8-year-olds and an increase for 15-year-olds in fluoridated areas, with the prevalence of very mild or greater levels increasing to 5.6% from a national prevalence of 1% in 1984. The level of fluorosis was higher in the fluoridated districts in both age groups. In the North-western Health Board (NWHB) in 1997/98 (28) the levels of fluorosis at the questionable level among 8- and 15-year-olds in nonfluoridated areas were 14.3% and 11%, respectively, and 22.9% and 21.5% in fluoridated areas; 9.6% of 8-year-olds and 4.5% of 15-year-olds were classified at the higher levels of very mild or greater fluorosis in nonfluoridated areas. In fluoridated areas these figures were 24.6% and 12.8%, respectively. Overall, the results showed that in most areas in Ireland the prevalence of fluorosis according to Dean's Index had increased since 1984 and in all areas fluorosis was more prevalent in fluoridated areas. There was considerable variation in the prevalence of fluorosis both within the fluoridated and nonfluoridated areas in different parts of Ireland. The recorded prevalence of

Table 2. Prevalence of fluorosis according to Dean's Index scores amongst 8-year-old children and 15-year-old adolescents in Ireland in 1984 and in three different administrative regions: Eastern, Southern and North-western Health Boards of Ireland in the 1990s

| | 8-year-olds | | 15-year-olds | |
|---|---|---|---|---|
| Year of survey/Health Board region/fluoridation status | Questionable percentage | Very mild or greater percentage | Questionable percentage | Very mild or greater percentage |
| 1984/Ireland/fluoridated (24) | 5 | 1 | 4 | 1.3 |
| 1993/Eastern Health Board/fluoridated (26) | 19.5 | 3 | 21 | 4 |
| 1995/Southern Health Board/fluoridated (27) | 6.1 | 3.0 | 5.9 | 5.6 |
| 1998/North-western Health Board/fluoridated (28) | 22.9 | 24.6 | 21.5 | 12.8 |
| 1984/Ireland/nonfluoridated (24) | 1.9 | 0 | 0.6 | 0 |
| 1995/Southern Health Board/nonfluoridated (27) | 2 | 0.6 | 3.5 | 1.9 |
| 1998/North-western/Health Board/nonfluoridated (28) | 14.3 | 9.6 | 11 | 4.5 |

Data are presented according to fluoridation status of the domestic water supply. 'Fluoridated' denotes domestic water supply fluoridated since birth, 'Nonfluoridated' indicates that the child has not lived at an address with a fluoridated domestic water supply.

fluorosis at the very mild and greater level in fluoridated communities was similar to the figures reported in the early US studies of water fluoridation (11–13), with the exception of the 24.6% of 8-year-olds with fluorosis in fluoridated areas of the NWHB in 1998.

In the UK, the most widely used index for measuring enamel defects has been the DDE index. To date less than 10% of the population of the UK receives a fluoridated water supply, fluoride-rinsing programmes are few in number and the use of fluoride supplements is not extensive. A national survey of Children's Dental Health in the UK in 1993 reported the prevalence of diffuse enamel opacities using the Developmental Defects of Enamel (DDE) Index among 12-year-olds to be 20%, ranging from 8% in Northern Ireland to 22% in England (29). Individual studies at a more local level in nonfluoridated areas in the UK have been largely in agreement with these data, showing that approximately 20% of children have diffuse opacities (30–32). Recent studies in fluoridated districts have shown that the prevalence of fluorosis is higher than in nonfluoridated communities, something which earlier studies failed to demonstrate (33). Milsom and Mitropoulous (34) reported that 48% of 8-year-old English children examined in a fluoridated area had diffuse opacities compared with 22% in a nonfluoridated area. For 9-year-old English children Hamdan and Rock (35) found prevalences of 27% and 8% in fluoridated and nonfluoridated areas, respectively. In a Welsh population of 14-year-olds Ellwood and O'Mullane (31) reported a higher prevalence of 54% amongst those who had fluoridated water and 36% amongst the nonfluoridated population. However, the DDE Index is not specific for fluorosis and its use in epidemiological studies over the past few decades in the UK makes it difficult to ascertain whether or not there has been a real increase in fluorosis. Indeed, a recent review of trends in fluorosis prevalence in the UK concluded that there was no clear evidence suggesting an increase in the overall prevalence of developmental defects of enamel, of which fluorosis plays a part, during the previous 30 years (33).

Most German drinking water is low in fluoride (4). A study of enamel defects in German children with different fluoride supplementation in a nonfluoridated area concluded that 18% of the children examined exhibited diffuse opacities compared with 8% of the control group (36). A study by Carvalho et al. (37) in nonfluoridated Belgium examined a total of 700 children in the 3-, 4- and 5-year-old age groups and assessed the level of fluorosis using the TF index. It was concluded that 19%, 17% and 9% of 3-, 4- and 5-year olds, respectively, exhibited signs of fluorosis. A further study assessing the apparent decline in dental caries among 12-year-old Belgian children between 1983 and 1998 showed early signs of fluorosis in 5% of the subjects in 1983 and 30% of the subjects in 1998 (38).

Salt fluoridation (250 mg F/kg) was introduced into France in 1987. Results of the 1991 National Survey of Children's Dental Health in France showed that 96% of 6- to 15-year-old children had no signs of fluorosis, with 4% exhibiting questionable to mild fluorosis (39, 40). In Holland, the prevalence of fluorosis in 15-year-old children in two areas was assessed using the TF index (41). The percentage of children affected by fluorosis was 24% in Tiel (1 ppm F) and 22% in Culemborg

(0.1 ppm F). Child participants in a fluoride programme at the Amsterdam dental school were assessed for fluorosis and 74% showed signs of mild to moderate fluorosis (42). The daily intake of fluoride tablets and use of 0.15% F toothpaste were thought to explain the high prevalence. A study carried out in Denmark in a low-fluoridation area looked at the prevalence of fluorosis among children participating in a nonsupervised fluoride tablet programme. The prevalence of fluorosis was shown to be 15% (43). The prevalence of caries and fluorosis in Italian communities with varying concentrations of water fluoridation was studied (44). Results showed that 95% of the children in the low-fluoride area had no evidence of fluorosis compared with 55% in the high-fluoride area.

Direct comparison of these fluorosis data from various European countries is difficult because of inherent differences in water consumption, climate, nutrition, living standards and availability of other fluoride sources within the different countries. Additionally the studies have all used different methods and a variety of measurement indices. The findings of several of the studies reviewed in this paper are shown in Table 3. The diversity of approaches to the measurement of this condition and the resulting difficulties in drawing comparisons are obvious. The overall results appear to show a trend towards higher fluorosis/diffuse opacities prevalence in fluoridated areas but where supplements such as fluoride tablets, for example, are used the prevalence in nonfluoridated areas approaches that in fluoridated areas. Some of the data suggest that diffuse enamel defects and fluorosis are more prevalent in fluoridated communities and that prevalence at the very mild level may be increasing. Further follow-up studies specific for fluorosis with standardization of experimental methodology are needed to evaluate and monitor the trends in prevalence of fluorosis more rigorously. Use of a standardized photographic approach would allow the development of protocols where the evaluation of fluorosis on the upper anterior teeth could be carried out under controlled circumstances. The images could be read by trained and calibrated examiners, blinded to the fluoridation status of the subject. Images could be double scored and cross-checked with development of consensus on the divergent scores. Such an approach would reduce the variation due to subjectivity in the measurement of diffuse opacities and fluorosis and would allow standardized geographic and temporal comparisons.

## Risk factors for the development of fluorosis

Although the early studies (11–13) indicated a 7–16% prevalence of fluorosis within an optimally fluoridated population it is thought that there is no specific threshold intake of fluoride below which fluorosis will not occur (45). What is of importance is to know at what level fluorosis becomes clinically apparent and potentially unaesthetic. The degree of fluorosis is related to the timing, duration and dose of fluoride exposure. The teeth of prime aesthetic concern, the permanent central incisors, are considered to be most at risk for fluorosis between the ages of 21 and 30 months for females and 15 and 24 months for males (46). Other studies have suggested an earlier at risk period during the first year of life for fluorosis development (47) and a meta-analysis of the available data concluded that no specific period of enamel formation could be singled out as being the most critical for the development of dental fluorosis. The duration of fluoride exposure during the amelogenesis, rather than specific risk periods, seemed to explain the development of dental fluorosis in the maxillary permanent central incisor (48). Increased fluorosis levels above those observed by Dean usually occur as a result of increased intake of fluoride from sources other than drinking optimally fluoridated water. It has been suggested that 60% of the total prevalence of fluorosis is attributable to fluoride sources other than water (49) and that the increase in fluorosis has been significantly greater in nonfluoridated than in fluoridated communities (14). Fluoridated toothpaste was first introduced into Europe in 1962 in Finland and now accounts for over 90% of the market in many countries including Portugal, Republic of Ireland, UK, Belgium, the Netherlands, France, Germany, Finland, Sweden, Denmark, Italy and Greece (9). The concentration of fluoride in toothpaste ranges from 500 to 1500 ppm. A direct relationship between concentration and effectiveness has been established with an increased benefit of 6% for each 500 ppm over 1000 ppm (50) whereas the effectiveness of toothpastes with $<$500 ppm has not been established.

Use of fluoride toothpastes by young children has been reported as a potential risk factor for fluorosis in a number of studies in fluoridated (34, 51–58) and nonfluoridated areas (52, 56, 59–61). Studies have been conducted in many regions of the world including Europe (34, 53, 56, 59), Canada (51), the USA (52, 54, 57, 58, 60, 61) and Australia (55). In

Table 3. Prevalence of fluorosis (fluorosis percentage) or diffuse opacities reported in studies on children in European countries 1983–98 with varying exposures to fluoride

| Country | Year | Index | Lighting | Age group | Fluoride | Fluorosis percentage[a] | Comments |
|---|---|---|---|---|---|---|---|
| UK (29) | 1993 | DDE | Natural, teeth wet | 12 | 10% of population in England have water fluoridation | 20 | Prevalence of diffuse opacities. Combinations of defects excluded as they are not mutually exclusive |
| England | | | | | | 22 | |
| Wales (national representative sample) | | | | | | 17 | |
| Scotland | | | | | | 16 | |
| Northern Ireland | | | | | | 8 | |
| Germany (36) | 1994 | DDE | Natural, teeth wet | 8.5–10 | Most water low in fluoride | | Combinations of defects were allocated the score of a single defect. Supplement group given supplements since birth |
| Supplement group | | | | $n = 158$ | | 18 | |
| Control group | | | | $n = 158$ | | 8 | |
| Belgium (38) | 1983 | TF | Artificial, teeth dried | 12 $n = 496$ | Low fluoride in water 0.1–0.2 ppm | 5 | Increase in percentage brushing twice per day (36–52) and using fluoride tablets (5–31%) between 1983 and 1998 |
| | 1998 | | | 12 $n = 533$ | | 30 | |
| France (39, 40) | 1991 | Dean's | Not stated | 6–15 $n = 18, 786$ | Fluoridated salt from 1987 | 4 | No supplements during period of tooth formation |
| Holland (41) | 1989 | TF | Teeth dry | 15 | At age 6 supplements used by 53% in Tiel and 30% in Culemborg water not fluoridated | | Fluorosis increased with increasing tablet use |
| Tiel | | | | | | 24 | |
| Culemborg | | | | | | 22 | |
| Denmark (43) | mid-1980s | TF | Teeth dry | 11 $n = 86$ | No tablets used | 15 | 56 subjects in other (study) group who were regular users of fluoride tablets from 18 months to 6 years had higher prevalence, actual figure not stated |
| Italy (44) | 1997 | Dean's | Not stated | 12 | | | |
| Catanzaro | | | | 462 cr[b] | Catanzaro = 0.3 mg/L | 5 | Questionable score not included |
| Naples | | | | 553 cr[b] | Naples = 2.5 mg/L | 45 | |

[a]Fluorosis at the very mild or greater levels, does not include fluorosis at the questionable level.
[b]cr, continuous residents since birth.

areas with water fluoridation the age at which brushing commenced (34, 51–53, 58) the frequency of brushing (53, 54, 57), the fluoride concentration (53, 56) and the amount of toothpaste applied to the toothbrush (53) and subsequently swallowed (53, 55) have all been implicated as potential fluorosis risk factors. In nonfluoridated areas age of commencement of brushing has been associated with fluorosis (52, 59, 61). Other factors implicated as potential fluorosis risk factors in fluoridated areas were inappropriate fluoride-supplement use (57, 58), infant formula use in the form of powdered concentrate (51, 57, 58), early weaning from breast feeding (55) and higher socioeconomic status (53, 56). In nonfluoridated areas fluoride-supplement use (52, 59–61) and higher socioeconomic status (56, 60) were associated with fluorosis.

Fluoride works best to prevent caries when a constant low ambient level of fluoride is maintained in the oral cavity (62). The major caries inhibitory effect of fluoride is posteruptive (63, 64). As there is no major benefit to be gained from fluoride ingestion during infancy it would appear reasonable to limit intake of fluoride to less than that estimated to be associated with increased risk of fluorosis. Preventive measures to minimize risk factors for fluorosis on aesthetically important anterior teeth include supervision of toothbrushing by children under 5 years, dispensing pea-sized quantities of toothpaste, and stringent criteria applied to the administration of fluoride supplements to children (15).

## Aesthetic concerns

The pioneering studies carried out in the process of developing Dean's Index were conducted during the period of the Depression in the USA and the aesthetic issue may have a different priority in today's economic climate. To date there is no index that objectively assesses the aesthetic ramifications of fluorosis as perceived by the community. Numerous studies have focused on establishing and evaluating the risk factors for dental fluorosis but there is a need also to investigate and address the public-health issue of aesthetics in relation to fluorosis. It is important for public-health authorities to have relevant and scientifically sound information from which to formulate public policy and set up prevention protocols. It is accepted that some dental fluorosis is unavoidable where there is a system of water fluoridation (40) and although fluorosis has not aroused public interest to date it is likely that the issue may be raised at some stage in the public arena in the future. An objective method for measuring the magnitude of the concern surrounding the aesthetics issue in relation to fluorosis is therefore required to validate any risk–benefit decision to be made.

The whole issue of aesthetics is complex and studies show that physical attractiveness is psychologically important, particularly to children and young adults. Society as a whole judges attractive people as generally more socially desirable than those who are less attractive and studies have shown that the oral region is of primary importance in determining overall facial attractiveness (65, 66). Interestingly, it has been proposed (67) that those with moderate to severe facial disfigurement suffer less psychological distress than those with a mild disfigurement. This is explained in part by the fact that those with more severe deformity appear to accept their condition as opposed to those with mild deformity who resent their deviation from the norm. Dental appearance is an important contributor to one's self-perceived body image (68). The orthodontic literature has shown that in excess of 80% of orthodontic patients seek out treatment for reasons of aesthetics rather than function or health (69). Mild fluorosis is seen by dental professionals to be of little cosmetic consequence but to the person involved it may be an aesthetic problem (70).

Hawley et al. (71) looked at fluorosis in a nonfluoridated community and the teenage subjects when questioned expressed concern over the appearance of teeth on photographs with a TF score of 3 or higher. Clark et al. (72) showed that out of a sample of 681 children with fluorosis 3% of the children and a slightly higher proportion of parents perceived there to be an aesthetic problem. TSIF score 1 accounted for the majority of cases and in the main neither children nor parents expressed concern about the aesthetics at this level. Riordan (73) also looked at the aesthetic concern expressed by nondental personnel with regard to fluorosis. When the TSIF score was 0 most assessors were unconcerned and as the TSIF score increased the level of concern increased to the level of TSIF score 3 where the majority felt treatment was warranted. The nondental personnel felt that high TSIF scores indicated neglect on behalf of the child. Contrary to the nondental personnel, dentists felt that severe fluorosis would be a greater issue for girls than boys. Ellwood and O'Mullane (74) found that dentists responded with more aesthetic concerns than lay people. Lalumandier and Rozier (75) assessed parental concern about aesthetics and concern levels

rose as the TSIF scores increased. Clark (76) showed that parents, children and dentists could all easily distinguish between the colour of teeth with different TSIF scores and that higher scores were associated with increasingly negative opinions. If it is established that there is a public-health problem in relation to cosmetic concerns of fluorosis the conditions under which fluorosis becomes clinically detectable and clinically unacceptable must be ascertained.

## Conclusion

In essence, the prevalence and trends in the prevalence of fluorosis across Europe are difficult to ascertain because of the complexity and inaccuracy in comparing studies of differing methodology carried out in the various countries. To date fluorosis does not appear to be of public-health concern in any of the countries discussed but to ensure continued support for the preventive use of fluoride the extent and severity of fluorosis must be monitored. However, there is an urgent need for researchers in Europe and elsewhere to adopt a standardized approach to the measurement of fluorosis. The use of a standardized photographic method would ensure that gathered information could be assessed by a number of indices at any point in time. There is a need to co-ordinate studies and to determine in more detail the aesthetic impact of fluorosis. Development of the profile of risk factors for fluorosis in the different countries is important as is the need to review regularly in each country the level of fluoride required for maximum preventive benefits with minimal associated cosmetic effects.

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