Community Dent Oral Epidemiol 1997; 25: 251–5
Printed in Denmark . All rights reserved

Community Dentistry and Oral Epidemiology
ISSN 0301-5661

Two types of intraoral distribution of fluorotic enamel

W. H. van Palenstein Helderman[1], L. Mabelya[2], M. A. van't Hof[3] and K. G. König[4]
[1]WHO Collaborating Centre for Oral Health Care Planning and Future Scenarios, Faculty of Dentistry, University of Nijmegen, [2]Department of Community and Preventive Dentistry, Muhimbili University College of Health Sciences, Dar-es-Salaam, Tanzania, [3]Department of Medical Statistics and [4]Department of Preventive Dentistry, University of Nijmegen, The Netherlands

van Palenstein Helderman WH, Mabelya L, van't Hof MA, König KG: Two types of intraoral distribution of fluorotic enamel. Community Dent Oral Epidemiol 1997; 25: 251–5. © Munksgaard, 1997

Abstract – Different distributions of fluorotic dental enamel within the dentition have been described in the literature. This report describes two patterns of intraoral distribution. In nine Tanzanian low fluorosis communities with a prevalence of pitting fluorosis of less than 2% and in five moderate fluorosis communities with a prevalence of pitting fluorosis of 16–59%, incisors and first molars were the least affected teeth. In four high fluorosis communities with a prevalence of pitting fluorosis of 86–97%, maxillary incisors exhibited lower Thylstrup-Fejerskov Index values than the maxillary canines, premolars and molars. The mandibular teeth exhibited increasing Thylstrup-Fejerskov Index values from the anterior to the posterior region. The curves presenting the intraoral distribution of the severity of dental fluorosis corresponded with the curve presenting the completion time of primary enamel formation of the various tooth types, with the exception of the first molars in high fluorosis communities. The similarity of the curves suggests that the later in life enamel is completed, the higher is the severity of dental fluorosis. This relation seems to be explained by the prevailing feeding and dietary habits, which result in minimal intake of fluoride in the first 18 months of life during breastfeeding, followed by increasing fluoride ingestion in the following years through consumption of tea, seafish and F-containing magadi salt.

Key words: dental fluorosis; fluoride

W. H. van Palenstein Helderman, WHO Collaborating Centre, Dentistry (117), P.O. Box 9101, 6500 HB Nijmegen, The Netherlands
Fax: +31 243 540265

Accepted for publication 4 August 1996

There is no unanimity about the intraoral distribution of signs of dental fluorosis. There is consensus though that contralateral teeth exhibit similar severity of fluorosis (1, 2). To a certain extent there is also consensus regarding the similarity in the distribution of fluorotic enamel among corresponding tooth types in the maxilla and the mandible (1, 2). However, the severity of fluorosis in different tooth types has been reported to vary and different intraoral distributions have been described. Most studies report that the incisors and first molars show less severe dental fluorosis than the canines, premolars and second molars (3–7). One study reports that the maxillary incisors had the highest score and the first molars the lowest score (8). In contrast, another study shows that the first molars are the most severely affected tooth type (2). An increase in severity of fluorosis from anterior to posterior teeth has also been observed (1). Studies conducted in countries of the industrial world among populations in low fluoride areas receiving fluoride supplements for caries prevention report distributional patterns of fluorosis which are different from those described in the studies cited above (9, 10).

This report contains findings from a cross-sectional survey on dental fluorosis in different geographical areas in Tanzania, where parts of its population are exposed to high fluoride drinking waters or diets or both. Three reports based on findings from that survey have been published. One contained a comparison of two fluorosis indices (11) and the other two presented findings on the prevalence and severity of dental fluorosis in relation to fluoride exposure (12, 13). This report contains findings on the intraoral distribution of signs of fluorosis in areas with different degrees of fluorosis and in addition it gives a

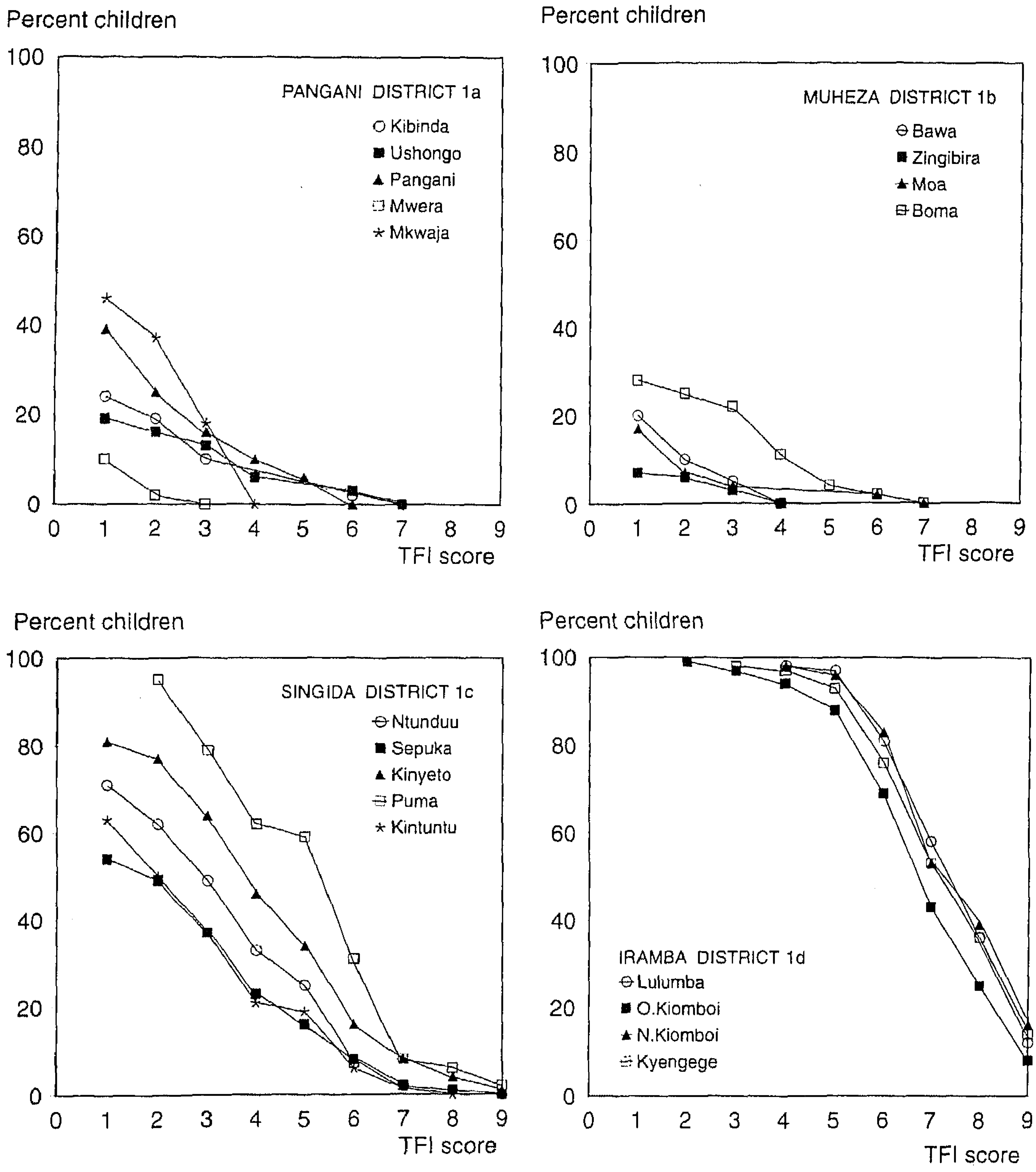

Fig. 1. Cumulative frequency distribution of children (in 18 villages of 4 districts) according to the highest TFI score of their dentition.

possible explanation for the differences in the distribution patterns of fluorotic enamel within the dentition.

Material and methods

The coastal districts Pangani and Muheza and the inland districts Singida and Iramba in the west of Tanzania at 1500 m altitude were the areas where the study was conducted. Table 1 presents the sample size and some relevant characteristics of these districts (13). The method of selecting 18 villages in these districts is described in detail in a separate article (13).

All children aged 12–17 years (n= 1566) attending primary school who had been born and raised in the respective villages were examined for dental fluorosis. Each child was examined in a portable chair under natural daylight in a shaded area by L.M. Buccal surfaces of all erupted permanent teeth, except the third molars, were wiped with cottonwool and dried using an air-blower; then cotton rolls were put in place and left for 2 min before examination. Teeth were scored according to the Thylstrup-Fejerskov Index (TFI) (1). Permanent teeth with the buccal surface less than half erupted were excluded. Enamel changes which are not described by the TFI were excluded from scoring. In case of doubt as to which TFI score should be given, the lower score was chosen.

Duplicate examinations were performed in 111 children from the 18 villages. A measurement error occurred in 4.5% of all scores. The weighted Kappa appeared to be 0.87 and the

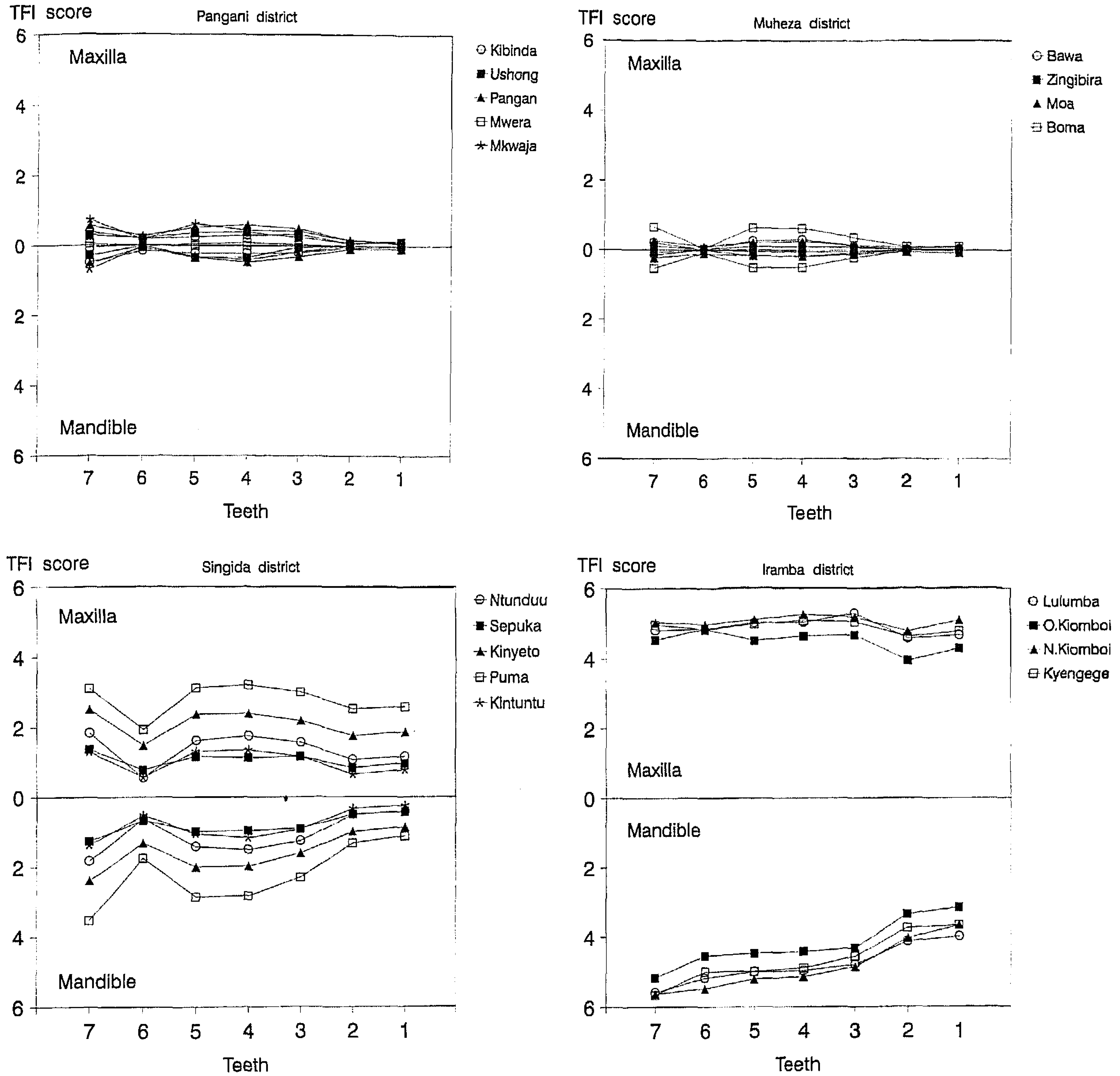

Fig. 2. Mean TFI score per tooth type in all 18 villages grouped per district.

measurement-remeasurement correlation was 0.97.

Results

Fig. 1 shows the prevalence and severity of dental fluorosis among children in the 18 villages. The cumulative frequency distribution figures reveal a prevalence of fluorosis of up to 46% in the villages of the two coastal districts. Severe fluorosis with enamel pitting (TFI>4) occurred on average in less than 2% of the children. In contrast, the Singida district showed an overall higher prevalence of fluorosis of 53% to 95% in different villages. Severe fluorosis (TFI>4) was seen in 16% to 59% of the children in the different villages. In the Iramba district the overall prevalence was almost 99%, with 86% to 97% of the children having severe fluorosis in the different villages.

The intraoral distribution of the severity of fluorotic enamel in the nine villages in the two coastal districts Pangani and Muheza was comparable, with the incisors and first molars having the lowest TFI values (Fig. 2). In addition, the intraoral distribution in the maxilla and mandible appeared to be similar. A comparable pattern of distribution of fluorotic enamel of the different tooth types, though on a higher TFI level than in the coastal villages, was found in the five villages in the Singida district. In contrast, the four villages in the Iramba district showed a different intraoral distribution of fluorotic enamel (Fig. 2). Firstly, the intraoral distribution of fluorotic enamel in the maxilla and in the mandible in Iramba was different. Secondly, the maxillary incisors exhibited lower TFI values than the maxillary canines, premolars and molars, whereas the mandibular tooth types exhibited an increased TFI value from anterior to posterior teeth.

Table 1. Sample size and characteristics of the districts investigated

District	Children *n*	Location	Altitude m	Water mean F mg/L	Magadi salt mean F mg/L
Pangani	233	NE coast	sea level	0.2–0.6	not used
Muheza	291	NE coast	sea level	0.3–0.8	not used
Singida	588	Mid-west	1500	0.4–0.7	128
Iramba	454	Mid-west	1500	0.4–0.8	2638

Discussion

The present study revealed two patterns of fluorotic enamel within the dentition. One pattern was found in the low to moderate fluorosis communities and another pattern was seen in high fluorosis communities. The pattern of the intraoral distribution of fluorotic enamel in the present low to moderate fluorosis communities is similar to the pattern found in other low to moderate fluorosis communities (3–7). The pattern of fluorotic enamel within the dentition in the present high fluorosis communities shows similarities with the pattern reported in a corresponding high fluorosis community in Tanzania (1).

The intraoral distribution of the severity of dental fluorosis has been suggested to depend either on the thickness of the enamel (1) or on the length of the enamel formation period (14). The two patterns of intraoral distribution of fluorotic enamel in this study do not clearly correspond with the thickness of the enamel.

Fig. 3 depicts the age at the start and the end of primary enamel formation of the various teeth (15). Some data (10) support the hypothesis that fluorosis may continue to develop for 1 to 2 years after the end of primary enamel formation but omission of this maturation period does not influence the shape of the curve indicating the end of primary enamel formation. Fig. 3 shows that the length of the enamel formation period does not correspond with the severity of fluorotic enamel of the respective teeth. For instance, the canines have the longest enamel formation period, but they are not the most severely affected tooth type according to Fig. 2. The curve indicating the end of primary enamel formation matches well with the curves presenting the intraoral distribution of the severity of fluorosis in the low and moderate fluorosis areas (Fig. 2). The similarity of the curves seems to support the hypothesis (10) that the later in life enamel formation is completed, the more severely the teeth will be affected.

An explanation for this can be found in the local conditions regarding the intake of fluoride. The investigated villages had drinking water with a low F content (Table 1). The people in low fluorosis villages in the coastal districts drink a lot of tea and eat a lot of seafish (12, 13), whereas those in moderate fluorosis villages in the Singida district consume fluoride-containing magadi salt (Table 1). Children in these communities are not likely to ingest much fluoride in the first year of life. In rural Tanzania 75% of the infants are still breastfed on demand up to the age of 18 months (16). Breast milk contains very low F concentrations, regardless of the amount of fluoride ingested by the mothers (17, 18). During weaning, the children start to eat the same food as the adults, resulting in a gradual increase in the intake of dietary fluoride with age. Thus the fact that these communities exhibited more severe fluorosis in teeth completed later in childhood than in teeth completed earlier seems to be explained by the prevailing feeding and dietary habits which result in increasing fluoride ingestion with age.

Although the above provides a likely explanation for the observed intraoral distribution of fluorotic enamel in low and moderate fluorosis communities, the effect of wearing of the outermost porous enamel surface soon after eruption of teeth, which has been suggested to occur (1), cannot be excluded as an alternative explanation. Such a mechanism could explain the relatively low TFI values of incisors and first molars in the examined children aged 12–17 years in the present low and moderate fluorosis communities. However, it is yet uncertain if wearing could decrease the TFI values, since this has not been substantiated by data from longitudinal studies on dental fluorosis.

A correspondence between the curve indicating the completion time of primary enamel formation and the curves showing the intraoral distribution of the severity of fluorotic enamel in high fluorosis communities was less evident.

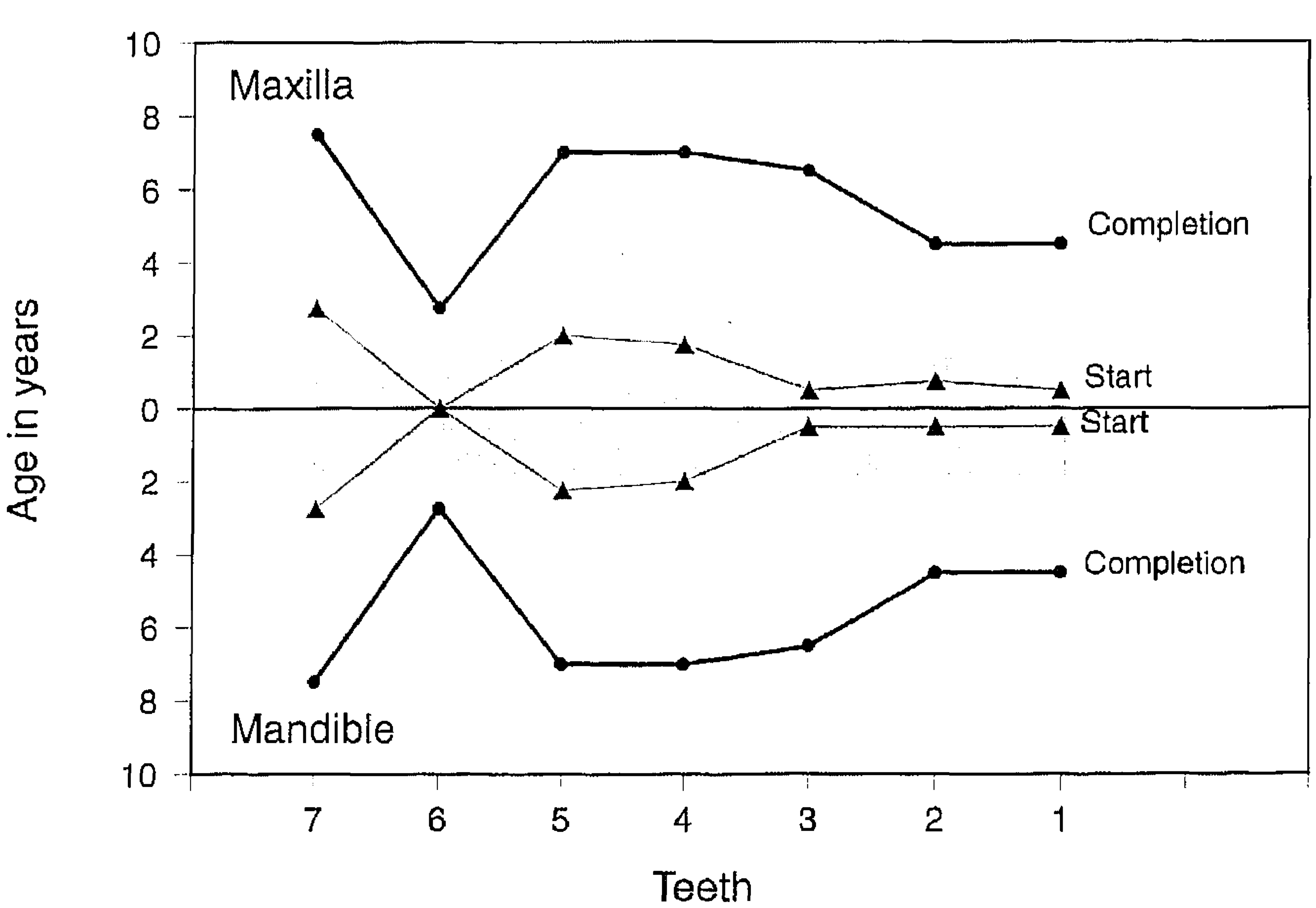

Fig. 3. Starting time and time of completion of primary enamel formation per tooth type according to WATSON & LOWREY's data (15). The grey area indicates a period of 18 months during which 75% of the infants are breastfed (16).

Particularly the relatively high TFI values of the first molars did not match with the curve of the completion time of primary enamel formation. Pitting of the enamel is known to occur posteruptively (1, 19). The severity of pitting is determined by both the degree of porosity of the enamel at the time of eruption and the extent of exposure of the tooth surface to masticatory forces. THYLSTRUP (19) has described the occurrence of pitting of permanent incisors soon after eruption in a 6-year-old girl. He observed less severe pitting of the incisors 1.5 years after eruption than after 1 year. Another study with a cross-sectional study design suggested that pitting of the enamel surface continues for several years after eruption, resulting in higher TFI values (20). Epidemiological data from longitudinal observations are lacking, and hence it remains unclear whether the relatively high TFI values of the first molars in the 12–17-year-old children of a high fluorosis community are the result of continued pitting.

In conclusion, two patterns of distribution of fluorotic enamel within the dentition were described, one in a low to moderate fluorosis area and one in a high fluorosis area. The intraoral distribution of the severity of dental fluorosis was related to the completion time of primary enamel formation of various teeth, with the exception of the first molars in high fluorosis communities.

References

1. THYLSTRUP A, FEJERSKOV O. Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dent Oral Epidemiol* 1978; *6:* 315–28.
2. MANJI F, BAELUM V, FEJERSKOV O. Dental fluorosis in an area of Kenya with 2 ppm fluoride in the drinking water. *J Dent Res* 1986; *65:* 659–62.
3. LARSEN MJ, KIRKEGAARD E, POULSEN S. Pattern of dental fluorosis in a European country in relation to the fluoride concentration of drinking water. *J Dent Res* 1987; *66:* 10–2.
4. NANDA R, ZIPKIN I, DOYLE J, HOROWITZ HS. Factors affecting the prevalence of dental fluorosis in Lucknow, India. *Arch Oral Biol* 1974; *19:* 781–92.
5. LARSEN MJ, KIRKEGAARD E, POULSEN S, FEJERSKOV O. Enamel fluoride, dental fluorosis and dental caries among immigrants to and permanent residents of five Danish fluoride areas. *Caries Res* 1986; *20:* 349–55.
6. MANJI F, BAELUM V, FEJERSKOV O. Fluoride, altitude and dental fluorosis. *Caries Res* 1986; *20:* 473–80.
7. NG'ANG'A PM, VALDERHAUG J. Prevalence and severity of dental fluorosis in primary schoolchildren in Nairobi, Kenya. *Community Dent Oral Epidemiol* 1993; *21:* 15–8.
8. MØLLER IJ, PINDBORG JJ, GEDALIA I, ROED PETERSEN B. The prevalence of dental fluorosis in the people of Uganda. *Arch Oral Biol* 1970; *15:* 213–25.
9. LARSEN MJ, KIRKEGAARD E, FEJERSKOV O, POULSEN S. Prevalence of dental fluorosis after fluoride gel treatment in a low fluoride area. *J Dent Res* 1985; *64:* 1076–9.
10. LARSEN MJ, RICHARDS A, FEJERSKOV O. Development of dental fluorosis according to age at the start of fluoride administration. *Caries Res* 1985; *19:* 519–27.
11. MABELYA L, VAN'T HOF MA, KÖNIG KG, VAN PALENSTEIN HELDERMAN WH. Comparison of two indices of dental fluorosis in low, moderate and high fluorosis Tanzanian populations. *Community Dent Oral Epidemiol* 1994; *22:* 415–20.
12. MABELYA L, KÖNIG KG, VAN PALENSTEIN HELDERMAN WH. Dental fluorosis, altitude and associated dietary factors. *Caries Res* 1992; *26:* 65–7.
13. MABELYA L, VAN PALENSTEIN HELDERMAN WH, VAN'T HOF MA, KÖNIG KG. Dental fluorosis and use of a high fluoride-containing trona tenderizer (magadi). *Community Dent Oral Epidemiol* submitted.
14. DEAN HT, ELVOVE E. Some epidemiological aspects of chronic endemic dental fluorosis. *Am J Publ Health* 1936; *26:* 567–75.
15. WATSON EH, LOWREY GH. *Growth and development of children.* Chicago: Year Book Medical Publ., 1962.
16. MATEE MIN, VAN'T HOF MA, MASELLE SY, MIKX FHM, VAN PALENSTEIN HELDERMAN WH. Nursing caries, linear hypoplasia, and nursing and weaning habits in Tanzanian infants. *Community Dent Oral Epidemiol* 1994; *22:* 289–93.
17. EKSTRAND J, SPAK CJ, FALCH J, AFSETH J, ULVESTAD H. Distribution of fluoride to human breast milk following intake of high doses of fluoride. *Caries Res* 1984; *18:* 93–5.
18. OPINYA GN, BWIBO N, VALDERHAUG J, BIRKELAND JM, LÖKKEN P. Intake of fluoride and excretion in mothers' milk in a high fluoride (9 ppm) area in Kenya. *Eur J Clin Nutr* 1991; *45:* 37–41.
19. THYLSTRUP A. Posteruptive development of isolated and confluent pits in fluorosed enamel in a 6-year-old girl. *Scand J Dent Res* 1983; *91:* 243–6.
20. BAELUM V, MANJI F, FEJERSKOV O. Posteruptive tooth age and severity of dental fluorosis in Kenya. *Scand J Dent Res* 1986; *94:* 405–10.