

Erosion, caries and rampant caries in preschool children in Jeddah, Saudi Arabia

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Abstract – Objectives: The objective of this study was to determine the prevalence of dental erosion in preschool children in Jeddah, Saudi Arabia, and to relate this to caries and rampant caries in the same children. **Methods:** A sample of 987 children (2–5 years) was drawn from 17 kindergartens. Clinical examinations were carried out under standardised conditions by a trained and calibrated examiner (M.Al-M.). Measurement of erosion was confined to primary maxillary incisors and used a scoring system and criteria based on those used in the UK National Survey of Child Dental Health. Caries was diagnosed using BASCD criteria. Rampant caries was defined as caries affecting the smooth surfaces of two or more maxillary incisors. **Results:** Of the 987 children, 309 (31%) had evidence of erosion. For 186 children this was confined to enamel but for 123 it involved dentine and/or pulp. Caries were diagnosed in 720 (73%) of the children and rampant caries in 336 (34%). The mean dmft for the 987 children was 4.80 (± 4.87). Of the 384 children who had caries but not rampant caries, 141 (37%) had erosion, a significantly higher proportion than the 72 (27%) out of 267 who were clinically caries free (SND=2.61, $P < 0.01$). Of the 336 with rampant caries, 96 (29%) also had evidence of erosion. **Conclusions:** The level of erosion was similar to that seen in children of an equivalent age in the UK. Caries was a risk factor for erosion in this group of children.

Key words: caries; erosion; preschool children; relation between caries and erosion

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Dental caries continues to play a dominant role in thinking and practice in child oral health throughout the world but tooth wear and, more particularly, erosion have emerged more recently as a problem affecting children and adolescents. Erosion is a direct result of chemical action on the tooth surface and is caused primarily by acids. These may include gastric acid that comes into contact with the teeth during regurgitation or, more often, acid contained in the diet (1). The type of acid, the nature of the food or drink which contains it and the pattern of consumption are all believed to be important in determining the effects of the acid. Subjects may also vary in their susceptibility to erosion, and saliva is believed to exert an important influence on the occurrence and severity of erosion as well as caries (2). Many foods and drinks

that are acidic in nature are also high in non milk extrinsic sugars so that caries and erosion might be expected to occur together in at least a proportion of cases. However, investigations of erosion have been largely confined to European countries, where caries has declined with time. It has been suggested that erosion may be more common amongst those who are less susceptible to caries (1–4) but there appears to have been little investigation of the relationship between the two. There has also been less consideration of erosion in countries and cultures, particularly developing countries, where caries affects a higher proportion of children.

Middle Eastern countries have undergone especially rapid development and modernisation with commensurate changes in lifestyle and diet for much of the population. These changes are likely

to have had an effect on oral health. In Saudi Arabia, for example, traditional dietary habits and practices have continued but foods and drinks typical of westernised diets are now cheap and readily available, particularly in major cities.

As in many developing countries, a high proportion of the population of Saudi is under 15 years of age and recent studies have demonstrated that caries represents a particular problem amongst children in Saudi (5–7). In most cases, information has been confined to school children but there have been a small number of studies of younger age groups. In one, a mean dmft of 1.2 was reported for 3–5-year-olds attending a dental clinic in Gizan in 1985 (8). In a second study, published after an interval of more than 10 years, a mean dmft of 6.9 per child was reported for a large sample of 4.5-year-old children in Riyadh (9). Whilst these studies have demonstrated the very high prevalence of disease, there has been little or no information about erosion in children in the kingdom.

Jeddah, one of the three major cities in Saudi Arabia and the largest city of the Western Province, lies on the Red Sea Coast and has a population of approximately 2 million. Like other cities in the Gulf region, Jeddah has expanded greatly over the last 30 years.

The aims of this study were to determine the prevalence of erosion in a sample of children attending kindergarten schools in Jeddah and to relate the presence of erosion to that of caries and rampant caries in the same group of children.

Material and method

The sample was drawn from 2–5-year-old children attending kindergarten schools in Jeddah. All those included had lived in the kingdom throughout their lives. Agreement for the study was obtained from the Ministry of Higher Education and President General for Girls Education office in Saudi.

A list of all kindergarten schools in the city was obtained from the Department of Education of the Western Province. The schools were stratified according to funding sources (private or public) and by area of the city (north, south, east and west). Of the 152 schools listed, 20 were public schools, attended by 2621 children. The remaining 132 were private schools attended by 11 317 children during 1997–98.

Sampling was carried out to include 400 children from public schools (100 from each area of the city) and 600 children from private schools (150 from

each area). These numbers were designed to allow estimation of the effect of school type attended as well as providing a reasonable representation of children in the city.

A total of 17 primary schools (6 public and 11 private) were randomly selected from each of the four geographic areas of the city (north, south, east and west). Letters were sent to parents requesting consent to their child being examined in schools and asking them to complete a short questionnaire. All children in selected schools were eligible to take part. Forms were therefore sent to parents of a total of 1554 children. These were returned for 1063. Of those children for whom forms were returned, 33 were absent at all visits to the school and 43 were unable to co-operate sufficiently to take part. Results for the clinical examination therefore relate to the 987 children who were dentally examined in schools.

Examinations were carried out for caries, rampant caries and for erosion of maxillary incisor teeth. Children were examined by one examiner (M.Al-M.) in a classroom at the school under standardised lighting conditions using a Daray light (Daray lighting Ltd, Leighton Buzzard, Luton, UK). Each child was examined supine and data recorded by a trained assistant. Diagnosis was visual with a plane mouth mirror used to assist visibility and cotton rolls employed to remove any plaque or debris where necessary.

All teeth and surfaces were examined for caries using BASCD criteria and scoring system (10). Rampant caries was defined as occurring when caries affected smooth surfaces of two or more maxillary incisors (11, 12). Examination for erosion was confined to primary maxillary incisors and used the scoring system shown in Appendix 1, which has been tested previously (13). Wear for all surfaces was noted but, for the purposes of the study and as in previous surveys of erosion in primary teeth (14–16), only erosion affecting palatal and/or buccal surfaces was scored as erosion, wear confined to incisal surfaces was excluded from further analysis.

Training and calibration exercises were conducted prior to the study. Duplicate examinations of a total of 30 children aged 4–5 years attending two kindergarten schools by two examiners (M.Al-M., R.D.H.), gave an inter-examiner kappa value of 0.85 for surfaces diagnosed as carious. Repeat examinations of 30 children were made during the study to check intra-examiner reproducibility of caries and erosion. Results yielded a kappa value

of 0.96 for surfaces diagnosed as carious, and 0.92 for surfaces diagnosed as having erosion.

For each child a questionnaire was supplied to parents through the school to be completed before the examination was carried out. This included general information on the child's age and gender, any chronic illness and medication taken by the child, as well as socio-economic questions including parental occupation and education.

For the purpose of this paper, school type and social class based on father's occupation were used as indicators of social class. The classification of occupations was based on that utilised in the Oral Health Survey of Saudi Arabia in 1991 (17) and was analogous to the Registrar-General's Classification of Occupations (18).

Results

A total of 987 children aged 2–5 years were included in the study: 511 boys and 476 girls. The youngest was 2 years 11 months and the oldest 5 years 9 months. There were 113 children aged 3, 459 aged 4 and 415 aged 5. In all, 642 of the children were from private schools and 345 from kindergartens that were publicly funded.

Prevalence of erosion, caries and rampant caries (Table 1)

The prevalence of erosion and of caries and rampant caries is shown in Table 1. Estimates are given separately for children from private and publicly funded kindergartens and for the sample as a whole. To allow for the disparity between sample and population in the type of school attended, weighted estimates of prevalence and of dmft and dmfs are also given in this table.

Of the 987 children included in the survey, 309 (31%) had evidence of tooth tissue loss affecting labial and/or palatal surfaces of one or more of

their maxillary incisors at clinical examination. These children were regarded as having loss that was wholly or partly a consequence of erosion. In the case of a further 389 (39%), wear was visible but was confined to the incisal edges of the teeth (wear involving incisal edges was also seen in 292 of the 309 children with erosion). There was little difference in prevalence of erosion for the two types of school and the weighted estimates of prevalence for these two groups of children in the city were therefore almost the same (31%).

For those children with erosion, the mean number of teeth affected was 2.7 (± 0.97) per child.

There was evidence of caries in 720 children in the sample (73%) and 336 children (34%) were diagnosed as having rampant caries (Table 1). Equivalent weighted estimates for the population were 72% with caries and 33% with rampant caries. Mean dmft for the sample studied was 4.80 (± 4.87) per child. This average dmft was made up of 3.97 decayed, 0.32 missing and 0.51 filled teeth. Mean dmfs was 12.67 (± 15.46), similarly composed of 9.87 decayed, 1.33 missing and 1.48 filled surfaces.

Erosion in relation to age and to social class

The prevalence of erosion and its severity in relation to age and to social class based on the occupation of the head of household and the school type attended is shown in Table 2. For 186 of those with erosion this was scored as being confined to enamel (score 1) but for 123 it had extended into dentine (score 2) and/or pulp (score 3) of the tooth (Table 2).

The prevalence of erosion in relation to age (Table 2) showed some evidence of an increase with age: 164 (29%) of those aged 4 or less showed evidence of erosion compared to 145 (35%) of those aged 5, but this relationship was not statistically significant when tested. Neither prevalence nor severity was significantly related to gender.

Sixty (28%) of the children whose fathers were in

Table 1. Prevalence estimates for erosion, caries and rampant caries

	Public schools <i>n</i> (%)	Private schools <i>n</i> (%)	Total	Weighted estimate (%)
Erosion	106 (30.7%)	203 (31.6%)	309 (31.3%)	31.4%
Caries	266 (77.1%)	454 (70.7%)	720 (73%)	71.9%
dmft (\pm SE)	5.52 (± 0.28)	4.41 (± 0.18)	4.80 (± 0.16)	4.62 (± 0.15)
dmfs (\pm SE)	14.60 (± 0.91)	11.64 (± 0.57)	12.67 (± 0.49)	12.19 (± 0.47)
Rampant caries	137 (39.7%)	199 (31.0%)	336 (34.0%)	32.6%

Table 2. Prevalence and severity of erosion in relation to age group of children, social class based on father's occupation and school type

Factors	No. of children	No. (%) of children			
		With no erosion	With any erosion	With erosion confined to score 1	With erosion scored 2 or more
Age group					
3 years	113	82 (72.6)	31 (27.4)	17 (15.0)	14 (12.4)
4 years	459	326 (71.0)	133 (29.0)	83 (18.1)	50 (10.9)
5 years	415	270 (65.1)	145 (34.9)	86 (20.7)	59 (14.2)
Total	987	678 (68.7)	309 (31.3)	186 (18.8)	123 (12.5)
Father's occupation					
Higher professional	211	151 (71.6)	60 (28.4)	37 (17.5)	23 (10.9)
Professional	125	80 (64.0)	45 (36.0)	22 (17.6)	23 (18.4)
Middle class	461	312 (67.7)	149 (32.3)	96 (20.8)	53 (11.5)
Unskilled and Others	190	135 (71.1)	55 (28.9)	31 (16.3)	24 (12.7)
Total	987	678 (68.7)	309 (31.3)	186 (18.8)	123 (12.5)
School type					
Private	642	439 (68.4)	203 (31.6)	118 (18.4)	85 (13.2)
Public	345	239 (69.3)	106 (30.7)	68 (19.7)	38 (11.0)
Total	987	678 (68.7)	309 (31.3)	186 (18.8)	123 (12.5)

Table 3. Prevalence of caries and rampant caries, mean dmft and dmfs in relation to age group, social class based on father's occupation and school type

Factors	No. of children	No. (%) of children			
		With no caries	With rampant caries	dmft (\pm SD)	dmfs (\pm SD)
Age group					
3 years	113	69 (61.0)	35 (30.9)	3.59 (\pm 4.74)	8.64 (\pm 13.59)
4 years	459	335 (72.9)	156 (33.9)	4.82 (\pm 4.89)	12.56 (\pm 15.33)
5 years	415	316 (76.1)	145 (34.9)	5.09 (\pm 4.85)	13.90 (\pm 15.90)
Total	987	720 (72.9)	336 (34.0)	4.80 (\pm 4.87)	12.67 (\pm 15.46)
Father's occupation					
Higher professional	211	138 (65.4)	59 (28.0)	3.6 (\pm 4.02)	8.9 (\pm 11.75)
Professional	125	95 (76.0)	44 (35.2)	4.8 (\pm 4.8)	12.0 (\pm 14.02)
Middle class	461	341 (74.0)	166 (36.0)	5.21 (\pm 5.12)	14.05 (\pm 16.84)
Unskilled & Others	190	146 (76.8)	67 (35.3)	5.07 (\pm 4.95)	13.91 (\pm 15.87)
Total	987	720 (72.9)	336 (34.0)	4.80 (\pm 4.87)	12.67 (\pm 15.46)
School type					
Private school	642	454 (70.7)	199 (31.0)	4.41 (\pm 4.64)	11.64 (\pm 14.53)
Public school	345	266 (77.1)	137 (39.7)	5.52 (\pm 5.22)	14.60 (\pm 16.91)
Total	987	720 (72.9)	336 (34.0%)	4.80 (\pm 4.87)	12.67 (\pm 15.46)

χ^2 for difference in prevalence of caries in relationship to father's occupation=8.38, $P=0.039$.

χ^2 for difference in prevalence of rampant caries in relationship to father's occupation=4.47, $P=0.215$.

Mann-Whitney test for differences in dmft and dmfs between the school types: * dmft $P=0.002$, ** dmfs $P=0.009$.

the higher professions had erosion, as did 45 (36%) of those with fathers in professions, 149 (32%) of those with fathers from the middle class and 54 (28%) of those whose fathers held unskilled or other

occupations. Differences in relation to social class based on occupation were not statistically significant.

Prevalence and severity of erosion in relation to

school type suggested that there was also little difference in prevalence of this condition between children attending the two school types.

Prevalence of caries and rampant caries and dmft in relation to age and to social class

Prevalence of caries, rampant caries, dmft and dmfs values in relation to age are shown in Table 3. Prevalence and severity of caries and rampant caries according to the age group at the time of examination shows that prevalence increased with age, from 61% at age 3 up to 76% in 5-year-old children (for caries) and from 31% at age 3 up to 35% in 5-year-olds (for rampant caries). Similarly, dmft and dmfs increased with age.

The lowest prevalence of caries was seen in children from higher professional families. Prevalence in children from other social classes was little different. A similar pattern was seen in relation to rampant caries, with fewer children from higher professional families showing evidence of rampant caries. Differences in relation to social class were statistically significant ($P=0.039$) for caries but not for rampant caries.

In all, 454 (71%) children from private schools and 266 (77%) children from public schools had some caries experience. Comparison of the proportion of children with caries in each school type showed the difference between them of 6%, just statistically significant ($P<0.05$). Rampant caries (i.e. caries affecting smooth surfaces of two or more maxillary incisors) was diagnosed in 336 (34%) of all the children examined. This total included 199 (31%) children from private schools and 137 (40%) from public schools. As in the case of caries, comparison of the two sample proportions with rampant caries showed the difference of 9% between schools to be statistically significant ($P<0.01$). There was a difference between school types in dmft and dmfs (1.11 in dmft and 2.96 in dmfs) with

lower values for children in private schools. Differences were tested using Mann-Whitney U-tests and were confirmed as statistically significant.

The relationship between erosion and caries

The relationships between the presence of caries and of erosion and between the presence of rampant caries and of erosion are summarised in Table 4. Because of the the potential difficulty in measuring rampant caries and erosion in the same tooth surface, the relationship between the presence of caries excluding rampant caries and that of erosion was also considered and results included in Table 4. Of the 720 children who had any caries experience, 237 (33%) had evidence of erosion. This was 6% higher than the 27% of children without caries who had erosion. Fewer children with rampant caries (96 of the 336; 29%) had evidence of erosion than those without this form of disease (213 of 651; 33%). Neither of these differences was statistically significant. In contrast, the relationship between presence of caries excluding rampant caries and of erosion proved to be statistically significant ($z=2.61$, $P<0.01$). Of the 384 children who had caries but not rampant caries, 141 (37%) had erosion, a significantly higher proportion than the 72 (27%) out of 267 who were caries free (Table 4).

Multivariate analysis

Multivariate analysis was carried out using logistical regression analysis for the outcomes of erosion, caries and rampant caries.

All variables were included at the start and those failing to show a significant relationship were subsequently removed in a stepwise fashion. The final model summarised in Table 5 shows that the only factor remaining significant in the outcome of erosion was caries excluding rampant caries (OR=1.4). Confidence intervals showed that for children with

Table 4. Relationship between caries, rampant caries and erosion

	No. of children	No. (%) of children			
		With no erosion	With any erosion	With erosion confined to score 1	With erosion scored 2 or more
With caries but excluding rampant caries	384	243 (63.3)	141 (36.7)	84 (21.9)	57 (14.8)
With rampant caries	336	240 (71.4)	96 (28.6)	58 (17.3)	38 (11.3)
With any form of caries experience	720	483 (67.1)	237 (32.9)	142 (19.7)	95 (13.2)
Without caries on examination	267	195 (73.0)	72 (27.0)	44 (16.5)	28 (10.5)
Total	987	678 (68.7)	309 (31.3)	186 (18.8)	123 (12.5)

Table 5. Results of logistical regression for erosion, caries and rampant caries: regression coefficient (B), standard error (SE), significance (P), odds ratio (OR) with 95% CI for OR

	Variable	B	SE	P	OR	95% CI for OR	
						Lower	Upper
Erosion	Caries excluding rampant caries*	0.392	0.1399	0.005	1.480	1.125	1.948
Caries	School type*	0.562	0.1664	0.001	1.755	1.266	2.432
	Age*	0.440	0.1141	0.000	1.553	1.242	1.943
Rampant caries	School type*	0.476	0.1495	0.001	1.610	1.201	2.159

* Coding used:

Caries excluding rampant caries: 0=no caries, 1=caries excluding rampant caries.

School type: 1=private, 2=public. Age: 1=3 years old, 2=4 years old, 3=5 years old.

caries excluding rampant caries, the OR in the population was between 1.1 and 1.9.

In a similar analysis for caries, the final model showed that factors which were independently related to the disease were school type (OR=1.7) and the age of the child (OR=1.5). The final model related to rampant caries showed again the importance of school type (OR=1.6).

Discussion

This study was concerned with erosion, caries and rampant caries in children in Saudi Arabia. Caries is well recognised as a significant oral health problem in the country but little is known about erosion. Erosion, like caries, is a result of acid attack on the tooth surface and may have common risk factors.

The aim of the study was to determine the prevalence of erosion in 2–5-year-old preschool children in Jeddah, Saudi Arabia, and to relate the presence of erosion to that of caries and rampant caries. Sampling was based on schools that had been stratified into those privately and those publicly funded. Weighted estimates for the population were derived using SPSS but the design effect (of clustering) was not considered to be significant and was not included in the analysis. The study used positive consent with forms sent out through the schools; as a result a proportion of children did not take part.

It is apparent from the results that the prevalence of erosion in this age group falls within the range seen in the UK, being lower than was reported for 5–6-year-olds in the National Survey of Child Dental Health, where more than half were affected, and higher than the prevalence of approximately 20% reported for younger children (14, 15). The estimate is also little different from the 29% reported for 3-year-olds in East Cumbria (19). Findings were also

similar to results of these studies demonstrating that erosion occurs most often on palatal surfaces and that more central than lateral incisors are affected. In most children in the sample included in the present investigation who had evidence of erosion, two or more teeth affected. Similarly, in the study of 1.5–4.5-year-old children, where palatal and/or buccal erosion was present, more than two surfaces per child were affected (15).

In the current study, as in the large national studies in the UK, examination was confined to primary maxillary incisors. The higher prevalence of 50% seen in one study in the West Midlands may have been partly because all primary teeth were included, as well as a different index being used.

It has been emphasised that differentiation between causes of wear may be difficult. In this survey, as in previous studies in the UK, measurement was confined to palatal and labial surfaces and wear affecting incisal edges was specifically excluded. Had these surfaces been included in the present study, 698 children (71%) could be regarded as having some experience of tooth wear. That 292 out of 987 children (30%) had wear affecting incisal edges as well as erosion indicates that the two processes may well occur concurrently in a high proportion of cases. Exact distinctions may be especially difficult in these cases.

Findings gave little indication of any consistent relationship between erosion and social class measured through school type or father's occupation. The lack may be a real one and the effect of social factors on diet, for example, may not be sufficient to influence erosion. Findings of a relationship in past studies (16, 19, 20) may therefore have been chance results and a consequence of sampling variation. This may be borne out by the fact that no relationship was demonstrated in at least one previous large study (15). The absence may also have

been related to the methods of social class assessment employed. More conventional measures of socio-economic status such as those based on father's occupation, for example, are complex, often including more than one component. In Saudi Arabia, they may also be made more difficult to use by the pace of modernisation and social change affecting the country. The income of many people has increased greatly within a short time interval and their life styles and value systems may well have altered radically in consequence. Nevertheless, the method used was one that has been employed previously (17).

It may also be that those habits and practices which influence erosion relate differently to social factors in Saudi Arabia than in other countries. It is of note that not all previous investigations have demonstrated a relationship between erosion and social factors and results have sometimes been contradictory. Even if a relationship does exist, it may not be sufficiently strong to appear consistently in all studies.

Prevalence estimates for caries were similar to those seen previously in studies in the city of Jeddah. Values reported for 6-year-olds in the city have been in the region of 70–76% and dmft values have ranged from 4.6 to 5.5 (7, 21).

Simple comparisons suggest that the values seen are also comparable to estimates for young children in other parts of Saudi Arabia. Studies over the last 10 years have reported prevalence estimates ranging from 45% to 89% (5–7, 9, 21–23) and dmft values from 0.2 to 7.12 (6, 23).

The same was true for rampant caries. The 34% prevalence reported here was within the range of 15–43% reported for a group of 0–6-year-olds in Riyadh (24).

Caries has been shown to relate clearly to social class with, in westernised developed countries, levels of disease being higher amongst children in the lowest classes and those whose families were especially disadvantaged (14, 15, 25, 26). The trend for caries to be higher in children from lower social classes has also been seen in young children in at least one study in Saudi Arabia (6); the present study showed the same trend. Caries was more prevalent and dmft and dmfs were higher in children from publicly funded schools. Findings were less consistent in relation to father's occupation, perhaps again reflecting difficulties in assessing social class effectively in Saudi Arabian society at the present time.

A previous study carried out using exfoliated

and extracted teeth has demonstrated that erosion and caries can affect the same tooth or tooth surface (13). This was confirmed in this survey where, in contrast to previous reports, results provided evidence that erosion and caries do occur together and that caries may be a risk factor for erosion in at least some children.

The relationship between erosion and rampant caries was less obvious. This contradictory finding may have been at least partly a consequence of the difficulty in measuring both forms of tooth tissue loss in the same surfaces of primary incisors. The lesions of rampant caries and erosion are very dissimilar, erosion resulting in smooth, shiny and shallow defects and rampant caries in more localised, rough, destructive and deeper lesions. It therefore seems unlikely that there was confusion between diagnosis of the two pathological processes. In permanent teeth and in westernised countries caries may be a slower process than erosion but this may not be true in primary teeth in a population with much higher caries levels. It may be that in at least some cases, superimposition of the greater and more rapid destruction of caries had effectively masked or removed any evidence of erosion. An alternative explanation might be that erosion may itself promote the mechanisms of rampant caries in this population. The failure to see a relationship between the two in other studies, including some in which erosion was more prevalent, makes this seem unlikely. However, further research would be of value in understanding more exactly the relationship between the two processes.

In conclusion, erosion affected almost one-third of the sample of children drawn from kindergartens in Jeddah, a prevalence similar to that seen in studies of children of equivalent age in the UK. Caries prevalence and severity were high. There was no evidence to suggest that erosion affected more of those children whose susceptibility to caries was low and in this sample of children, caries proved to be a significant predictor for erosion.

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Appendix 1

Scoring system and criteria used for diagnosis of erosion (12).

Score 0: No evidence of tooth wear: No loss of enamel surface features, no change of contour.

Score 1: Tooth wear into enamel: Loss of enamel surface features giving a smooth glazed, shiny appearance. Relatively wide, shallow concavities on enamel, dentine not involved. Increased translucency of the tooth due to loss of enamel thickness. Evidence of "rimming" around the cervical margins.

Score 2: Tooth wear into dentine: Extensive loss of enamel with dentine involvement.

Exposure of dentine and/or secondary dentine. Distinct evidence of "rimming" around the cervical margins.

Score 3: Tooth wear into pulp: extensive loss of enamel and dentine with pulp exposure.

Score 9: Cannot be assessed: extensive caries, fractures, large restorations or missing teeth.

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