

## Tooth wear in children with Down syndrome

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### Abstract

**Background:** Several studies have described the impact that dental caries and periodontitis may have on the dentitions of individuals with Down syndrome, but there are few reports about the effects of tooth wear. This investigation aimed to compare the aetiology, prevalence and severity of tooth wear in 49 cytogenetically confirmed Down syndrome children with 49 non-Down syndrome controls.

**Methods:** This study involved three aspects: an oral examination, including obtaining dental impressions; a dietary analysis spanning three days; and a questionnaire seeking information about habits, medical problems and medications. Tooth wear severity was scored on a 4-grade scale (none-to-little; moderate; severe; very severe), while aetiology was classified as being due to attrition mainly, erosion mainly, or a combination of both. Double determinations established scoring method reliability and chi-square tests assessed associations between samples.

**Results:** Tooth wear was significantly more frequent ( $p < 0.01$ ) in the Down syndrome than the non-Down syndrome sample (67.4 per cent cf 34.7 per cent), with more of the Down syndrome children showing severe to very severe wear (59.2 per cent cf 8.2 per cent). Significantly more Down syndrome children ( $p < 0.05$ ) displayed a multifactorial aetiology of tooth wear, i.e., both attrition and erosion (46.7 per cent cf 28.6 per cent), although no particular dietary link was established. Gastric reflux and vomiting were reported in over 20 per cent of the Down syndrome sample.

**Conclusions:** Given the potential consequences of high levels of tooth wear, associated with tooth grinding and an acidic oral environment in Down syndrome children, educational programmes aimed at increasing awareness of carers and health professionals are needed urgently.

**Key words:** Trisomy 21, attrition, bruxism, acidic oral environment, educational programmes.

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important oral condition that has largely been ignored in these individuals is pathological tooth wear. Unpublished clinical observations by dentists suggest that many individuals with Down syndrome have excessive levels of tooth wear. In addition, care workers at institutions have remarked on the high frequency of tooth grinding by residents with Down syndrome. However, there do not appear to be any detailed studies conducted that document levels of tooth wear seen in Down syndrome, or determine causes for the wear.

A high level of acid reflux is known to occur in the Down syndrome population.<sup>5</sup> It is likely that the heavy levels of tooth wear in individuals with Down syndrome may be due to both bruxism and erosion due to a proposed high consumption of carbonated soft-drink and fruit juice compounded by acid reflux.

Although dietary causes for tooth wear can, ultimately, be corrected via alterations in the types of erosive foods and drinks consumed, bruxism is not as easily managed for a number of reasons. Firstly, a theoretical justification for 'tooth grinding' has not been established or agreed upon, which limits our ability to understand this condition. In addition, bruxism in the intellectually disabled is not easily manageable because the condition can occur when awake or asleep, or both. This contrasts to bruxism in non-affected individuals, which tends to occur mainly during sleep. The provision of a night-guard in mentally impaired individuals is not usually successful, and behavioural techniques to eliminate the 'habit' are generally futile.

As well as being destructive to the dentition and a source of suffering to the individual, pathological tooth wear can be a perplexing problem for the dentist planning restorative and prosthetic replacement of the worn teeth. Restoring badly worn teeth in patients with Down syndrome will generally be very difficult. Complex restorative work, such as occlusal build-ups or crowns, is likely to be both unsuccessful and often inappropriate in a mentally impaired patient. There are also difficulties with removable prosthodontic appliances due to alterations in muscle activity and tongue size relative to the oral cavity in individuals with Down syndrome. Intra-osseous dental implants are not often a viable option for replacing extracted teeth with excessive tooth wear as many individuals with Down syndrome have immune deficiency and poor healing capacity.

### INTRODUCTION

A number of reports have outlined the impact that dental caries and periodontitis have on the dentitions of individuals with Down syndrome.<sup>1-4</sup> However, an

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**Table 1. Tooth wear severity classification**

Group A	No tooth wear or mild tooth wear – a small degree of physiological wear present on 1-2 teeth – tooth wear that requires no clinical intervention.
Group B	Moderate level of tooth wear – a higher than physiological level of wear on two or more teeth that has not affected function or aesthetics – tooth wear that requires clinical intervention.
Group C	Moderate-severe tooth wear – pathological wear on four or more teeth, defined as teeth with approximately two-thirds to one-half of the clinical crown remaining – tooth wear that requires immediate and aggressive clinical intervention.
Group D	Severe tooth wear – pathological wear on four or more teeth, defined as teeth with one or more of the following features: (a) less than one-third of the clinical crown remaining (b) wear to the gum-line (c) severely scooped dentine – tooth wear of a severity rarely seen in this age group – tooth wear that requires immediate and aggressive clinical intervention.

Estimates of the prevalence of tooth wear in human populations vary, ranging from 7 to 88 per cent in one review<sup>6</sup> and from 5 to 20 per cent in another,<sup>7</sup> with no significant difference according to sex or age. In the past decade, the impact of dental erosion on the dentition has become a popular issue, and the prevalence of erosion has been reported to range from 5 to 30 per cent in the general population.<sup>8</sup> Small sample sizes and lack of uniformity in the methods for recording tooth wear account, to some extent, for the wide range of reported values.

Lindqvist and Heijbeil,<sup>9</sup> Swallow<sup>10</sup> and Richmond and co-workers<sup>7</sup> found that children with severe mental retardation (without reference to specific conditions) had significantly more tooth wear than children without mental retardation. The latter study also found that mentally-retarded patients, 18 years or younger, were less likely to both brux (determined from staff reports) and have wear into dentine, than mentally-retarded patients over the age of 18 years.<sup>7</sup>

Since Down syndrome is the most common chromosomal abnormality causing intellectual disability, the present study aimed to determine the prevalence, severity and aetiology of tooth wear in Australian children with Down syndrome, and to compare these findings with those from a sample of non-Down syndrome children.

## MATERIALS AND METHODS

The investigation was approved by the University of Adelaide Human Ethics Committee, and adhered to ethical guidelines of the National Health and Medical Research Council of Australia. Using the mailing list for members of the Down Syndrome Society of South Australia, letters were sent to parents of children with DS living in Adelaide, South Australia. The response rate was 34 per cent. The 'self-selected' study sample

**Table 2. Tooth wear aetiological classification**

Group	Aetiology
A	= no wear
B	= well-defined facet (indicating attrition)
C	= ill-defined facet (indicating multifactorial aetiology)
D	= well-defined areas of dentine or pitting of dentine (indicating erosion).

comprised 49 children with cytogenetically confirmed Down syndrome, 26 boys and 23 girls, with ages ranging from four to 18 years.

The study consisted of three components: (1) performing an examination of the children's teeth, including obtaining dental impressions and occasionally intra-oral photographs; (2) a three-day diet diary; and (3) obtaining a 'tooth wear and general health' questionnaire.

## Oral examination

A detailed oral examination of all children with Down syndrome, including obtaining alginate impressions from which dental models were made, was performed by the one investigator (EB). The wear on each tooth was scored on the dental models using two systems to record both severity and aetiology of tooth wear. The severity of tooth wear was scored according to the criteria shown in Table 1, whereas the aetiology of tooth wear was scored using the criteria shown in Table 2.

## Diet diary

A three-day diet diary comprising two weekdays and one day on the weekend was included to provide an indication of the dietary impact on levels of tooth wear. Parents were instructed to record, on behalf of their child, the time, quantity and type of food or drink consumed. Scoring of the diet sheets was based on Järvinen and associate's work<sup>11</sup> on the erosive potential of various dietary risk factors. The diet sheets were scored as low risk (L), medium risk (M) and high risk (H), with respect to the acidity of the diet. Determining pH values of each food or beverage was beyond the limits of this study.

## Tooth wear and general health questionnaire

A questionnaire was completed by parents of children with Down syndrome and included questions relating to habits, general medical conditions and medications, and beverages. Some of these factors are known to possibly influence levels of tooth wear.

Dental models of 49 non-Down syndrome children, matched as closely as possible for chronological age and dental age based on the basis of eruption status, served as controls. Children enrolled in an ongoing investigation of the teeth and faces of twins and their families were randomly selected from names in the study register book. No further information was provided about the subjects with respect to diet and habits.

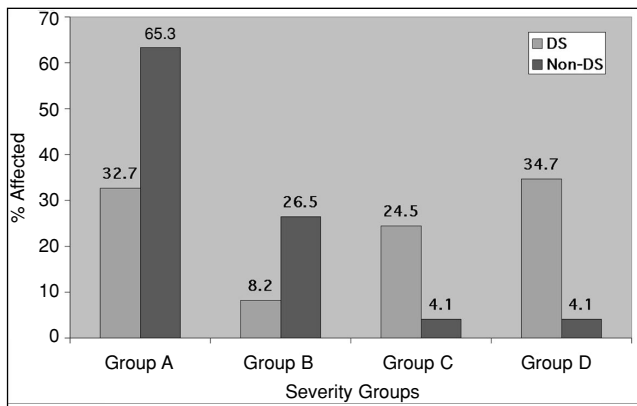


Fig 1. Comparison of the severity of tooth wear in Down syndrome children and non-Down syndrome children (A=no tooth wear or mild tooth wear; B=moderate level of tooth wear; C=moderate to severe tooth wear; D=severe tooth wear).

Reliability of the scoring methods for tooth wear was established by scoring all the dental casts on two different occasions. Double determinations were used to compare the first and second scores, and they showed that errors of the method were small (<5 per cent) and, thus, unlikely to bias results.

Results from the scores for 'severity' and 'aetiology' of tooth wear were summarized as the percentage of subjects within each group. In both Down syndrome and non-Down syndrome children, chi-square tests were used to make comparisons between groups for (a) severity of tooth wear; and (b) aetiology of tooth wear. Chi-square tests were also used to assess associations between presence of erosion and erosive potential of the diet in the Down syndrome children, with significance set at the 5 per cent level. Results from the questionnaire were analysed descriptively and percentages of children with Down syndrome who had been reported, by parents, to display behavioural or medical conditions that may influence levels of tooth wear were calculated.

## RESULTS

Severity of tooth wear in children with Down syndrome was found to be high, with 59.2 per cent of

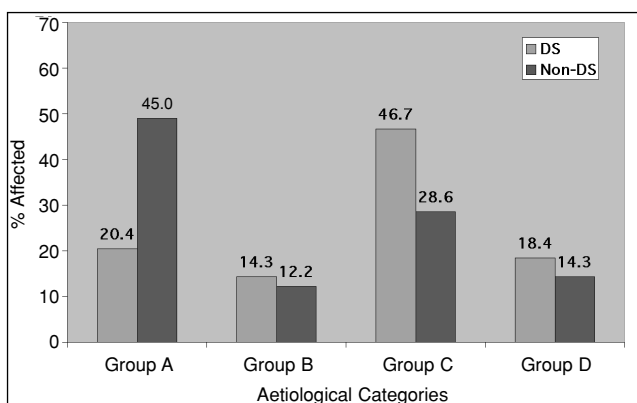


Fig 2. Comparison of the aetiology of tooth wear in Down syndrome and non-Down syndrome children (A=no wear; B=well-defined facet; C=ill-defined facet; D=well-defined areas of dentine or pitting of dentine).



Fig 3. Example of attrition in Down syndrome. Dental models of a 12-year-old girl with Down syndrome exhibiting pathological attrition due to day-time bruxism. The attritional lesions are particularly evident on the buccal cusps of the mandibular molars and incisal edges of maxillary incisors.

children placed in either Group C or D (pathological wear) and 34.7 per cent with very severe tooth wear (Group D). Comparison of the severity of tooth wear in Down syndrome children and non-Down syndrome children is depicted in Fig 1. Tooth wear (Groups B, C and D) was significantly more frequent ( $p < 0.001$ ) in the Down syndrome than the non-Down syndrome sample (67.4 cf 34.7 per cent). In addition, a significantly greater number of Down syndrome children ( $p < 0.001$ ) exhibited severe to very severe wear in comparison to non-Down syndrome children (59.2 cf 8.2 per cent).

Comparison of the aetiology of tooth wear in Down syndrome and non-Down syndrome children is illustrated in Fig. 2. Significantly more Down syndrome children ( $p < 0.05$ ) displayed a multifactorial aetiology of tooth wear, i.e., both attrition and erosion in comparison to non-Down syndrome children (46.7 cf 28.6 per cent). In addition, it was observed that 2 per cent (one child) showed obvious evidence of abrasion due to habitual gripping of objects, and just over 10 per cent (five children) had fractured teeth. None of the non-Down syndrome children showed evidence of these two destructive processes on the dentition. Figures 3, 4 and 5 provide examples of some wear patterns seen in children with Down syndrome.

Of the children with Down syndrome who participated in the study, the diet diary was completed by over half of the parents (57.1 per cent). No



Fig 4. Example of erosion in Down syndrome. Dental models of an 8-year-old boy with Down syndrome presenting with pathological erosion due to frequent consumption of carbonated drinks. Cupped lesions are most evident on the anterior teeth.

correlation was found between the severity or perceived aetiology of tooth wear and diet acidity.

The response rate of the questionnaire was of a moderate level, with 71.4 per cent of parents filling in the questionnaire. Parents reported that 31.4 per cent of Down syndrome children engaged in tooth grinding. Of these children, 27.3 per cent were diurnal grinders, 36.4 per cent were nocturnal grinders and 36.4 per cent were both diurnal and nocturnal grinders. In addition, 6 per cent of Down syndrome children were reported to be 'former grinders'. Many parents also stated that they only became aware of this condition after receiving the questionnaire, and were very surprised by their child's high level of tooth grinding. With respect to other habits, parents reported that in children with Down syndrome: 11.4 per cent clenched their teeth; 8.6 per cent tapped their teeth; 14.3 per cent chewed objects; 8.6 per cent held objects in mouth; 2.9 per cent swished drinks in mouth before swallowing; and 8.6 per cent were vigorous tooth brushers. All children used soft toothbrushes.

Reports of pain were generally low. Most of the parents stated that their child would not tell them if they were in pain, or said that their child could not talk. Parents stated that 2.9 per cent of Down syndrome children reported pain in facial muscles, 8.6 per cent in the temporomandibular joints and 5.7 per cent in jaw muscles. 11.4 per cent of children complained of headaches and 5.7 per cent woke in the morning with a headache. Medications that induce xerostomia were taken by 31.4 per cent of Down syndrome children,



Fig 5. Example of tooth wear of multifactorial aetiology in Down syndrome. Dental models of a 15-year-old boy with Down syndrome demonstrating unilateral abrasive tooth wear on the left side due to habitual gripping of an object in the mouth, superimposed with erosion due to a combination of acid reflux and dietary sources.

and levels of reported reflux and vomiting were reported to be high, being 28.6 per cent and 20 per cent respectively.

## DISCUSSION

Delayed dental development is a recognized clinical manifestation of Down syndrome, the deciduous teeth generally erupting and exfoliating later than in the general population.<sup>12</sup> Agenesis of deciduous teeth occurs in a small percentage of individuals with Down syndrome.<sup>13</sup> However, more often several permanent successor teeth are missing congenitally.<sup>13-15</sup> In addition, some children with Down syndrome have hypoplastic, mottled teeth<sup>14,16</sup> or teeth with thin enamel.<sup>17,18</sup> In general, enamel hypoplasia places a child at greater risk of (a) chipping and attrition of enamel and (b) exposure and premature wear of dentine.

The aforementioned factors impact directly on the levels of wear seen in the Down syndrome children compared to non-Down syndrome children. Many of them are difficult to control. At best, matching children in both groups by chronological and dental age served as a means of eliminating some of the extraneous variables.

The severity of wear in Down syndrome children in this study is of great concern. The frequency of erosion

in the Down syndrome children was very high and indicates that it is important to identify the causative factors for this type of wear, i.e., whether it is due to (a) dietary substances (b) medical conditions, or (c) medications, in order to address and manage the problem. A large number of the Down syndrome children showed high levels of attrition due to bruxism, and in many cases several teeth were worn to the gumline. Identifying the cause of bruxism in this group is important, and evaluating methods of treating the condition is crucial.

It is also important to note that 10 per cent of the Down syndrome sample (five children) had fractured incisor(s), whereas no child in the non-Down syndrome group presented with this feature. Although no formal questioning was undertaken to identify the reason for tooth fracture, one case appeared to be due to trauma (as no other teeth showed evidence of tooth wear), and the remaining four cases were due to bruxing alone or a combination of bruxing and fragile enamel due to erosion. In all cases, parents were unaware that their child had fractured teeth. It is suggested that parents who have a child with Down syndrome should be educated in detecting such pathology.

Responses in a questionnaire may underestimate the true level of tooth grinding. Some bruxing may be carried out undetected, given that the activity is thought to be cyclic.<sup>19</sup> At any given time, an individual may not be in a period of grinding. Also a parent may not be in close proximity to detect audible tooth grinding.

The moderate response rate of the questionnaire and diet sheets introduced obvious limitations to generalizing the results to the wider Down syndrome population. Inaccurate reporting of foods and drinks consumed is recognized as a common problem in all dietary analyses.<sup>8</sup> Basically, the best one can hope to gain from a diet sheet is an indication of the type of diet being consumed. While some studies have shown a correlation between diet and dental erosion,<sup>20-22</sup> other studies have shown no correlation between these two factors.<sup>8,23</sup>

The present study showed no significant correlation between erosive potential of the diet and presence of dental erosion. There are many possible reasons for such a finding. Some parents may have been unaware of the erosive potential of certain beverages and, therefore, failed to include all drinks in the diet sheets. Other factors such as gastric reflux and vomiting may be responsible for the presence of erosive tooth wear. Both of these conditions were found to occur in many of the Down syndrome subjects. Other factors that relate to the severity of erosive wear, such as frequency of intake of beverages, timing of intake, retention of beverages in the mouth, and tooth-brushing patterns may have an influence on wear features. Some of the children with Down syndrome exhibited hypoplastic teeth, which might have accelerated tooth wear in these individuals.

Previous studies have analysed the composition of saliva in individuals with Down syndrome and found

that the saliva is more alkaline, therefore less erosive, than saliva of non-Down syndrome individuals.<sup>24,25</sup> In addition, during clinical examinations of the children with Down syndrome, many children seemed to produce large amounts of saliva. Buffering capacity of saliva depends on the flow rate of serous, parotid and submandibular secretions, so it is possible that intrinsic or extrinsic acids are sufficient in Down syndrome individuals to overwhelm salivary protection of the teeth against erosion. However, salivary samples were not collected in the present study because the children were seen at various times of the day. As salivary flow rates depend on the time of day they are recorded, the results would have been inconsistent.

Anecdotal reports by health care workers at institutions have indicated high levels of tooth grinding are present in residents with Down syndrome, most of whom are adults. It would be worthwhile to compare the difference in levels of tooth wear in children and adults who have Down syndrome. Also, many children with Down syndrome have dietary restrictions placed upon them by parents, whereas adults with Down syndrome may make more autonomous decisions about their diet (particularly with respect to the consumption of acidic beverages). It is possible that adults with Down syndrome may have higher levels of erosive tooth wear due to greater freedom to consume soft drinks and cordial.

Studying Down syndrome children who have greater behavioural problems would also be valuable. Many parents of Down syndrome children who were invited to participate in the study expressed their support for the investigation, but stated that their child would not sit in a dental chair. This leads to speculation about whether the Down syndrome children who have greater behavioural problems, may have higher levels of tooth wear. The current study may actually underestimate the levels of tooth wear present in children with Down syndrome.

## CONCLUSION

Severity of tooth wear was significantly greater in Down syndrome than non-Down syndrome children. Significantly more Down syndrome children displayed a multifactorial aetiology of tooth wear, i.e., both attrition and erosion, compared with non-Down syndrome children.

These findings are of undoubted importance to individuals with Down syndrome and their carers, as well as to health professionals, including dentists.

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