K. R. Stenhagen, I. Berntsen, M, Ødegaard, A. Mulic, A. B. Tveit

Department of Cariology and Gerodontology, Faculty of Dentistry, University of Oslo, Norway

email: k.r.stenhagen@odont.uio.no

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Has the prevalence and severity of dental erosion in Norway changed during the last 30 years?

ABSTRACT

Aims *To find out if dental erosion is more frequent nowadays, the objective was to compare the prevalence and severity of dental erosion among 16–18 year-olds in Norway in 2012 with 15 year-olds in 1985. Further, the intention was to investigate the incidence and progression of erosive lesions from age 15 to 21.*

Materials and methods *Two calibrated clinicians recorded dental erosion on study models from 1985 (n=300; 150 girls/ 150 boys), at age 15 (born 1970). To record the incidence and progression of dental erosion, study models of the same individuals were examined at ages 18 (1988, n=88) and 21 (1991, n=35). The Visual Erosion Dental Examination (VEDE) system was used to score dental erosion on index surfaces; occlusal surfaces on permanent first molars and labial/ palatal surfaces on maxillary front teeth.*

Results *The prevalence of dental erosion 30 years ago was 64% (60% with enamel lesions only) compared to 59% recently (44% with enamel lesions only). In 1985, 4% had dentin erosions compared to 15% lately. Male adolescents had higher prevalence of dental erosion than female ones; (p=0.006). Regarding the incidence, 4% of the healthy surfaces developed enamel erosion during three (47/1295 surfaces) and six years (18/517 surfaces), respectively. Of the erosive lesions, 26% progressed during three years (27/104 surfaces), and 42% during six years (16/38 surfaces).*

Conclusion *Thirty years ago, the prevalence of dental erosion was in the same order as reported nowadays, but the condition seemed less severe.*

Keywords *Erosive wear; Prevalence; Severity.*

Introduction

The reported prevalence of dental erosion among adolescents during the last years varies from 22–59% [Arnadottir et al., 2010; Bardolia et al., 2010; El Aidi et al., 2010; Hasselkvist et al., 2010; Margaritis et al., 2011; Mulic et al., 2013; Okunseri et al., 2011; Sovik et al., 2014]. Parallel to the caries decline [Marthaler, 2004], especially in Nordic countries, the focus on dental erosive wear has increased. In a recent questionnaire survey among Norwegian dentists, the majority had the impression of a higher prevalence of erosive lesions among their patients today than 10–15 years ago [Mulic et al., 2012].

It has been speculated that if the observed high prevalence of dental erosion in young individuals nowadays is a "new" phenomenon and a result of changes in lifestyle [Ganss et al., 2012; Lussi et al., 2006], this may have led to risk behavior like high and frequent consumption of acidic beverages and foods [Gambon et al., 2011; Gambon et al., 2012; Jarvinen et al., 1991; Johansson et al., 2002; Johansson et al., 2004; Lussi et al., 2004; Moazzez et al., 2000; Nunn, 1996]. Also, the present ideal of being slim and fit may have triggered the onset of excessive physical exercise and/or the consumption of healthy foods/beverages with high erosive potential [Schlueter and Tveit, 2014].

Only a few studies are published on dental erosive wear from as far back as 25–40 years ago [Lussi et al., 1991; Sognnaes et al., 1972; Xhonga and Valdmanis, 1983]. Mainly adults were included in these studies that reported a prevalence varying from 18% to 25%. So, the impression that the prevalence of dental erosion has increased may have been based on clinical observations rather than on comparison of scientific data.

Further, there are only few longitudinal and retrospective studies on dental erosive wear. They have reported that the prevalence increases linearly with age and that the lesions progress into more severe lesions [Dugmore and Rock, 2004; El Aidi et al., 2010; El Aidi et al., 2008; Harding et al., 2010; Lussi and Schaffner, 2000]. However, incidence and progression of erosive lesions on tooth/individual level have not been recorded except in one recent longitudinal study [El Aidi et al., 2010], and one that recorded erosion on orthodontic casts over a 5 year period as far back as 1977 [Ganss et al., 2001]. In the latter study the authors concluded that at that time dental erosion was a significant, but not serious problem for dental health in German adolescents.

In order to elucidate whether dental erosion is an increasing problem, the objective was to record the prevalence and severity of dental erosion on study

1985	1985, 1988	1985, 1988, 1991
15 yrs old	15-18 yrs old	15, 18, 21 yrs old
n=300	n=88	n=35
150 ♀, 150 ♂	60 ♀, 28 ♂	24 ♀, 11 ♂

TABLE 1 The study sample (with the gender distribution), investigated when the adolescents were 15, 18 and 21 years old.

models among Norwegian 15 year-olds in 1985, and compare these data with recently reported prevalence among adolescents. In addition, it was the intention to investigate the incidence and the progression of erosive lesions among small subgroups of these adolescents from 15 to 18 and 15 to 21 years of age, respectively.

Materials and methods

Study population

The study sample (Table 1) consisted of plaster models of 300 individuals which was a random subgroup of the "Nittedal" material that had been collected by the Department of Orthodontics, University of Oslo, starting in 1972 [el-Batouti et al., 1995; el-Batouti et al., 1994]. The material included in the present study was those study models (made from alginate impressions and blue plaster) of 15 year-olds, born in 1970, that were anonymous, that means thet they had been numbered and all signs that could identify the persons had been removed. This selection of the present study sample was done randomly among the whole "Nittedal" material by staff responsible for the Nittedal study archive. The number of individuals with longitudinal recordings (after 3 and 6 years) was limited (Table 1).

Calibration

The examiners (IB and MØ) were trained and calibrated ahead of the study start with a previously calibrated examiner (AM) [Hove et al., 2013; Mulic et al., 2010]. Thirty index surfaces on study models from a previous study [Hove et al., 2013], were examined and scored by the Visual Erosion Dental Examination (VEDE) system [Mulic et al., 2010]. In cases where the examiner was in doubt of the score, the lowest was chosen. The calibration was repeated after two weeks under the same room and light setting.

Recording dental erosion

Dental erosion was scored on the following index surfaces on the models: the occlusal surfaces on all permanent first molars and the labial and palatal surfaces on all maxillary front teeth (canines, lateral incisors and central incisors). These surfaces were chosen due to a reported higher prevalence of erosion compared to other surfaces in the mouth [Hove et al., 2013; Jaeggi and Lussi, 2014]. It was the intention that index surfaces with restorations, retainer or attrition should be excluded from the registration. In the present study the excluded surfaces (n=66 surfaces; 1.4 %) were all due to restorations.

The VEDE system, previously validated and judged as acceptable [Mulic et al., 2010], was used to register and determine the severity of dental erosion. The VEDE system is based on both clinical criteria and photos on surface level; grade 0 = no erosion, grade 1 = initial loss of enamel, grade 2 = distinct loss of enamel, grade 3 =<1/3 of the surface has dentin exposed, grade 4 = 1/3-2/3 of the surface has dentin exposed, grade 5 = >2/3 of the surface has dentin exposed. In order to strengthen a comparison of data with recent prevalence studies from Norway, the same index teeth and the VEDE system were used in the present study.

Baseline registrations were made on the study models from 1985 when the participants were 15 year-olds (born in 1970). New models of subgroups when the same individuals were 18 (1988) and 21 (1991) years old were examined. The examination of the models from 1988 and 1991 was performed in random order and blinded. The study population and gender distribution are shown in Table 1. The registrations in 1988 and 1991 were compared with baseline data from 1985.

Statistical analyses

The statistical analyses were performed using the IBM Statistical Package for the Social Sciences (SPSS) version 20. The inter- and intra-observer agreement from the calibration was expressed by the weighted Cohen`s kappa (Kw) [Landis and Koch, 1977] and interpreted as follows: <0.40 fair agreement, 0.41-0.60 moderate agreement, 0.61-0.80 substantial agreement, 0.81-1.0 almost perfect agreement. Descriptive analyses with frequency distributions were performed and Chi-square was used to test possible associations between the variables (5% significance level).

Results

Calibration

The calibration data for the registrations on study models (n=30 surfaces) showed almost perfect intra-observer agreement for the two examiners (κw 0.87 and κw 0.94, respectively) and inter-observer agreement (κw 0.87). There was moderate agreement (κw 0.60) for both examiners versus the previously calibrated examiner (AM).

The prevalence, distribution and severity of dental erosions among the 15 year-olds (n=300) in 1985, the prevalence of dental erosion was 64% (193 individuals), 60% of these had one or more surfaces with enamel erosion only, and 4% had dentin erosion. Of the erosive

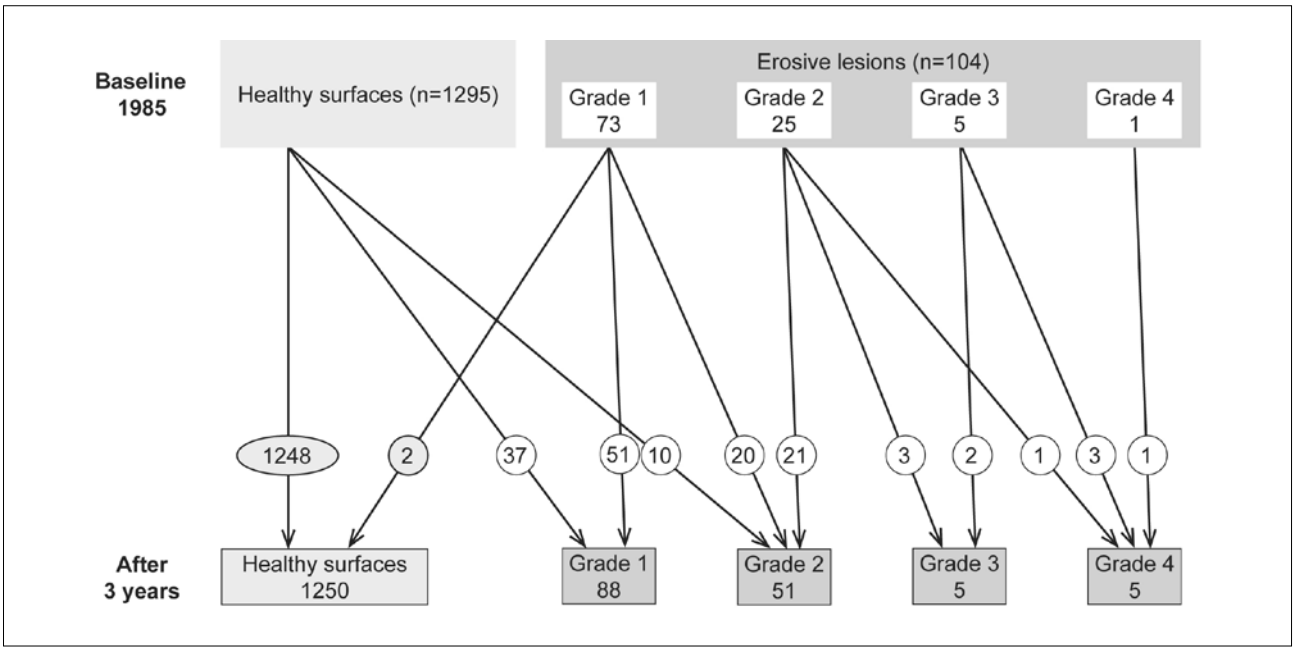

FIG. 1 The severity, incidence and progression of erosive lesions was recorded in a subgroup (88 individuals; n=1399 index surfaces (9 excluded) with longitudinal data from baseline in 1985 to three years later in 1988 using the VEDE index (grade 1 and 2 =enamel lesions, grade 3-5 =dentin lesions). Two surfaces registered as grade 1 in 1985 were registered as healthy in 1988 representing an over-registration.

lesions into dentin only one was graded score 4, while the other lesions were graded 3.

Of the 193 individuals recorded with dental erosion, 134 (69%) had just 1 or 2 affected surfaces and these were enamel lesions (except for two surfaces with dentin lesions). Forty individuals (21%) had 2 or 3 surfaces affected, and 19 individuals (10%) had ≥5 surfaces affected.

The male adolescents had a higher prevalence of dental erosion than the female; 108/150 vs.85/150 respectively (p= 0.006). The same trend was observed for erosion into dentin; 7/150 males vs. 5/150 females (not sign).

The occlusal surfaces of the lower first permanent molars (FPM) were most frequently affected by dental erosion (49%) followed by the palatal surfaces of the upper central incisors (17%) and lateral incisors (10%). Of the affected lower FPM, 12 occlusal surfaces had dentin erosion (4%) in contrast to none in the upper FPM. The incidence of dental erosion over three and six years (individual level) among the subgroup of adolescents (n=88) examined both at age 15 (1985) and age 18 (1988), 45 individuals (51%) had dental erosion at age 15 and 53 (60%) at age 18. All 8 individuals newly identified with the condition showed enamel lesions only. Two individuals (2/45 affected) showed progression of lesions and changed status from enamel lesions only to at least one dentin lesion during these three years.

Among the subgroup of adolescents (n=35) examined both at age 15 (1985) and age 21 (1991), 20 individuals (57%) had erosion at age 15, increasing to 22 individuals (60%) when 21 years old. The two new individuals identified with the condition when they were 21 years old showed enamel lesions only. Six individuals (6/20 affected) showed progression of lesions and changed status from enamel lesions only to at least one dentin lesion during these six years. One individual suffered from more severe dental erosion when 21 years old than all other individuals; with 8 affected teeth (3 with enamel erosion grade 2, 1 with dentin erosion grade 3 and 4 with dentin erosion grade 4).

The progression of the erosive lesions over three and six years (surface level): few lesions progressed from enamel to dentin after three (4%) and six years (20%), respectively. Four lesions changed status from enamel lesions to healthy (2 from 15-18 years old and 2 from 18-21 year old) representing an over-registration, healthy surfaces recorded as enamel erosion at baseline (Fig. 1, 2).

Discussion

The prevalence of dental erosion in Norway was 38% among 18 year-olds in 2008 and 59% among 16–18 year-olds in 2012 [Mulic et al., 2013; Sovik et al., 2014]. These data are in line with findings in other countries [Arnadottir et al., 2010; Bardolia et al., 2010; El Aidi et al., 2010; Hasselkvist et al., 2010; Margaritis et al., 2011; Okunseri et al., 2011]. The present study does therefore not clearly support the assumption that the prevalence of dental erosions among adolescents in Norway was

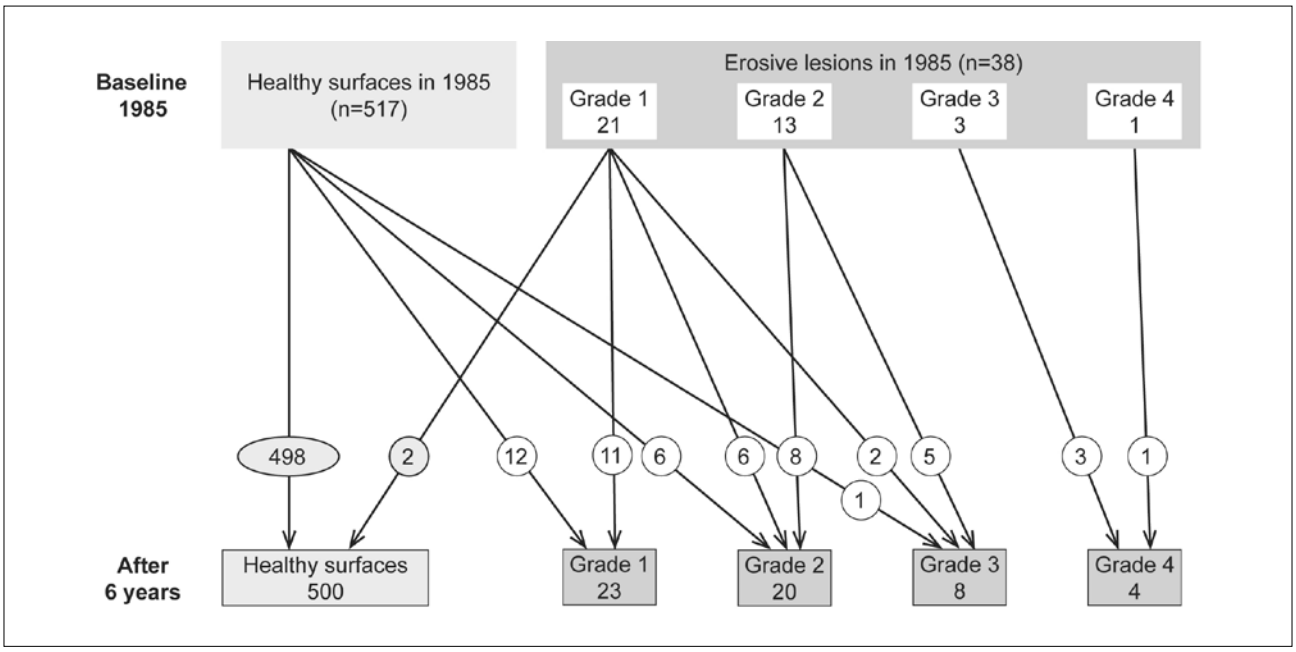

FIG. 2 The severity, incidence and progression of erosive lesions was recorded in a subgroup (35 individuals (n=555 index surfaces (5 excluded) with longitudinal data from baseline in1985 to six years later in 1991. Two surfaces registered as grade 1 in 1985, were registered as healthy in 1991; representing an over-registration.

lower 30 years ago, since the prevalence was found to be 64% [Sovik et al., 2014]. However, the condition seemed less severe than in recent reports since fewer surfaces were affected per individual and the lesions were mostly initial enamel lesions. Male adolescents were most frequently affected by dental erosion in line with reports in a recent review [Jaeggi and Lussi, 2014]. More prevalent and severe erosive lesions in men have been explained by risk behaviour in young men, like high and frequent use of acidic drinks [Hasselkvist et al., 2010] and also that men have more muscle mass and chewing strength [Bardsley et al., 2004]. Together with acids this could increase the loss of dental hard tissue. The explanation may be more complex since it has been found that females have thicker enamel which offers better protection against erosive damage [Smith et al., 2006]. In addition it was found recently that polymorphisms in enamel formation genes are statistically associated with an individual's susceptibility to dental erosive wear [Sovik et al., 2015]. Study models have been used to record dental erosion in several clinical studies [Ganss et al., 2001; Johansson et al., 1997; Saeves et al., 2012]; in the latter study the VEDE system was applied. There are few validation studies where registration of erosive lesions on study models has been tested. However, in a study which aimed to assess the reliability and validity of recordings of dental erosion on study models and clinical photographs using the VEDE system, the inter-method agreement on photographs and study models versus the clinical evaluation were approximately in the same range (KW 0.45) [Hove et al., 2013]. A previous study suggested that the advantage of using casts/study models was that the evaluation could be performed repeatedly and under optimal illumination, viewing them from all sides and without any pressure of time [Ganss et al., 2001].

Even clinically, initial erosive lesions in enamel are difficult to diagnose and it is also challenging to determine whether dentin is exposed or not [Ganss et al., 2006]. Taking these possible limitations into consideration, enamel erosion grade 1 and 2 were frequently recorded on the models in the present study and there seems to be little over-registrations since there were few "reversals": of 73 enamel lesions (grade 1) recorded at baseline (1985), 2 were recorded as healthy in 1988 (Fig. 1). The similar was observed for 2 of 38 recorded enamel lesions after six years (in 1991) (Fig. 2). The longitudinal registrations were performed in random order and the examiners were blinded.

The general severity of the condition seems to have changed to the worse during the last 30 years at least in Norway. In 1985, 4% of the 15 year olds had dentin erosion (VEDE grade 3) in contrast to 15% of the 16 year olds in 2012 [Sovik et al., 2014], where some individuals also had severe dentin erosion (VEDE grade 4 and 5). In comparison; data of erosive lesions into dentin vary from 5.5% in Iceland [Arnadottir et al., 2010] to 23.8% in the Netherlands [El Aidi et al., 2010] both among 15 year-olds. Among young adults in Sweden (age 20), the prevalence of dental erosive wear was recently reported to be as high as 75% [Isaksson et al., 2014] and >50% in European countries in a multicenter study among 18–35 year-olds [Bartlett et al., 2013]. However, in the study from Sweden the

authors concluded that the level of severe erosion was low (18% with extensive erosion; ≥3 molars with cuppings and/or erosion on maxillary incisors). The definition of severe erosion differs in studies and complicates a direct comparison. In general prevalence data from different studies and countries are difficult to compare due to different methodologies like the choice of index, age group, index teeth/surfaces and whether the examiners are calibrated or not [El Aidi et al., 2010]. This may result in a lack of data to support or not, if the prevalence of dental erosion really has increased [Ganss et al., 2001]. In the present and other Norwegian prevalence studies on dental erosion [Mulic et al., 2013; Sovik et al., 2014], the age of the study population, the grading system (VEDE), the choice of index teeth, as well as the calibration of the examiners were identical. This supports the validity of the comparison of the results from the present study with the reported prevalence from these studies. On the other hand, the results may not be entirely comparable since the present investigation recorded dental erosions on study models and not by clinical examination. However, when comparing clinical scorings of dental erosions with scorings on study models of the same teeth, moderate agreement was found (κW0.43) [Hove et al., 2013].

There are only few studies on erosive tooth wear from as far back as 30–40 years ago and these studies reported a prevalence varying from 18% to 25% [Lussi et al., 1991; Sognnaes et al., 1972; Xhonga and Valdmanis, 1983], which is lower than the 16-59% prevalence reported in recent studies. The studies from 1972–1991 investigated adults, where the wear processes may have been a combination of attrition, abrasion and erosion in contrast to studies on adolescents with mainly erosive wear. One study investigated erosive wear in adolescents aged 14 in 1991 and found a prevalence of 30% [Milosevic et al., 1994]. In a recent cross-sectional study on erosive tooth wear among army recruits in Switzerland in 1996 and 2006 it was found that erosion in enamel was less frequent in 2006 than in 1996; 60% vs. 82%, and in dentin 23% vs. 30.7% respectively, despite a significant increase in consumption of acidic products [Lussi et al., 2015].

A recent review reports that the distribution of erosive tooth wear shows a predominance of affected occlusal surfaces of mandibular FPM followed by facial surfaces of maxillary incisors [Jaeggi and Lussi, 2014]. A similar pattern of distribution was found in the present study, except that the palatal surfaces of the upper central incisors (17%) and lateral incisors (10%) were the second and third most affected surfaces, respectively.

The incidence and progression data from the present study must be interpreted with precaution and just as indications, since the number of individuals in the 3 and 6 year follow- up was low and possibly underpowered (n=88 and n=35, respectively). Also the gender distribution in these subgroups was not balanced and may have introduced bias. However, such data are scarce and may still shed some light on the severity and progression of the condition at that time. During 3 years (1985-1988), the prevalence of dental erosion increased from 51.1% to 60.2%. The incidence was mainly represented by enamel erosion (VEDE grade 1-2) and two individuals had lesions that developed from enamel to dentin (VEDE grade 3). During 6 years (1985-1991) the prevalence of dental erosions increased from 57% to 60%, mainly represented by new individuals going from healthy to a status with enamel erosion (3). There are few longitudinal studies to compare with, but in the Netherlands it was shown that among adolescents (mean age 12) the prevalence increased from 32.2% to 42.8% during 1.5 years and the severe lesions increased from 1.8% to 13.3% [El Aidi et al., 2008]. In a 3 year follow up, the prevalence increased from 30.4% (age 11) to 44.2% (age 15) and deep enamel or dentin lesions were present in 1.8% and 23.8% of the adolescents respectively [El Aidi et al., 2010]. In these studies the condition was in general more severe than in the present study.

The high prevalence and severity of dental erosion reported nowadays is thought to be associated with changes in diet and lifestyle; mainly through high consumption of acidic drinks and diets [Cavadini et al., 2000; O'Sullivan and Curzon, 2000]. In general, during the last 50 years the availability of a greater variety of fruits, fruit juices, soft drinks and sweets has increased and with improved economy in Western countries the consumption of these products has changed and is often a part of an everyday diet [Gambon et al., 2011; Gambon et al., 2012]. Unfortunately, information about the lifestyle, diet and habits of the investigated individuals in the present study, do not exist, but the trend for the changes in the common Norwegian diet since 1980, when the investigated adolescents were 10 years old, till today, is a 50% reduction in the milk consumption pro person/year parallel to an increase in the consumption of soft drinks. The total intake of sugar-containing soft drinks, diet soft drinks and flavoured (lime or citrus) bottled water increased slightly during the study period from 1980 to 1991, but nearly doubled from 1990 to 2012 (58 vs. 114 liter/person/year, respectively) [Bryggeri- og drikkevareforeningen, 2011; HOD, 2013]. In addition, Norway's largest retailer (representative of 39% of the Norwegian retail sector) reported a 33% increase in the sale of sour sweets in the last 3 years [pers. Commun.]. On the other side, in a study among Swiss army recruits, where individuals reporting over 5 acid intakes daily increased from 1996 to 2006, one would expect an increase in dental erosion over these 10 years, but on the contrary the prevalence decreased [Lussi et al., 2015]. The authors emphasised the multifactorial aetiology of the conditions and that other factors may have had an impact on the risk status.

Conclusion

In summary; thirty years ago, the prevalence of dental erosion (64%) was in the same order as reported nowadays, but the condition seemed less severe. Within the limitations of small samples for the longitudinal part, the incidence was mainly represented by healthy surfaces developing enamel lesions over 3–6 years and the results indicates that the progression was slow.

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