

The importance of oral hygiene on variation in dental caries in adults

Espen Bjertness

Section for Epidemiology, Department of Community Medicine, National Institute of Public Health, Oslo, Norway

Bjertness E. The importance of oral hygiene on variation in dental caries in adults. *Acta Odontol Scand* 1991;49:97-102. Oslo. ISSN 0001-6357.

The aim of the present study was to analyze the relative importance of oral hygiene and other selected independent variables on the number of carious surfaces in a random sample of 35-year-old Oslo citizens. In addition to oral hygiene status (OHI-S), the independent variables frequency of tooth cleaning, regular dental visits, years at school, sex, and number of filled and missing surfaces were included in the analyses. Multiple Classification Analysis (MCA) was used for statistical evaluation of the results. The results indicate that oral hygiene status was the most important predictor in explaining variation in the number of carious surfaces. The total explanation factor was, however, low ($R^2 = 0.146$). □ *Dental visits; epidemiology; filled surfaces; missing surfaces*

Espen Bjertness, National Institute of Public Health, Section for Epidemiology, Department of Community Medicine, Geitmyrsvn. 75, 0462 Oslo 4, Norway

Plaque has to be present on a tooth surface to promote caries (1), but the relationship between oral hygiene and caries remains controversial (2, 3). Professional tooth cleaning programs with treatment intervals of 1 to 3 months have resulted in a high level of oral cleanliness and almost completely eliminated dental caries in children, adolescents, and adults (4-9). Clinical trials with self-performed oral hygiene programs have, however, not proved to be a successful way of preventing dental caries. The relationship of caries prevalence to oral cleanliness, variation in brushing frequency, and oral hygiene level shows controversial results (2). Among 35-year-old Oslo citizens a statistically significant bivariate relation between oral hygiene scores (OHI-S) (10) and number of carious lesions was disclosed in a study from both 1973 and 1984 (11).

Most investigations of oral hygiene and caries have dealt with children and young adults and have not considered confounding variables. The aim of the present study was to analyze the relation between OHI-S (10) and the number of carious surfaces, in a

multivariate design including selected confounding variables such as socioeconomic variables, frequency of tooth cleaning, regular dental visits, and number of filled and missing surfaces. Sex and level of education are factors reported to be of importance for variation in dental caries among adults (12, 13). Studies have also shown that female sex (14) and high educational level (12) correlate with good oral hygiene habits. In some old studies frequency of tooth cleaning was a factor showing a controversial relationship with caries (2). Today fluoride dentifrice constitutes the main share of the dentifrice market (11). The frequency of tooth cleaning might therefore also be an indicator of the frequency of fluoride exposure. From previous studies it is concluded that regular dental visits are of importance for dental health (13), but a relationship with the oral hygiene level is uncertain.

Plaque retention studies have demonstrated that restorations predispose for plaque retention (15). It was therefore considered important to include the number of filled surfaces in the present study as a con-

founding variable. Furthermore, the number of missing surfaces was included as a control for surfaces at risk of dental caries.

Materials and methods

The present study was based on data from 35-year-olds collected in 1984 (11). From a total of 200 randomly sampled individuals, 156 met for the clinical and roentgenologic examination. Twelve non-Caucasian immigrants were excluded from the present study because of oral conditions different from those of the Norwegians (11). Two individuals presented with high numbers of untreated carious lesions compared with the remaining 142 participants (22 and 41 carious lesions). Owing to the excessive influence on the mean values of these atypical participants, they were not included in the present analyses. Decayed surfaces were recorded clinically and radiographically (11, 16, 17). The independent variables supposed to contribute to variation in number of carious surfaces included in the investigation are presented in Table 1. The oral hygiene was scored in accordance with the Simplified

Oral Hygiene Index (OHI-S) (10), and the scores were operationalized in groups of low, medium, and high (11). A regular dental visitor was defined as a person having visited a dentist at least once a year for the past 3 years.

A statistical program package, the DDPP (Discrete Data Program Package) (18), developed at the University of Oslo was used for analysis of the present results. Multiple Classification Analysis (MCA) (19) was the multivariate method chosen in this study to detect possible correlations between the dependent and the selected independent variables within the frame of an additive model. The method supposes that every score for the dependent variable is created by many additive coefficients (independent variables). The degree of relationship between each independent and the dependent variable in the MCA is expressed by the eta and beta coefficients. Beta and eta indicate the relationship between the independent and the dependent variable, with and without adjustment for the relationships between the other variables, respectively. Beta gives a measure of the relative ability (power) of the independent variable in

Table 1. Bivariate relation between selected independent variables and the dependent variable, Number of carious surfaces. Analysis of variance (*F* test)

| Independent variables | Values | <i>n</i> | Mean no. of carious surfaces |
|---------------------------------------|-----------------|----------|------------------------------|
| A. Sex | Women | 72 | 2.4NS |
| | Men | 70 | 3.4 |
| B. Regular dental visits | No | 15 | 5.1* |
| | Yes | 127 | 2.6 |
| C. Years at school | ≤10 | 34 | 3.9* |
| | >10 | 108 | 2.6 |
| D. No. of missing surfaces | 0-20 | 81 | 2.5 |
| | 21-34 | 40 | 2.9NS |
| | 35+ | 21 | 4.3 |
| E. No. of filled surfaces | 0-40 | 18 | 3.1 |
| | 41-65 | 73 | 2.6NS |
| | 66+ | 51 | 3.2 |
| F. Oral hygiene status (OHI-S scores) | Low (0-0.99) | 47 | 1.6 |
| | Middle (1-1.99) | 61 | 3.1* |
| | High (2+) | 34 | 4.3 |
| G. Frequency of tooth cleaning | 1/day | 26 | 3.7NS |
| | >1/day | 116 | 2.7 |

Statistical significance. * $p < 0.05$; NS = not significant.

explaining the variation of the dependent variable. R-square indicates the part of the variation of the dependent variable which can be explained by the total number of independent variables included.

In addition to the MCA, analyses of variance were applied in the present study (20). The level of significance was set at $p < 0.05$.

Results

Of the individual factors tested bivariately, Oral hygiene status, Regular dental visits, and Years at school were statistically significantly related to number of carious surfaces (Table 1). Table 2 shows the eta and beta values for the selected independent variables assumed to contribute to the variation in number of carious surfaces. The independent variables are ranked in accordance with the calculated beta values. The most important factor for explaining the variation in untreated carious surfaces was Oral hygiene status (Table 2). The effect of Oral hygiene status on the number of carious surfaces decreased slightly when other independent variables were taken into consideration ($\beta < \eta$). The total explanatory factor (R^2) based on all the independent variables together was 15% ($R^2 = 0.146$) (Table 2).

Table 3 presents the mean number of carious surfaces three-variately for the groups low, medium, and high OHI-S scores when the selected independent variables were con-

sidered one by one. A positive relation between caries and OHI-S scores was detected as a general trend (Tables 3A–F). However, low n values for some of the groups must be considered when interpreting these results. When Frequency of tooth cleaning (Table 3C) was taken into consideration, there was no difference in the number of carious surfaces between those with low OHI-S scores and only a small difference between those with medium or high scores. There was a lower number of carious surfaces for all the three OHI-S groups among the regular dental visitors than among the irregular attenders (Table 3D).

Discussion

The attendance and the reliability of the caries registrations are discussed in a previous paper and were considered satisfactory (11).

Epidemiologic investigations should utilize the potential of multivariate methods to elucidate a multifactorial etiology of dental caries. The MCA makes it possible to correlate a set of independent variables to one dependent variable, as demonstrated in Table 2. The MCA was chosen for this purpose in the present investigation owing to the possibility of analyzing categorical independent variables (19).

The participants were divided into groups in accordance with the OHI-S scores low (0.0–0.9), medium (1.0–1.9), and high

Table 2. The correlation of selected independent variables with the dependent variable, Number of carious surfaces. R^2 indicates the total explained variance of the dependent variable. Multiple Classification Analysis (MCA)

| Independent variables | Eta | Beta |
|------------------------------------|---------------|---------|
| Oral hygiene status (OHI-S scores) | 0.327* | 0.248* |
| Regular dental visits | 0.244* | 0.196* |
| No. of filled surfaces | 0.105NS | 0.162NS |
| No. of missing surfaces | 0.200* | 0.146NS |
| Years at school | 0.170* | 0.123NS |
| Sex | 0.145NS | 0.077NS |
| Frequency of tooth cleaning | 0.093NS | 0.013NS |
| | $R^2 = 0.146$ | |

Statistical significance, * $p < 0.05$; NS = not significant.

Table 3. Relation between Simplified Oral Hygiene Index scores (OHI-S) (low, 0.0–0.9; medium, 1.0–1.9; high, 2.0+) and the number of carious surfaces, when taking different independent variables into consideration. Analysis of variance (*F* test)

| | OHI-S | <i>n</i> | No. of carious surfaces |
|---------------------------------------|--------|----------|-------------------------|
| A. Number of missing surfaces | | | |
| Low | Low | 30 | 1.6 |
| | Medium | 36 | 2.7* |
| | High | 15 | 4.1 |
| Medium | Low | 12 | 0.8 |
| | Medium | 19 | 3.5* |
| | High | 9 | 4.3 |
| High | Low | 5 | 3.6 |
| | Medium | 6 | 4.5NS |
| | High | 10 | 4.6 |
| B. No. of filled surfaces | | | |
| Low | Low | 8 | 1.9 |
| | Medium | 2 | 2.5NS |
| | High | 8 | 4.4 |
| Medium | Low | 25 | 1.8 |
| | Medium | 29 | 2.3* |
| | High | 19 | 4.2 |
| High | Low | 14 | 1.1 |
| | Medium | 30 | 4.0* |
| | High | 7 | 4.4 |
| C. Frequency of tooth cleaning | | | |
| 1/day | Low | 5 | 1.6 |
| | Medium | 12 | 3.5NS |
| | High | 9 | 5.0 |
| > 1/day | Low | 42 | 1.6 |
| | Medium | 49 | 3.0* |
| | High | 25 | 4.0 |
| D. Regular dental visits | | | |
| Yes | Low | 44 | 1.5 |
| | Medium | 56 | 3.0* |
| | High | 27 | 3.7 |
| No | Low | 3 | 3.2 |
| | Medium | 5 | 4.2NS |
| | High | 7 | 6.6 |
| E. Sex | | | |
| Women | Low | 31 | 1.6 |
| | Medium | 28 | 3.0NS |
| | High | 13 | 3.1 |
| Men | Low | 16 | 1.6 |
| | Medium | 33 | 3.2* |
| | High | 21 | 5.1 |
| F. Years at school | | | |
| ≤ 10 years | Low | 11 | 2.0 |
| | Medium | 12 | 4.5NS |
| | High | 11 | 5.3 |
| > 10 years | Low | 36 | 1.5 |
| | Medium | 49 | 2.8* |
| | High | 23 | 3.8 |

Statistical significance, * $p < 0.05$; NS = not significant.

(2.0+) (11). The division reduces the problem of outliers but may simultaneously reduce the information from the oral hygiene factor. However, the intention was to relate

dental caries to oral hygiene in general on the basis of the OHI-S index, which utilizes recordings from six surfaces only.

The factor Years at school was dichot-

omized into ≤ 10 and > 10 . A distinction between low and high level of education is commonly made at 10 years of education (21, 22). This distinction fits well with the common utilization of the Norwegian school system and has been used in other oral health studies (21). The factor Regular dental visits includes individuals who have visited the dentist at least once a year for the past 3 years. This factor and the factor Frequency of tooth cleaning are difficult to assess and may be a source of bias due to misclassification. The percentage of people brushing their teeth more than once a day was slightly higher than in a study from Sweden (23). There is a tendency for some people to want to give a more positive impression of their own situation than the real one (24). The direction of this bias is, however, favorable with regard to the probability of committing a type-1 error (25).

Bivariately, a statistically significantly higher number of carious surfaces was found in the group with high OHI-S scores than in the low score group (Table 1). The importance of oral hygiene status was also confirmed in the multivariate analyses (Table 2). However, it must be realized that the selected independent variables together explained only a small part of the variation in the number of untreated carious surfaces (15%) (Table 2). Other factors, not taken into consideration in the present study, such as dietary habits, the oral microflora, salivary factors, behavioral factors, and the dentist's philosophy of intervention, may be of importance.

Possible interactions with oral hygiene on the number of carious surfaces may be discovered by presenting data in a three-variate analysis as demonstrated in Table 3. The mean number of carious surfaces is recorded for each of the three groups with low, medium, and high OHI-S scores when taking selected independent variables into consideration. In the present material there is an example of an interaction between Regular dental visit and OHI-S scores on the number of carious surfaces (Table 3D), indicating a lower number of carious surfaces among the regular dental visitors than among the irregular ones for all levels of OHI-S scores. It is

reasonable to believe that the lower number of carious surfaces among the regular dental visitors is due to a higher repair rate.

An argument against a relation between oral hygiene and dental caries has been that individuals with a good oral hygiene are more frequent brushers and thereby receive more fluorides from the toothpaste (2). In accordance with other studies (2), the oral hygiene tended to be better, and there was a tendency towards a lower number of carious surfaces (Table 1F) among frequent than among less frequent brushers. However, when Frequency of tooth cleaning was taken into consideration in a three-variate analysis (Table 3C), the group with a low OHI-S score had the same number of carious surfaces regardless of the frequency of toothbrushing. For the groups with medium and high scores there were only small differences. This indicates that the quality, not the frequency, of toothbrushing is of importance for caries prevention among adults. This may also be discovered from the multivariate analysis (Table 2), for which the beta values were low with regard to Frequency of tooth cleaning and high for the quality (oral hygiene status), further indicating that fluorides from the toothpaste give no additional effect on the number of carious surfaces when increasing the frequency of application from once to twice a day.

Conclusions

The present study has demonstrated a lower number of carious surfaces among 35-year-old Oslo citizens with low OHI-S scores than among those with high scores (Table 1). This is confirmed multivariately (Table 2). One should realize that oral hygiene was assessed by a coarse method (OHI-S) and that a more detailed assessment of plaque on caries-susceptible surfaces might have demonstrated a stronger relation between caries and oral hygiene status in the present study population. The explanatory factor for all the independent variables ($R^2 = 0.146$) might also have been higher. This low factor indicates that the set of independent variables chosen for the additive model in the present study gives limited knowledge of the

dynamics of caries in the study population. A multifactorial approach taking into consideration more of the total number of variables of possible influence on the caries status may be essential in detecting the full potential of variables relevant for dental caries in adults.

Acknowledgement.—This study received financial support from the Norwegian Research Council for Science and the Humanities.

References

1. Løe H, Fehr FR von der, Rindom Schjøtt C. Inhibition of experimental caries by plaque prevention. The effect of chlorhexidine mouthrinses. *Scand J Dent Res* 1972;80:1–9.
2. Bellini HT, Arneberg P, Fehr FR vd. Oral hygiene and caries (A review). *Acta Odontol Scand* 1981;39:257–65.
3. Andlaw RJ. Oral hygiene and dental caries—a review. *Int Dent J* 1978;28:1–6.
4. Axelsson P, Lindhe J. The effect of a preventive programme on dental plaque, gingivitis and caries in school-children. Results after one and two years. *J Clin Periodontol* 1974;1:126–38.
5. Lindhe J, Axelsson P. The effect of controlled oral hygiene and topical fluoride application on caries and gingivitis in Swedish schoolchildren. *Community Dent Oral Epidemiol* 1973;1:9–16.
6. Bellini HT, Campi R, Denardi JL. Four years of monthly professional toothcleaning and topical fluoride application in Brazilian schoolchildren. I. Effect on gingivitis. *J Clin Periodontol* 1981;8:231–8.
7. Marthaler TM. Decrease of DMF-levels 4 years after the introduction of a cariespreventive program; observation in 5819 school children of 20 communities. *Helv Odontol Acta* 1972;16:45–68.
8. Malmberg E. Tuve-forsöket. Tre års profylaktisk behandling av 16-19-åringar. *Tandlakartidn* 1976;68:1087–8.
9. Axelsson P, Lindhe J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. *J Clin Periodontol* 1978;5:133–51.
10. Greene JC, Vermillion JR. The simplified oral hygiene index. *J Am Dent Assoc* 1964;68:25–31.
11. Bjertness E, Eriksen HM, Hansen BF. Caries prevalence of 35-year-old Oslo citizens in 1973 and 1984. *Community Dent Oral Epidemiol* 1986;14:277–82.
12. Bærum P, Holst D, Rise J. Dental health in Trøndelag. Changes from 1973–1983. Oslo; Directorate of Health, 1985.
13. Holst D. Levekår og tannhelse i Finnmark. Oslo: Institute of Community Dentistry, University of Oslo, 1988:130.
14. Heløe LA. Tannhelsen i Norden. Holdninger, interesse, kunnskap. Rapport fra enquete-undersøkelse, foretatt 1977. Oslo: Institute of Community Dentistry, University of Oslo, 1979:81.
15. Skjörland KKr. Plaque accumulation on different dental filling materials. *Scand J Dent Res* 1973;81:538–42.
16. Klein H, Palmer LE, Knutson JW. Studies in dental caries. I. Dental status and dental needs of elementary school children. *Publ Health Rep* 1938;53:751–65.
17. Hollender L, Koch G. Roentgenographic partial recording of caries in assessment of effect of prophylactic measures. *Odontol Rev* 1969;20:267–82.
18. Jacobsen PH. Håndbok i DDPP. Oslo: Universitetsforlaget, 1982:283.
19. Andrews FM, Morgan JN, Sonquist JA, Klem L. Multiple classification analysis. A report on a computer program for multiple regression using categorical predictors. Institute of social research. Ann Arbor: The University of Michigan, 1973:104.
20. Dunn OJ. Basic statistics: A primer for the biomedical sciences. New York: John Wiley & Sons, 1967.
21. Hansen BF. Dental conditions in a 35-year-old Norwegian urban population [Thesis]. Oslo, Norway: University of Oslo, 1976.
22. Fasler-Chu BB, Curilovic Z, Wally M, Ottiker J, Meier C. Zahnverlust und Zahnersatz bei einer Gruppe 35-jähriger Zürcher. *Schweiz Monatsschr Zahnheilkd* 1981;91:166–72.
23. Laurell L, Holm G, Hedin M. Tandhälsan hos vuxna i Gävleborgs län. *Tandlakartidn* 1983;75:759–77.
24. Brandburn NM, Sudman S, Blair E, et al. Improving interview method and questionnaire design (Response effect to threatening questions on survey research). San Francisco: Jossey-Bass, 1980:214.
25. Bourke GJ, Daly LE, McGilvray J. Interpretation and uses of medical statistics. Oxford: Blackwell Scientific Publications, 1985:330.