# Restorative treatment decisions on occlusal caries in Scandinavia

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In order to map variations in the operative treatment threshold for occlusal caries, a pre-coded questionnaire was sent to a random sample of 759 dentists in Norway, 923 in Sweden, and 173 in the Danish Public Dental Health Service inquiring about caries and treatment strategies. A further intention was to explore the type of operative treatment and filling material dentists in Scandinavia would use given an occlusal lesion in the lower 2nd molar in a 20-year-old. It is found that close to 70% of dentists in the 3 countries would put off carrying out operative treatment of occlusal caries until they registered a moderately sized cavity and/or any radiolucency in dentin. In Sweden, 26.7% of dentists and in Denmark 24.3% would postpone operative treatment until the lesion had a large cavity and/or until radiolucency could be observed in the middle third of the dentin; in Norway, only 11.5% of dentists indicated this. The majority of dentists in all 3 countries preferred to drill only the carious part of the fissure, though in Norway more dentists (30.9%) would tend to drill the whole fissure compared to their Swedish (23.4%) and Danish (9.5%) colleagues. The majority of Danish dentists (52.4%) suggested amalgam for restoring the occlusal surface, while 19.9% of Norwegian and 2.9% of Swedish dentists would use amalgam. Composite was the first material of choice for 71.5% of the Swedish dentists, the remaining 25.6% suggesting conventional glass ionomer cement, light-cured 'glass ionomer cement', or a combination of glass ionomer cement and composite. The corresponding values for the Norwegian dentists were 39.1% and 41.0%, respectively, and for the Danish dentists 29.2% and 18.4%. In Scandinavia, the leading strategy for occlusal caries seems to be to postpone operative treatment until a definite cavity or radiolucency in the outer third of dentin can be observed, and to carry out operative treatment only of the part of the fissure that is carious. Composite resin is the predominant material of choice in Sweden, while in Denmark the majority of dentists preferred amalgam. Composite, or composite in combination with glass ionomer cement material, was the choice of almost 80% of Norwegian dentists. □ *Caries diagnoses; operative treatment; restorative materials*

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While the prevalence of caries has declined in the Western world (1–4), the relative amount of occlusal caries has increased, and occlusal surfaces are probably more susceptible to attacks than approximal and buccal surfaces (5–7). Several authors have documented the difficulty of accurate clinical diagnosis of occlusal caries (8–10). Radiographs are often recommended as a supplement to the clinical examination of occlusal surfaces (11–13). Van Amerongen (14) concluded that bitewings are valid diagnostic aids when lesions extend more than 0.5 mm beneath the dentinoenamel junction.

While restorative treatment thresholds in accordance with lesion severity have frequently been reported for approximal caries (15–24), the same is not the case for occlusal caries. In 2 studies, Scottish dentists were asked how they would manage occlusal lesions of different severity, and to indicate the point at which an amalgam filling would become necessary (20, 25). About 55% of the dentists felt that a filling ought to be provided prior to visible cavitation for lesions of the occlusal surfaces of a 12-year-old (20). Only 35% of a group of Ontario dentists indicated that they would do the same (26). This percentage dropped to 17% with patients 30 years of age. However, the majority of dentists in that study would not place a restoration in older patients until the cavity was at least 0.5 mm in diameter and had a soft floor (26). A similar strategy was chosen by Swedish dentists; in a questionnaire study, 67% reported that they would only consider immediate restorative treatment of an occlusal surface if obvious cavitation and/or radiographic signs of dentin caries could be observed (27). For a lower 2nd molar with a minor occlusal caries lesion combined with a suspected dentin involvement judged radiographically, about half of the dentists reported that they would restore the carious part only and 27% would seal the rest of the system in addition (28).

Since variations in the operative treatment strategy of approximal caries have been demonstrated among dentists in Norway and Sweden (23, 27), we aimed to describe possible variations in the operative treatment threshold used for occlusal caries by dentists in Scandinavia. We also explored the type of operative treatment and the preferred

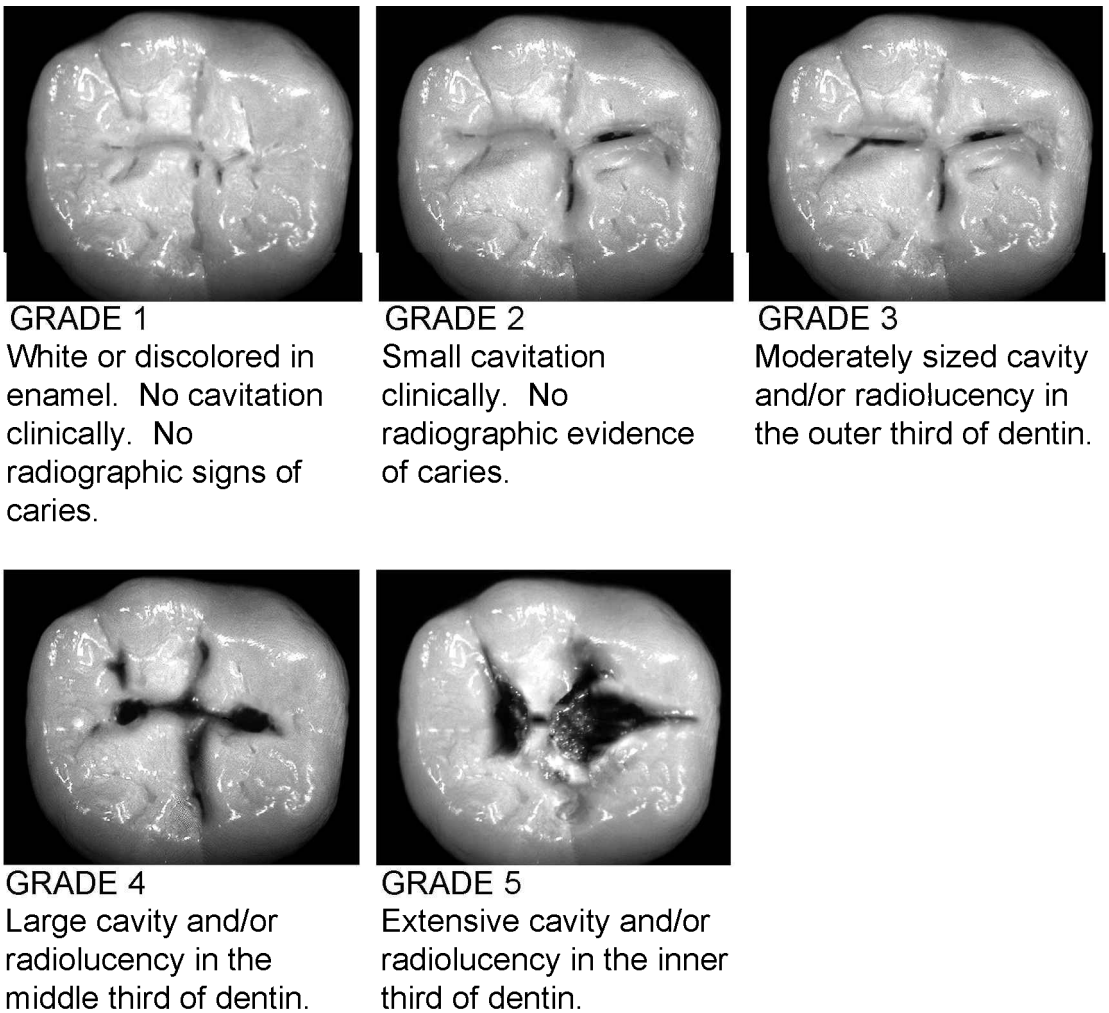


Fig. 1. Illustrations of occlusal caries of different severities used in questions 1 and 2.

filling material dentists in Norway, Sweden and Denmark would use given an occlusal lesion in the lower 2nd molar in a 20-year-old.

## Materials and methods

A pre-coded questionnaire was sent to a random sample of 759 Norwegian dentists and to 923 Swedish dentists during November 1995 and October 1996. They were drawn from the registers of authorized dentists of the Norwegian Dental Association and the Swedish National Board of Health and Welfare. Dentists 67 years of age and over in Norway and 65 years and over in Sweden, along with specialists, full-time teachers and administrators, were excluded. The same questionnaire was answered by 173 dentists working in the Danish Public Dental Health Service who had subscribed for a course about caries and treatment strategies.

Three questions asked about opinions and routines in connection with radiographic and clinical examination of occlusal caries. *Question 1*: The photographs in Fig. 1 show occlusal surfaces with carious lesions of different severity: Grade 1 – white or brown discoloration in enamel, no clinical cavitation, no radiographic evidence of caries; Grade 2 – small cavity formation, or discoloration of the fissure with a surrounding opaque or gray zone of enamel and/or radiolucency in enamel; Grade 3 – moderately sized cavity and/or radiolucency in the outer 1/3 of the dentin; Grade 4 – large cavity and/or radiolucency in the middle 1/3 of the dentin; Grade 5 – extensive cavity and/or radiolucency in the inner 1/3 of the dentin. Which lesion or lesions should be restored immediately? *Question 2*: How would you treat this surface if it is assumed that the lesion is in the lower 2nd molar in a 20-year-old patient with adequate hygiene and who uses fluoride toothpaste? During drilling, you observe the lesion in the dentin. Would you: 1) Drill the carious part of the fissure? 2) Drill the whole fissure? 3) Take some other course? *Question 3*: Which filling material would you choose between: 1)

Table 1. Some characteristics of the national dentist samples

| | No. of respondents (reply rate) | Type of practice | | | Mean age (†) |
|---|---|---|---|---|---|
| | | Private practice | Public Dental Health Service | Combinations or dentist not in practice (other) | |
| Norway | 640 (84.4%) | 366 (58.4%) | 248 (39.6%) | 13 (2.1%) | 45.4 (10.7) |
| Sweden | 590 (70.5%) | 244 (42.3%) | 301 (52.2%) | 32 (5.5%) | 46.1 (9.3) |
| Denmark | 173* | | 169 (97.7%) | 4 (2.3%) | 45.5 (8.0) |

* No random sample selected; respondents attended courses organized by the Public Dental Health Service.
† Standard deviation in parentheses.

amalgam; 2) composite; 3) conventional glass ionomer cement; 4) light-cured 'glass ionomer cement'; 5) combination of glass ionomer cement and composite; 6) any other alternative (describe). In addition, the dentists were asked about criteria for restoring approximal caries. These results were described in separate papers (23, 27).

The Norwegian dentists who returned the questionnaire were asked to write their names on the reply envelope. Those who did not reply within 2 weeks were sent a reminder. Returned questionnaires were treated anonymously. Data were analyzed employing standard programs available in the statistical package SPSS for Windows, release 9.0.0. Multiple comparisons between groups of dentists were completed using one-way ANOVA and the post hoc test with Bonferroni correction for multiple comparisons. Chi-squared tests were also used. For correlation analysis during exploration of the data the nonparametric Spearman's rho was used. In general, statistical significance was accepted at the 5% level (two-tailed).

## Results

A total of 1403 dentists responded to the questionnaire (Table 1), with a reply rate of 84.4% in Norway and 70.5% in Sweden; the Danish material was collected as a pre-course questionnaire among participants in the Public Dental Health Service who entered for a course about caries and treatment strategies. Participants' ages are given in Table 1. There was no statistically significant age difference between private practitioners and Public Dental Health Officers responding in Norway, whereas Swedish private practitioners had a mean age of 47.7 years compared to 45.0 for Public Dental Health Officers ($P = 0.001$).

### *Treatment criteria*

Table 2 presents the distribution of dentists according to the treatment criteria for occlusal caries and patient history given in *Question 1*. The majority, close to 70% of the dentists in the 3 countries, would wait to do operative treatment until they registered a moderately sized cavity and/or any radiolucency in dentin. In Sweden, 26.7% of the dentists and in Denmark 24.3% would postpone operative treatment until the lesion had a large cavity and/or they could observe radiolucency in the middle third of dentin (Grade 4), while only 11.5% of the Norwegian dentists indicated that they would do the same. More dentists in Norway (17.8%) answered that they would restore at an earlier stage (Grade 1 or 2) compared to their Swedish (5.9%) and Danish (4.6%) colleagues.

A comparison between dentists working in the Public Dental Health Service and private practitioners is given in Table 2. The only statistically significant difference was

Table 2. Criteria for instigating restorative treatment in accordance with grade of severity of occlusal caries. The values are given in percentage and cumulative percentages in parentheses. The differences between dentists (total) in Norway and Sweden and Norway and Denmark are all statistically significant ($P < 0.000$), but not between Sweden and Denmark ($P = 1.000$)

| | | Criteria for restorative therapy according to photographs and text in Fig. 1 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | *n* | |
| Norway | Private practice | 0.3 | 14.0 (14.3) | 70.7 (85.0) | 14.5 (99.5) | 0.5 (100.0) | 365 | |
| | Public Dental Health Service | 0.8 | 21.5 (22.3) | 70.0 (92.3) | 7.3 (99.6) | 0.4 (100.0) | 247 | $P = 0.002$ |
| | Other | | 30.8 | 61.5 (92.3) | 7.7 (100.0) | | 13 | |
| | All (Norway) | 0.5 | 17.3 (17.8) | 70.2 (88.0) | 11.5 (99.5) | 0.5 (100.0) | 625 | |
| Sweden | Private practice | | 5.8 | 62.8 (68.6) | 31.0 (99.6) | 0.4 (100.0) | 242 | |
| | Public Dental Health Service | | 6.0 | 69.6 (75.6) | 24.1 (99.7) | 0.3 (100.0) | 299 | NS |
| | Other | | 6.5 | 74.2 (80.7) | 19.4 (100.1) | | 31 | |
| | All (Sweden) | | 5.9 | 67.0 (72.9) | 26.7 (99.6) | 0.3 (99.9) | 572 | |
| Denmark | Public Dental Health Service | | 4.1 | 69.8 (73.9) | 24.9 (98.8) | 1.2 (100.0) | 169 | |
| | Other | | 25.0 | 75.0 (100.0) | | | 4 | |
| | All (Denmark) | | 4.6 | 69.9 (74.5) | 24.3 (98.8) | 1.2 (100.0) | 173 | |

Table 3. Relationship between dentist's age and the criteria for restorative treatment of occlusal caries in Norway. The values are given in percentage and cumulative percentages in parentheses. The difference between the youngest and oldest age groups is statistically significant ($P = 0.015$)

| | Criteria for restorative therapy according to photographs and text in Fig. 1 | | | | | |
|---|---|---|---|---|---|---|
| Age group | 1 | 2 | 3 | 4 | 5 | *n* |
| ≤35 year | 0.8 | 9.2 (10.0) | 73.8 (83.8) | 15.4 (99.2) | 0.8 (100.0) | 130 |
| 36–47 year | 0.4 | 18.1 (18.5) | 69.0 (87.5) | 11.9 (99.4) | 0.4 (99.8) | 226 |
| ≥48 year | 0.4 | 20.6 (21.0) | 69.0 (90.0) | 9.7 (99.7) | 0.4 (100.1) | 277 |

found among Norwegian dentists. Compared to the dentists in Public Dental Health Service, more private practitioners would wait longer (Grade 4: 15.0% vs 7.7%) and fewer would start operative treatment earlier (Grade 1 or 2: 14.3% vs 22.3%). This tendency was not observed among the Swedish dentists.

When the treatment criteria were correlated to age of the dentist it was found that the youngest dentists in Norway would postpone restorative treatment of occlusal caries longer, until it reached a more advanced stage, compared to the older dentists (Table 3). No difference between age groups could be found for the Swedish and Danish dentists.

### *Preparation technique*

The majority of dentists in all 3 countries preferred to drill only the carious part of the fissure: 68.3% in Norway, 76.2% in Sweden, and 90.3% in Denmark. In Norway, more so than in Sweden, dentists tended to drill the whole fissure (31.7% and 23.8%, respectively). In Denmark the percentage was 9.7. The differences between countries were all statistically significant ($P < 0.01$).

### *Restorative material*

The majority of the Danish dentists (52.4%) suggested amalgam for restoring the occlusal surface, while 19.9% of the Norwegian and 2.9% of the Swedish dentists would do the same (Table 4). Composite was the first material of choice for 71.5% of the Swedish dentists, the remaining 25.6% suggesting conventional glass ionomer cement; light-cured 'glass ionomer cement', or a combination of glass ionomer cement and composite. The corresponding values for the Norwegian dentists were 39.1% and 41.0%, respectively, and for the Danish dentists 29.2% and 18.4%. Very few dentists indicated that they used other materials or combinations of materials than suggested in the questionnaire (Table 4).

### *Relationship between treatment of approximal and occlusal caries*

Table 5 is a cross tabulation of the criteria for determining operative treatment occlusally and the treatment threshold for approximal caries given by the same dentist (23, 27). A regression analysis with the criterion for operative treatment of the occlusal surface as dependent variable, and the criterion for operative treatment of approximal surface as independent variable, gave the explained variance ($R^2$) of 0.170 ($\beta = 0.413$, $P < 0.000$). Splitting to national level the Norwegian values were $R^2 = 0.146$, $\beta = 0.384$, $P < 0.000$; the corresponding values for Sweden were $R^2 = 0.113$, $\beta = 0.339$, $P < 0.000$ and Denmark $R^2 = 0.137$, $\beta = 0.376$, $P < 0.000$, respectively. Squared $R$, the proportion of variation in the dependent variable explained by the regression model, ranges in value from 0 to 1. The actual values indicate significant relationships between the threshold levels for instigating restorative care occlusally and approximally.

## Discussion

The dentist samples examined differ between Denmark and the other 2 countries. The sample sizes in Norway and Sweden were 640 and 590, which are response rates of 84.4% and 70.5%, respectively (Table 1). In Norway the age distribution was close to the dentist population (23). In Sweden the proportions of responding dentists between the Public Dental Health Service and private practice were virtually the same as the national proportion between the 2 groups (27). The results are therefore likely to be representative of the national dentist populations in the 2 countries. The Danish sample is not necessarily represen-

Table 4. Filling material of first choice in an occlusal cavity in a 2nd molar in the lower jaw among Scandinavian dentists

| | Amalgam | Composite | Conv. GIC | Resin modified GIC | Combined GIC and composite | Other | Total (*n*) |
|---|---|---|---|---|---|---|---|
| Norway | 19.9 | 39.1 | 10.5 | 11.9 | 16.1 | 2.7 | 100.0 (639) |
| Sweden | 2.9 | 71.5 | 5.6 | 5.8 | 12.6 | 1.6 | 100.0 (586) |
| Denmark | 52.4 | 29.2 | 1.2 | 1.2 | 14.3 | 1.8 | 100.0 (168) |
| All dentists | 16.7 | 51.5 | 7.3 | 8.0 | 14.4 | 2.0 | 100.0 (1393) |

Table 5. Cross-table showing criteria for instigating operative treatment occlusally and approximally split into nations

| | | Radiographic criteria for operative treatment of approximal caries | | | | |
|---|---|---|---|---|---|---|
| | Criteria for restorative therapy (occlusally) according to photographs and text in Fig. 1 | Lesion in enamel | Up to outer 1/3 of dentin | Up to outer 1/2 of dentin | Up to 2/3 dentin thickness | Total |
| Norway | 1 | 2 | 1 | | | 3 |
| | 2 | 40 | 62 | 8 | | 110 |
| | 3 | 68 | 312 | 65 | 1 | 446 |
| | 4 | 6 | 18 | 50 | 1 | 75 |
| | 5 | | 1 | 1 | 1 | 3 |
| | Total | 116 | 394 | 124 | 3 | 637 |
| Sweden | 2 | 8 | 18 | 8 | | 34 |
| | 3 | 22 | 195 | 172 | 5 | 394 |
| | 4 | 4 | 27 | 122 | 2 | 155 |
| | 5 | | | 1 | 1 | 2 |
| | Total | 34 | 240 | 303 | 8 | 585 |
| Denmark | 2 | 2 | 4 | 2 | | 8 |
| | 3 | 6 | 68 | 45 | 2 | 121 |
| | 4 | | 9 | 31 | 2 | 42 |
| | 5 | | 1 | | 1 | 2 |
| | Total | 8 | 82 | 78 | 5 | 173 |

tative of the dentists in the Public Dental Health service, since it is based on course participants, but it may point to some trends in the Danish dental population.

Small variations in treatment thresholds were observed between the dentists in Scandinavia. For occlusal caries, dentists in Norway intervened earlier than dentists in the other 2 countries, the more so among dentists in the Public Dental Health Service. The same tendency was observed in the case of approximal lesions; dentists in Norway would carry out operative treatment earlier than their Swedish colleagues (23, 27). Compared with dentists in Public Dental Health Service, Norwegian dentists in private practice would operate on approximal lesions when the lesion had reached a less advanced stage. This could be because dentists in the Public Dental Health Service regularly see patients who are under 20 years of age and have more experience with primary caries in approximal and occlusal surfaces, while dentists in private practice see more occlusal surfaces with chronic carious lesions in older patients. Their basis for experience of caries progression is therefore related to different age groups of patients and different tooth surfaces.

In the Norwegian data a correlation was found between age of the dentist and treatment thresholds; the younger the dentist the greater the likelihood of operative treatment of the occlusal surface being postponed. This same relationship was found for approximal carious lesions in the Swedish study (27), but not for occlusal caries in Sweden and Denmark in the present data. This observation corresponds with the findings in a Canadian study (26); unlike the case with approximal caries, relatively older dentists would restore occlusal surfaces without cavitation.

There is a statistically significant relationship between the stage at which dentists suggest restorative treatment for occlusal and approximal caries. In the pooled dentist group there was a tendency for early intervention occlusally to be accompanied by early intervention approximally, although the regression analysis did not reveal more than 17% explained variance. When comparing dentists who apply grade 3 as the criterion for restoring occlusal caries, about 85% (380/406) of Norwegian dentists restore approximal lesions before they pass through the outer 1/3 of dentin; the corresponding percentages in Sweden and Denmark were 55 (217/394) and 61 (74/121), respectively (Table 5). In other words, even when comparing practitioners who apply the same treatment criteria for occlusal caries, the Norwegian dentists tend to treat approximally at an earlier stage. Factors that can influence treatment philosophy include the dentist's own experiences with his/her patients, but also criteria asserted by the dental schools and/or health authorities. In Sweden the health authorities have produced recommendations on treatment criteria (29) and in Denmark (30) and Norway (31) authorities associated with dental schools have been active in guiding clinicians. It follows therefore that advice to clinicians about when to treat caries differs in the Scandinavian countries (32) and this may explain some of the disparity. In a similar study in the 1980s, Norwegian dentists were shown to take a more positive attitude to early intervention than Dutch dentists (33). So there may still be a tendency for Norwegian dentists to favor an early 'drill and fill' philosophy compared to clinicians in some European countries.

The leading strategy in Scandinavia concerning occlusal caries seems to be to postpone operative treatment until a definite cavity or radiolucency in the outer third of dentin can be observed. This is the reported majority opinion as far as a molar in a 20-year-old patient is concerned and

seems to be in agreement with Ontario dentists' proportions of treatment of occlusal caries in older patients (26).

It could be suggested that clinical decision-making based on pictures of actual cases, as in this questionnaire study, is far from the real situation of clinical inspection and probing. Concerning clinical inspection without using a probe, Pitts (24) claims that: 'The changes in lesions morphology and activity and concern about the apparent increase in occult or hidden caries has also spurred changes in diagnostic criteria. The present trends are therefore away from probing with an explorer toward entirely visual diagnosis; and away from needing to see cavitation before calling a surface carious. Frank and open cavitation is no longer viewed as an absolute requirement for a diagnosis of dentin caries.' Though, the probe is still a useful instrument in the clinical situation for removing plaque from the surface to be inspected, visual examination without probing the carious lesion combined with radiographic examination may be more realistic than ever and be close to the clinical procedure recommended by Pitts (24).

For a small occlusal carious lesion requiring a restoration, the preventive resin restoration is a widely accepted procedure. This technique, first described by Simonsen and Stallard (34), offers much more conservation of the health tooth tissue than classical full-scale occlusal restoration. The preventive resin restoration involves limited excavation to remove carious tissue, restoration of the excavated area with a composite resin, and application of a sealant over the surface of the restoration and remaining, sound, contiguous pits and fissures (35). The procedure of operative treatment specifically of the carious part of the fissure is the most frequently proposed in the present study. However, dentists in Denmark are conservative, with only 1.8% of them doing operative treatment of the whole fissure compared to 23.5% of the dentists in Sweden and 30.7% of the dentists in Norway. The Swedish data are very close to the reported data from Canada; 23% of Ontario dentists indicated that they would prepare a conventional cavity extending to include all fissures and restore the tooth with amalgam or composite when the occlusal surface had a small cavity (1–1.5 mm) that had penetrated the dentino-enamel junction (26). From a study dealing with restorative caries treatment patterns in Denmark, data pertaining to maxillary molars indicated a tendency to placement of small fillings related to the tooth specific morphology in contrast to the extended fillings in mandibular molars (36). In the same study it was reported that, in 1986, 0.5% of the occlusal fillings were tooth colored resin materials in contrast to 6% in 1991. In the present study, 28.9% of the Danish dentists said they would prefer composite resin materials while 14.5% indicated use of a combination of glass ionomer cement and composite. In Sweden, composite resin material is the predominant material of choice for the occlusal surface; 71.6% said they used this material and 12.6% said they would use it in combination with glass ionomer cement. The proposed restorative materials for use in treating occlusal caries correspond to the government's recommendation in Sweden that amalgam should not be used in children and young adults, and to the reported reduction in its use (37, 38). There is no ban in Sweden on the use of amalgam and the recommendation is not so strongly declared against amalgam use in adults as it is in children and young adults. Among the Danish dentists in the present study, amalgam is still the predominant material for restoring occlusal surfaces, which indicates that there may be less debate on the possible health hazards in Denmark than there is in the other 2 Scandinavian counties. The Norwegian data indicate that considerably less amalgam is used for restoring occlusal surfaces. This corresponds well with the recent publication of Mjör et al. (39), who have noted a marked shift away from amalgam restorations during the past 2 decades in Norway. The change from amalgam to tooth-colored material has been particularly noticeable for Class I and Class V restorations.

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