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Risk Factors for High Occlusal Wear Scores in a Population-Based Sample: Results of the Study of Health in Pomerania (SHIP)

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**Purpose:** Using a population-based sample of the cross-sectional epidemiologic “Study of Health in Pomerania” (SHIP), this study evaluated whether certain occlusal and sociodemographic factors besides age and gender are risk factors for high dental wear.

**Materials and Methods:** Medical history and dental and sociodemographic parameters of 2,529 dentate subjects selected representatively and according to age distribution were checked for correlations with the occurrence of high occlusal wear symptoms using a multivariate logistic regression model. Occlusal wear was recorded using the attrition index by Ekfeldt et al and was age adjusted by determining high occlusal wear for every 10-year age group as index values \( \geq 90 \)th percentile. **Results:** The following independent variables were found to be correlated with high occlusal wear: male gender, odds ratio 2.2; frequent bruxism, odds ratio 2.5; loss of molar occlusal contact (Eichner classification), odds ratio from 1.5 to 3.1; edge-to-edge relation of incisors, odds ratio 1.7; unilateral buccolingual cusp-to-cusp relation, odds ratio 1.8; and unemployment, odds ratio 1.6. In contrast, anterior cross-bite, unilateral posterior cross-bite, and anterior crowding were protective for high occlusal wear levels, as shown by significantly reduced odds ratios. Gender-separated analysis showed that self-reported bruxism was a risk factor only for men. **Conclusion:** In addition to some occlusal factors, the main factors associated with occlusal wear were bruxism and gender. Int J Prosthodont 2004;17:333–339.

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Occlusal wear is defined as loss of substance on opposing units or surfaces as a result of attrition or abrasion.\textsuperscript{1} It can occur because of contact of occluding surfaces (tooth-to-tooth contact) or contact of teeth with other materials introduced into the mouth.\textsuperscript{2,3} Epidemiologic studies have shown that the occurrence of occlusal wear increases with age.\textsuperscript{4,5} However, strong occlusal wear is low in industrialized countries.\textsuperscript{6,7} Nevertheless, several authors state an increase of occlusal wear in these populations for children and adults.\textsuperscript{8–10} Epidemiologic studies on adults to confirm this statement are rare, and those that do exist did not use random samples and investigated only a few subjects.\textsuperscript{11} Most of the larger studies were performed up to the mid-1990s.\textsuperscript{6–8}

High occlusal wear may become an esthetic problem. Because of the loss of the vertical dimension, the occlusal situation also can be adversely affected.\textsuperscript{6} A relationship between temporomandibular disorders (TMD) and occlusal wear was not found.\textsuperscript{12,13} Treatment of extremely worn teeth...
is complicated, results in the restoration of the whole den-
tition, and is thus quite expensive.14,15

In general, there has been a strong decline in caries and an
improvement of oral health in industrialized countries in
the past years.16-18 Hence, a longer period of tooth func-
tion results, and age-dependent occlusal wear may
become a relevant problem in higher age groups.19 High
occlusal wear scores are also found among younger in-
dividuals.8 Besides age, the main risk factors of dental wear
are bruxism and the number of remaining teeth.7,20 Several
factors such as diet, saliva buffering capacity, and social
parameters are also discussed.11

The reported signs of an increase in occlusal wear
need further substantiation by evaluation of a random
population-based sample. Furthermore, the effect of sev-
eral risk factors for occlusal wear should be weighted. The
aim of the present study was to determine the prevalence of
occlusal wear within a population-based sample of the
cross-sectional epidemiologic “Study of Health in
Pomerania” (SHIP) and to evaluate whether certain oc-
clusal and sociodemographic factors besides age and
gender are risk factors for high occlusal wear.

Materials and Methods

Among 4,310 randomly selected subjects, 2,529 dentate in-
dividuals were examined from October 1997 to May 2001
within SHIP21 and screened for risk factors for high occlusal
wear levels using a multivariate logistic regression model.
SHIP is a population-based cross-sectional study intended
to systematically describe the prevalence of and risk fac-
tors for diseases common in the population of Pomerania
in northern Germany. The gross sample comprised 6,267
subjects with an age range of 20 to 79 years. The response
rate of the study was 68.8% overall and 71.3% for the age
groups 20 to 74 years. An analysis of nonresponders found
that the main reasons for nonparticipation were disinter-
rest (39.7%), health problems (23%), adequate available
medical care (11.6%), lack of time (16.7%), fear of exami-
nation results (3%), and other reasons (8%). Sample re-
cruiting was performed randomly via residents’ registra-
tion office files. The study consisted of four parts: a medical and
a clinical dental examination including the functional analy-
sis, an interview, and a questionnaire.

Clinical dental examinations were performed by eight
calibrated examiners. Training of the examiners and con-
sensus discussions were carried out before the study
started and took place twice a year while the study was
running. Inter- and intraexaminer reliability were checked
and have already been published.22

For occlusal wear calculations, only the data from den-
tate subjects could be included in the regression model.
Subjects were excluded if in two or more sextants (the
complete dentition was divided into six sextants, two an-
terior and four posterior), three or more teeth per sextant
were missing (excluding third molars), regardless of
whether the missing teeth had been prosthetically re-
placed. This means that the absolute minimum number of
remaining teeth necessary for including subjects in the
model was 15. This limitation was necessary to determine
different types of malocclusion.

Occlusal wear was recorded using the method by
Hugoson et al:7 0 = no or minimal wear (uncertain wear);
1 = attrition of enamel down to dentin spots; 2 = wear of
the dentin down to one third of the crown height; and 3 =
wear of the dentin more than one third of the crown height
or excessive wear on dental materials. The individual tooth
wear (IA) was calculated using the attrition index by Eklundt
et al23 using the following formula:

\[
(10G_1 + 30G_2 + 100G_3)/(G_0 + G_1 + G_2 + G_3)
\]

where \(G_0, G_1, G_2, \) and \(G_3\) = number of teeth with occlusal
wear scores of 0, 1, 2, and 3, respectively. High occlusal
wear was first determined as index values \(\geq 90\)th per-
centile (total sample), and then as index values \(\geq 90\)th
percentile for every 10-year age group. Furthermore, mean
values of the wear score were calculated to illustrate the
high-wear group and make the prevalence comparable
with other studies.

The following variables were included in the logistic re-
gression model:

1. Symptoms of malocclusion: angle Class II and III, an-
terior and posterior crowding, mucogingival cusp-to-
cusp relation, edge-to-edge relation of the incisors,
and anterior/posterior cross-bite.
2. Existence of remaining natural occlusal supports ac-
cording to the Eichner index.24 The Eichner index was
summarized as: \(\text{A} = \text{no loss of natural occlusal sup-
ports; and \(B_1\) to \(B_4\) = loss of one to four (all) natural }
occlusal support areas.
3. Symptoms of TMD (tenderness or palpation pain in
the temporomandibular joint [TMJ] or masticatory
muscles).
4. Sociodemographic and anamnestic parameters (taken
from the interview): marital status (single, married,
separated, divorced), higher education level (high
school diploma), frequent bruxism, frequent heart-
burn, daily intake of acidic soft drinks, daily intake of
sweets, and current or previous unemployment.

For details of the clinical dental examination and interview,
see Hensel et al.22

For the regression analysis, the independent variables
were checked for significance by age category and gen-
der using a backward stepwise analytic method. A \(P\) value
\(< .001\) was required for entering the model, and statistical
significance was defined as \(P\) values \(< .05\). Analysis was
performed using SPSS logistic regression (SPSS) with the
colinearity diagnostics option, and assumptions of regression were checked. All statistical assumptions were met. In a first step, the 90th percentile of the attrition index was calculated over all age groups and gender and used as a dependent variable in the regression model. In a second step, the 90th percentile of the attrition index adjusted for the age groups was used in the analysis to exclude the influence of age on attrition. This method delivered associations for all investigated variables with the dependent variable “high occlusal wear.” These associations were expressed as odds ratios (OR), eg, a 1:1 ratio implied no increased risk. The coefficient of determination, Nagelkerke $R^2$, a factor that indicates the explanatory quality of the model, was also computed.25 Prevalence data were given to describe the sample structure. Age group–adjusted 90th percentile scores of the attrition index were used to determine high occlusal wear. Descriptive statistics were done with cross-table calculations. All calculations were performed with SPSS 11.0.

### Results

Mean numbers for score 1 varied between 33% and 45%, for score 2 between 8% and 32%, and for score 3 between 0.4% and 5%. Scores 2 and 3 increased with age. The 90th percentile over all age groups for all subjects was 24.3 (Table 1). Mean values of all scores varied between 0.6 and 1.4. Men showed significantly higher scores than women (with the exception of the highest age group). Mean scores of the high-wear group were nearly twice as high as the mean scores of the whole sample according to the age groups (Table 2).

### Table 1 Mean and Standard Deviation (SD) of Tooth Wear Parameters

<table>
<thead>
<tr>
<th>Age group (y)</th>
<th>Total teeth</th>
<th>Wear score 1</th>
<th>Wear score 2</th>
<th>Wear score 3</th>
<th>Occlusal attrition index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>20–29</td>
<td>28.4</td>
<td>2.4</td>
<td>44.8</td>
<td>24.1</td>
<td>8.1</td>
</tr>
<tr>
<td>30–39</td>
<td>26.7</td>
<td>3.0</td>
<td>44.1</td>
<td>24.2</td>
<td>14.0</td>
</tr>
<tr>
<td>40–49</td>
<td>25.4</td>
<td>3.3</td>
<td>40.1</td>
<td>24.4</td>
<td>20.3</td>
</tr>
<tr>
<td>50–59</td>
<td>24.1</td>
<td>3.4</td>
<td>33.8</td>
<td>23.3</td>
<td>29.9</td>
</tr>
<tr>
<td>60–69</td>
<td>20.7</td>
<td>3.3</td>
<td>33.0</td>
<td>25.9</td>
<td>32.2</td>
</tr>
<tr>
<td>70–79</td>
<td>21.8</td>
<td>2.8</td>
<td>34.4</td>
<td>28.5</td>
<td>31.9</td>
</tr>
</tbody>
</table>

$P$<90 = 90th percentile.

### Table 2 Mean and Standard Deviation (SD) of Occlusal Wear Scores According to Age Group

<table>
<thead>
<tr>
<th>Age group (y)</th>
<th>Total sample</th>
<th>Men</th>
<th>Women</th>
<th>High-wear group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>20–29</td>
<td>0.6</td>
<td>0.3</td>
<td>0.7**</td>
<td>0.3</td>
</tr>
<tr>
<td>30–39</td>
<td>0.8</td>
<td>0.4</td>
<td>0.9*</td>
<td>0.4</td>
</tr>
<tr>
<td>40–49</td>
<td>1.0</td>
<td>0.4</td>
<td>1.0*</td>
<td>0.4</td>
</tr>
<tr>
<td>50–59</td>
<td>1.2</td>
<td>0.4</td>
<td>1.3**</td>
<td>0.4</td>
</tr>
<tr>
<td>60–69</td>
<td>1.3</td>
<td>0.5</td>
<td>1.4*</td>
<td>0.5</td>
</tr>
<tr>
<td>70–79</td>
<td>1.4</td>
<td>0.5</td>
<td>1.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**P < .005, *P < .001; Mann-Whitney U test.

### Table 3 Sample Structure (n Total = 2,529, n High Wear = 252) and 90th Percentile of Attrition Index, Adjusted for Age

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency total</th>
<th>Frequency within high-wear group (≥ 90th percentile)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1,220</td>
<td>48</td>
</tr>
<tr>
<td>Female</td>
<td>1,309</td>
<td>52</td>
</tr>
<tr>
<td>Age group (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–29</td>
<td>572</td>
<td>23</td>
</tr>
<tr>
<td>30–39</td>
<td>673</td>
<td>27</td>
</tr>
<tr>
<td>40–49</td>
<td>549</td>
<td>22</td>
</tr>
<tr>
<td>50–59</td>
<td>462</td>
<td>18</td>
</tr>
<tr>
<td>60–69</td>
<td>214</td>
<td>8</td>
</tr>
<tr>
<td>70–79</td>
<td>59</td>
<td>2</td>
</tr>
<tr>
<td>No. of teeth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15–19</td>
<td>115</td>
<td>4</td>
</tr>
<tr>
<td>20–24</td>
<td>698</td>
<td>28</td>
</tr>
<tr>
<td>Eichner classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1,379</td>
<td>78</td>
</tr>
<tr>
<td>B1</td>
<td>334</td>
<td>13</td>
</tr>
<tr>
<td>B2</td>
<td>163</td>
<td>6</td>
</tr>
<tr>
<td>B3</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>B4</td>
<td>8</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

Sample structure and prevalence of the variables that were included in the logistic regression model are given in Tables 3 to 5. The high occlusal wear group was adjusted for every 10-year age group, as can be seen in the percentages given in Table 3. Gender distribution was nearly equal in the total sample, but there were nearly twice as many men as women in the case group. The
number of remaining teeth per subject of the dentate sample group was not less than 15, as stipulated by the definition of the orthodontic variables. Most of the subjects belonged to Eichner class A, no loss of natural occlusal support zones.

In Table 6, the logistic regression model is shown, using the 90th percentile over all age groups as cases. Because of the backward stepwise method, only variables with a \( P \) value \(< 0.10\) remained in the model. Male gender, age, loss of natural occlusal support areas, some occlusal factors, self-reported bruxism, and unemployment were significantly related to high occlusal wear. Men had a higher risk of suffering from high occlusal wear than did women (OR 2.2). There was a clear dose/response effect for age up to the 60- to 69-year-old age group and for the loss of one and two natural occlusal support areas (Eichner class B1 OR 1.9 and B2 OR 2.7). Age showed high ORs within all age groups compared to baseline. In addition to the occlusal factor “unilateral buccolingual cusp-to-cusp relation” with an increased OR for high occlusal wear (1.9), unilateral posterior cross-bite and anterior and lateral crowding seemed to be protective, as reduced ORs showed. Bruxism was strongly related to high occlusal wear (OR 2.2), while unemployment showed only a slightly elevated OR (1.6). The explanatory quality (Nagelkerke \( R^2 \)) of this model was 32%.

After exclusion of age as a risk by adjusting the 90th percentile of the attrition index to the age groups, additional occlusal factors became significant and entered the logistic regression model: edge-to-edge bite of the incisors (OR 1.7) and anterior cross-bite (OR 0.2). Furthermore, “tenderness of the masticatory muscles or the TMJ” showed a reduced OR (0.7). The other variables did not change noticeably (Table 7). Because of exclusion of age, the explanatory quality of the model was reduced to 12%.

Gender-separated analyses revealed that bruxism (OR 3.0), unilateral buccolingual cusp-to-cusp relation (OR 1.7), and edge-to-edge relation of the incisors (OR 2.3) were risk factors for high occlusal wear only in men.

**Discussion**

There are several methods and indices to assess tooth wear. Some authors have also used casts or photographs to determine the loss of dental hard tissue. Because of the extensive examination, our study focused only on occlusal wear, assessing mainly attrition and abrasion, although erosion also affects occlusal surfaces. Assessment of tooth wear was performed using the method of Hugoson et al., despite its limitations in assessing occlusal wear in restorations, to be comparable with other authors who also used graded scores to assess occlusal tooth wear. The subsample was selected using the criteria for the assessment of symptoms of malocclusion because occlusal factors should be evaluated as risk factors of occlusal wear. Therefore, only dentate persons who had at least 15 teeth were included in the study. Because of the different measurement scales and techniques used in the studies and the different methods...
in presenting the results, it is difficult to compare prevalence. In spite of this, the prevalence of occlusal wear found in the present study was certainly higher than that of Hugoson et al., but still lower than that found for Saudi, Indian, and Mexican-American and European-American populations, and it may be closest to the data of Salonen et al.

To determine risk factors for occlusal wear, it was necessary to calculate an index for detected wear scores. We used the attrition index by Ekfeldt et al., which should be a reliable tool to rank persons with occlusal wear and to differentiate between the wear scores. Because of the multifactorial character of the development of tooth wear, a stepwise logistic regression analysis was used to determine factors that are related to occlusal wear. The explanatory quality of the first model, which included age, was high, considering that this is a biologic system.

There is no doubt that occlusal wear increases throughout life, a fact confirmed in the present study. Only Seligman et al. did not find a correlation between age and attrition, but they did not use a randomly selected sample with different age strata. Age seems to be the most important factor in the progression of occlusal wear. ORs became very high for higher age groups, and after exclusion of age, Nagelkerke $R^2$ decreased by about two thirds.

Of all the occlusal factors we investigated, only those that alter the normal or maximal interocclusal contacts were related to occlusal tooth wear, ie, an edge-to-edge or cusp-to-cusp situation of the incisors or molars. Angle Class II or III malocclusion did not show a relation to occlusal wear, which was also reported by Seligman et al., whereas a 20-year follow-up could show that angle Class II malocclusion in childhood predicts increased tooth wear in adulthood.

Interestingly, an examination of a skull sample from the 15th and 16th centuries with advanced dental wear showed only a few dental anomalies and no skeletal malocclusions. Angle Class II occlusion, deep bite, crowding, spacing, and lateral cross-bite occurred with significantly lower frequencies in this skull sample compared to a present-day population. The author suggested that the dietary transition from hard to soft food is the most probable cause of the increased occlusal variation.

### Table 6: Odds Ratios of Significant Variables for Men and Women

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio</th>
<th>95% confidence interval</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age group (y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–29†</td>
<td>0.4</td>
<td>0.3–0.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>30–39</td>
<td>1.9</td>
<td>1.3–2.7</td>
<td>.010</td>
</tr>
<tr>
<td>40–49</td>
<td>2.7</td>
<td>1.7–4.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Unilateral posterior cross-bite</td>
<td>0.7</td>
<td>0.5–1.0</td>
<td>.054</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age group (y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–29†</td>
<td>1.7</td>
<td>1.3–2.7</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>30–39</td>
<td>2.3</td>
<td>1.9–3.8</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Unilateral posterior cross-bite</td>
<td>0.7</td>
<td>0.5–1.0</td>
<td>.054</td>
</tr>
</tbody>
</table>

*Reference group.

### Table 7: Odds Ratios of Significant Variables for Men and Women

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio</th>
<th>95% confidence interval</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge-to-edge bite of incisors</td>
<td>1.8</td>
<td>1.1–2.9</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Unilateral buccolingual cusp-to-cusp relation</td>
<td>1.8</td>
<td>1.3–2.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Tenderness in TMJ or masticatory muscles</td>
<td>0.7</td>
<td>0.5–1.0</td>
<td>.070</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge-to-edge bite of incisors</td>
<td>1.9</td>
<td>1.4–2.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Unilateral buccolingual cusp-to-cusp relation</td>
<td>1.8</td>
<td>1.3–2.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Tenderness in TMJ or masticatory muscles</td>
<td>0.7</td>
<td>0.5–1.0</td>
<td>.070</td>
</tr>
<tr>
<td>Edge-to-edge bite of incisors</td>
<td>1.8</td>
<td>1.2–2.1</td>
<td>.003</td>
</tr>
</tbody>
</table>

*Reference group.
and high frequency of malocclusion in present-day populations. As a risk factor for occlusal wear, the number of remaining teeth was also identified by Ekfeldt et al. To a certain degree, we also included number of teeth in our study, using the Eichner occlusal index. In our study, a dose/response effect between the decreasing number of occluding contact areas and an increase of the attrition index was observed. As in earlier studies, we did not find any positive relation between tenderness of the masticatory muscles and high occlusal wear. Instead, subjects with tenderness of the masticatory muscles or TMJ showed almost significantly less occlusal wear. It can be concluded that people who are affected by bruxism, whether self-reported or evident as occlusal wear facets, do not necessarily develop tenderness of the muscles or joint. It is more likely that tenderness prevents the development of wear facets or prevents bruxism. Several authors discuss the value of erosive nutrients for the development of dental wear because erosion also occurs on occlusal surfaces. In agreement with Pigno et al., the present study found no influence of soft drinks or fruit juices on the development of occlusal wear. Of the social factors investigated, only unemployment was significantly related to occlusal wear. The sample area of the study, West Pomerania, suffers from a high unemployment rate. Thus, the prevalence rate of 43% of people who are or have been unemployed in the past is not surprisingly high; however, the relation to high occlusal wear (OR 1.6) was quite low.

Conclusion

Men show higher occlusal wear scores than do women. Bruxism is a considerable risk factor for high occlusal wear in men. Adverse occlusal situations, such as edge-to-edge or cusp-to-cusp situations or loss of natural occlusal support zones, are associated with high occlusal wear. Crowding and cross-bite are protective for high wear because they provide a more stable interocclusal contact pattern. In our study, nutrition habits did not show a visible influence on occlusal wear.

Acknowledgments

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References