Radiographic Osteoarthritis in the Elderly Population of Zagreb: Distribution, Correlates, and the Pattern of Joint Involvement

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Aim. To determine the prevalence of radiographic osteoarthritis on five joint groups in an urban population sample of 306 women and 304 men over the age of 45 and to assess the influence of some risk factors on osteoarthritis. The validity of concept of generalized osteoarthritis was also examined by analyzing the association of osteoarthritis on different joint sites.

Methods. Radiographs of both hands, both knees, and the right hip were taken. Osteoarthritic changes on distal interphalangeal, proximal interphalangeal, first carpometacarpal joints, knees, and hip were graded according to the Kellgren-Lawrence scale. The association among osteoarthritis on different joint sites was analyzed using logistic regression. Subjects were tested for age, duration of postmenopause, anthropometric measures, blood pressure, and smoking as risk factors for osteoarthritis.

Results. Hip was the most frequent site of osteoarthritis in men (27.3%), whereas distal interphalangeal joints predominated in women (43.5%). Polyarticular osteoarthritis (≥3 joints) was present in 10.8% women and 5.9% men. There was a significant influence of age on single joint osteoarthritis, but not on multiple joint involvement. Obesity was significantly correlated with knee osteoarthritis in women and with osteoarthritis on distal interphalangeal joints in men.

Conclusions. In our population sample, the prevalence of knee osteoarthritis was lower and the prevalence of hip osteoarthritis higher than reported for most of other populations. The tendency towards polyarticular osteoarthritis that is more common than would be expected by age, suggests a subset of generalized osteoarthritis.

Key words: aged; arthritis, degenerative; Croatia, elderly; obesity; osteoarthritis, radiography; x-ray, diagnostic

Osteoarthritis is the most common joint disease. Its prevalence is high throughout the world, but the distribution of the disease differs from one geographical or ethnic area to another. A method of studying such chronic disease is by epidemiological approach. Many epidemiological studies have presented the results of prevalence and characteristics of the disease and also pointed out several risk factors. By confirming the multifactorial nature of osteoarthritis, epidemiological data helped to assess the role and influence of those factors on different subsets of osteoarthritis (1-4).

Osteoarthritis can be localized on one, two, or more joints, but if it affects three or more joint groups, it is usually known as polyarticular or generalized osteoarthritis. Common concepts of the pathogenesis of osteoarthritis suggest that it may be a final common pathway, precipitated by a variety of systemic or constitutional factors and local biomechanical influence (1). In many cases osteoarthritis is a local disease, confined to one or two joint sites (5-7), but many studies report multiple joint involvement in patients with osteoarthritis (2,5-10). The concept of polyarticular, generalized osteoarthritis as a disease subset, has been advocated and would be consistent with a strong constitutional or genetic predisposition to osteoarthritis in the affected individuals (11,12). However, the prevalence of osteoarthritis increases with age and an apparent association between osteoarthritis at different sites could be the consequence of greater reporting and investigating of symptoms in patients with multiple pathology. The concept of generalized osteoarthritis still requires further evidence, and radiological surveys of random population samples would now be difficult to justify. However, we had access to radiographs from a population study undertaken in Croatia in 1981-83 (13).
and we used the data from this study to address the issue of osteoarthritis.

The aim of this study was to determine the prevalence of radiographic osteoarthritis in a population sample of Zagreb, to compare the results to similar population surveys in the world, and to examine the validity of the concept of generalized osteoarthritis.

Subjects and Methods

Subjects

The radiographs in this study were taken as a part of the Epidemiological Study of Physical, Social and Psychological Health of Elderly People, organized by the European Office of the World Health Organization (13). The study was a part of a wider international study that aimed to collect as much information as possible about elderly people in European countries and suggest measures for improving the quality of their life. The study was conducted in Zagreb between 1981 and 1983.

Participants have been selected from the population records from ten municipal offices in Zagreb. They were stratified according to age and sex in order to get approximately equal number of men and women, older than 45 years. The random sample of 1,220 subjects were selected from population records and invited to attend for review. Of the 683 (56%) who agreed to do so, full data were collected from 629. Those who had rheumatoid arthritis or gout and those with amputated fingers or limbs were excluded from the study. Finally, 306 women and 304 men participated in the study.

As part of a larger collection of information on health and lifestyle, basic anthropometric measurements were made, including body height and body weight. Body mass index (BMI) was calculated using the formula: body weight (kg) divided by a square of height (m²). Nutritional status was classified into five categories, using the BMI index: lean: BMI<18.0; below average: 18.0≤BMI<20.0; average: 20.0≤BMI<25.0; above average: 25.0≤BMI<30.0; excess fat BMI≥30.0 (14).

Blood pressure was measured in all subjects. Those who had systolic blood pressure over 140 mmHg and/or diastolic blood pressure greater than 90 mmHg were recorded as hypertensive.

None of the postmenopausal women took hormonal replacement therapy.

All subjects were questioned about their smoking habits and were classified as never smoker, ex-smoker, and current smoker. Both ex-smokers and active smokers were included in further analysis.

Radiographs

Radiographs of both hands, both knees, and the right hip were taken from all participants. Hands were radiographed in posteroanterior projection and knees and right hip in anteroposterior projection (standing position). The degree of osteoarthritis in an individual joint was graded on a five-point scale, according to the standard of Kellgren and Lawrence (15). Grades 2, 3 and 4 were considered a definitive sign of osteoarthritis. Degenerative changes were graded for the distal and proximal interphalangeal joints and for the first carpometacarpal joints of the hands, for the tibio-femoral joints in the knees, and for the right hip. Those who had radiographic signs of osteoarthritis on three or more joints were considered as having generalized osteoarthritis.

Hand, hip, and knee radiographs were evaluated by different readers who were blinded to the results of the radiographic scoring in the other joints. Each joint group was evaluated by a different reader. To test the reliability of reading osteoarthritic changes, each observer repeatedly evaluated a sample of 100 radiographs. Concordance between those readings was determined by the Kappa statistic. Intraobserver reproducibility for grading osteoarthritic changes was 0.72 for the hands, 0.78 for the hip, and 0.68 for the knee radiographs.

Statistics

The differences in the prevalence of osteoarthritis between men and women and between right and left sides were tested by the t-test for proportions.

The association between radiographic osteoarthritides on different joint sites was analyzed using logistic regression, where odds ratio (the relative odds of having osteoarthritis in one joint if the other also had osteoarthritis) was calculated using a log-linear model.

Multiple regression analysis was used to test the relationship between several independent variables and osteoarthritis as a dependent variable.

The value p<0.05 was considered to be significant in t-test, chi-square test, and in multiple regression.

Results

A total of 610 subjects participated in the study. As shown in Table 1, there were no differences between men and women in mean values of age, body mass index (BMI), and blood pressure. The mean age was 63.6±10.9 years in women and 62.6±10.4 years in men. One third of women and 26.6% of men were overweight (BMI>25.0). Hypertension was found in 47.8% of women 50.1% of men. There were 15.7% female smokers and 27.9% male smokers (p<0.001).

Joint distribution

Table 2 shows the prevalence of radiographic osteoarthritis at five joint groups in men and women. The most frequent sites in women were distal interphalangeal joints (43.5%), first carpometacarpal joint (20.3%) and the hip (18.6%). Osteoarthritis in the hip joint was most frequent in men (27.3%), followed by distal interphalangeal joints (24.0%). Except for the hip, osteoarthritis on other joint sites was significantly more frequent in women (distal interphalangeal joints p<0.0001; proximal interphalangeal joints p<0.05; first carpometacarpal joints p<0.05; knees p<0.01).

Polyarticular involvement with osteoarthritis (≥3 joint groups) was present in 10.8% women and 5.9% men. Osteoarthritis at three different sites was recorded in 25 women (8.2%) and 15 men (4.9%) (Table 3). Six women (1.9%) and 3 men (0.9%) had osteoarthritis on four joints, whereas osteoarthritis on five joints was recorded only in 2 women (0.7%).

Comparing right and left sides, osteoarthritis was equally distributed in hands and knees. The exception were distal interphalangeal joints in women, where the right side (39.2%) was significantly more affected compared with the left side (30.4%) (p<0.05).

Associations

The strength of association between osteoarthritis on different joint groups was explored using log-linear

| Table 1. Age, body mass index (BMI), duration of postmenopause, and systolic and diastolic blood pressure in study participants |
|---|---|---|
| Clinical parameter | Women (n=306) | Men (n=304) |
| Age (years) | 63.6±10.9 | 62.6±10.4 |
| BMI (kg/m²) | 28.6±4.3 | 28.1±3.4 |
| Postmenopause (years) | 16.1±11.9 | 16.1±11.9 |
| Systolic R/R (mmHg) | 157.6±23.9 | 158.1±23.1 |
| Diastolic R/R (mmHg) | 93.1±12.7 | 93.5±13.7 |

*a Table shows the mean values and standard deviations. There were no significant differences in those parameters between men and women.*
model, where odds ratio was calculated with 95% confidence intervals (CI) (Table 4). Significant associations of osteoarthritis between all analyzed joint groups were found in both sexes. The strongest association was found between knees and hip in both sexes (men: 42.4, CI=19.4-92.9; women: 19.2, CI=7.0-52.0). The significant association, but of lower magnitude, was found in both sexes between osteoarthritis on distal and proximal interphalangeal joints (women: 6.9, CI=3.0-15.9; men: 6.0, CI=2.8-12.7). Similar associations were found only in women between proximal interphalangeal joints and first carpometacarpal joints (8.2, CI=3.4-19.4) and between first carpometacarpal joints (8.2, CI=3.4-19.4) and between first carpometacarpal joints and knees (6.4, CI=2.8-14.7). Table 5 shows the relationship between several independent variables (age, duration of postmenopause, body mass index, blood pressure and smoking) with radiographic osteoarthritis on each joint group separately and also with generalized osteoarthritis as dependent variables. There was a significant correlation between higher age and osteoarthritis, when controlling for other independent variables, in both sexes. Therefore, higher age was the best predictor for developing osteoarthritis, except for hip osteoarthritis in men. Body mass index was significantly correlated with knee osteoarthritis in women (p<0.05) and with osteoarthritis on distal interphalangeal joints in men (p<0.01). Duration of postmenopause, hypertension, and smoking did not correlate with osteoarthritis in both sexes.

Discussion

In this study, we found that hand joints were the most common site of radiographic osteoarthritis. The same observation was made in other studies of Caucasian populations (2,7,16). On the other hand, osteoarthritis in the knee joint was found to be the most common in West African and South African blacks, and in Saudi Arabsians (8,17,18). We found that distal interphalangeal joints were most affected in our population, followed by the first carpometacarpal joints and proximal interphalangeal joints, which is in agreement with other studies (2,7,16,19). The prevalence of hand osteoarthritis was approximately 15% higher in our population than it was reported for the urban population in Leigh, England (7). Prevalence of hand osteoarthritis in urban population of Malmö, Sweden, in the age of 79 and 85 years, was 34.7% in women and 27.1% in men (19), which is similar to our population sample of the same age.

Table 2. Number and percent of women and men with radiographic osteoarthritis at different joint sites

<table>
<thead>
<tr>
<th>Joint groups</th>
<th>Women</th>
<th>p</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal interphalangeal joints</td>
<td>133 (43.5)</td>
<td>&lt;0.05</td>
<td>73 (24.0)</td>
</tr>
<tr>
<td>Proximal interphalangeal joints</td>
<td>45 (14.7)</td>
<td>&lt;0.01</td>
<td>25 (8.3)</td>
</tr>
<tr>
<td>First carpometacarpal joint</td>
<td>62 (20.3)</td>
<td>&lt;0.01</td>
<td>38 (12.6)</td>
</tr>
<tr>
<td>Knee</td>
<td>30 (9.9)</td>
<td>&lt;0.001</td>
<td>13 (4.3)</td>
</tr>
<tr>
<td>Hip</td>
<td>57 (18.6)</td>
<td>&lt;0.01</td>
<td>83 (27.3)</td>
</tr>
<tr>
<td>Total</td>
<td>306 (100.0)</td>
<td></td>
<td>304 (100.0)</td>
</tr>
</tbody>
</table>

Table 3. Number (%) of men and women according to the number of joint groups affected with radiographic osteoarthritis

<table>
<thead>
<tr>
<th>No. of joint groups</th>
<th>Women</th>
<th>p</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>125 (40.8)</td>
<td>&lt;0.05</td>
<td>153 (50.3)</td>
</tr>
<tr>
<td>1</td>
<td>84 (27.5)</td>
<td>NS</td>
<td>93 (30.6)</td>
</tr>
<tr>
<td>2</td>
<td>64 (20.9)</td>
<td>&lt;0.05</td>
<td>40 (13.2)</td>
</tr>
<tr>
<td>3</td>
<td>25 (8.2)</td>
<td>NS</td>
<td>15 (4.9)</td>
</tr>
<tr>
<td>4</td>
<td>6 (1.9)</td>
<td>NS</td>
<td>3 (0.9)</td>
</tr>
<tr>
<td>5</td>
<td>2 (0.7)</td>
<td>NS</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>306 (100.0)</td>
<td></td>
<td>304 (100.0)</td>
</tr>
</tbody>
</table>

*Not significant.

Table 4. The strength of association between osteoarthritis on different joint groups, odds ratio (95% confidence intervals)

<table>
<thead>
<tr>
<th>Joints groupsa</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIP and PIP</td>
<td>6.9 (3.0-15.9)</td>
<td>6.0 (2.8-12.7)</td>
</tr>
<tr>
<td>DIP and CMC I</td>
<td>3.5 (1.7-7.2)</td>
<td>3.4 (1.8-6.2)</td>
</tr>
<tr>
<td>PIP and CMC II</td>
<td>8.2 (3.4-19.4)</td>
<td>3.0 (1.5-5.9)</td>
</tr>
<tr>
<td>DIP and knees</td>
<td>7.8 (3.5-17.2)</td>
<td>3.6 (2.0-6.6)</td>
</tr>
<tr>
<td>PIP and knees</td>
<td>2.3 (0.8-6.7)</td>
<td>2.5 (1.2-5.0)</td>
</tr>
<tr>
<td>CMC I and knees</td>
<td>6.4 (2.8-14.7)</td>
<td>2.6 (1.3-4.8)</td>
</tr>
<tr>
<td>DIP and hip</td>
<td>2.0 (1.1-3.4)</td>
<td>3.0 (1.6-5.5)</td>
</tr>
<tr>
<td>PIP and hip</td>
<td>1.3 (0.5-3.1)</td>
<td>1.9 (0.9-4.0)</td>
</tr>
<tr>
<td>CMC I and hip</td>
<td>0.9 (0.4-2.0)</td>
<td>1.4 (0.7-2.7)</td>
</tr>
<tr>
<td>Knees and hip</td>
<td>19.2 (7.0-52.0)</td>
<td>42.4 (19.4-92.9)</td>
</tr>
</tbody>
</table>

*aAbbreviations: DIP, distal interphalangeal joints; PIP, proximal interphalangeal joints; CMC I, first carpometacarpal joints.

Compared to other studies (7,15,19,21), our study found a lower prevalence of knee osteoarthritis, especially in comparison to the results of Framingham study where the prevalence was 31% in men and 34% in women (21) and with the Baltimore study with the prevalence of 32.3% in men and 37.3% in women (20). We noticed the domination of hip osteoarthritis in men, which is the same observation as in the most other studies, although the total prevalence of the hip osteoarthritis in our male population was higher (8.3-20.2%) than in others (7,16,17,22). It is difficult to explain such a marked difference in hip osteoarthritis between our population and other populations, but it could be related to a relatively high prevalence of congenital hip dysplasia in Slavs (23). Wiberg found that mild variant of acetabular dysplasia might go undetected, and that almost all children with acetabular dysplasia later developed osteoarthritis (24). In contrast, Croft found no evidence that dysplasia entailed a predisposition to osteoarthritis (25). Regardless of the influence of the developmental abnormalities on a high prevalence of hip osteoarthritis, it remains an obvious characteristic of our population. It would be useful to perform a separate grading of radiographic changes in osteoarthritis and to investigate whether any of them particularly contributed to the higher prevalence of hip osteoarthritis.

Many authors have emphasized that differences in prevalence between populations could be a consequence of several factors. The first is differences in the criteria for the diagnosis of osteoarthritis. Kellgren and Lawrence criteria
(15) are the most widely used for the radiographic evaluation of osteoarthritis and we have compared our results to studies that had been based on that method. The second important factor may be possible differences in the selection of subjects for the study. Our sample was representative for the community, whereas some other studies included patients with rheumatic complaints or those who had already been referred to rheumatologist and orthopedist and who may have had a more severe osteoarthritis. The third factor to consider in comparing population prevalence is interobserver as well as intraobserver variations in the interpretation of radiographs. Although it is probable that all these factors could contribute to some “artificial” differences between populations, their effect on the study results are not known. Our results are more similar to those studies which took place at the same time (16,19), compared to the studies that had been conducted earlier (7,22). This may reflect the secular variations in the frequency of diseases. But this presumption could be confirmed only if other factors are excluded, such as changes in the age and sex structure of population (i.e., due to war) or different diagnostic methods during the time.

We tested the association and clustering between osteoarthritis at different joint sites. Significant association existed between osteoarthritis at different joint groups of the hand and between osteoarthritis of the hand and knee joints. A less marked association was observed between the hip and other joints. We observed a tendency to polyarticular, general form of the disease. Using the multiple regression analysis, we found that multiple joint involvement was not influenced by age.

High correlation between osteoarthritis of the knees and proximal and distal interphalangeal joints has been found in Baltimore longitudinal study of aging (20). Such a significant association cannot be explained by chance or by age alone. Acheson found a correlation between the prevalence of osteoarthritis of the fingers and osteoarthritis of other joints, after controlling for age (22). Cooper et al also found a tendency towards polyarticular osteoarthritis in a study sample of 702 women (2). The strongest association was found between distal and proximal interphalangeal joints (2), the same as in our study. Cooper’s study also found that the disease on the distal interphalangeal joints was also linked to the thumb base and knee disease, whereas a less marked association was found between the knee and hip disease. Our study had a similar finding. Multiple joint involvement occurred more frequently than would be expected in terms of chance or increasing age. Cushnagan et al proposed that the high incidence of polyarticular disease associated with overweight, hypertension, and Heberden’s nodes suggested that most subjects with osteoarthritis had a background systemic predisposition for the disease (5).

We have analyzed the relationship between osteoarthritis and several parameters known as potential risk factors for developing osteoarthritis. Age was the most important risk factor for osteoarthritis on single joints, except for hip osteoarthritis in men. As mentioned previously, that could partly be explained by predominant influence of congenital dysplasia in our population. However, our results showed that the increase in the number of osteoarthrotic joints in each subject is higher than one would expect from the increase in age. That is in agreement with Cooper et al who have found that multiple joint involvement was significantly more frequent than could be explained by chance alone (2).

The duration of postmenopause had no effect on the prevalence of osteoarthritis in women. Although epidemiological and clinical observations have suggested a relationship between osteoarthritis and hormonal and menopausal factors in women (26), our results failed to confirm those findings.

Obesity significantly correlated with knee osteoarthritis in women and with osteoarthritis on distal interphalangeal joints in men. Several cross-sectional studies have shown an impressive association between obesity and knee osteoarthritis. The Framingham study found that body mass at the study onset had predicted the development of knee osteoarthritis 36 years later (27). Some studies of hand osteoarthritis have also shown a positive relationship between those two factors (28,29).

There was no significant influence of high blood pressure on osteoarthritis in our population sample. Law-

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**Table 5.** Associations (beta values of multiple regression analysis) of age, duration of postmenopause (PM), body mass index (BMI), and smoking blood pressure (R/R) with radiographic signs of osteoarthritis on different joint groups in men (M) and women (W)

<table>
<thead>
<tr>
<th>Joint groups</th>
<th>Age</th>
<th>PM</th>
<th>BMI</th>
<th>R/R systolic</th>
<th>R/R diastolic</th>
<th>Smoking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal inter-phalangeal joint</td>
<td>0.35</td>
<td>-0.05</td>
<td>0.25</td>
<td>-0.05</td>
<td>0.12</td>
<td>0.07</td>
</tr>
<tr>
<td>Proximal inter-phalangeal joint</td>
<td>0.22</td>
<td>-0.05</td>
<td>0.08</td>
<td>-0.04</td>
<td>-0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Carpo-metacarpal joint</td>
<td>0.21</td>
<td>-0.18</td>
<td>0.07</td>
<td>-0.01</td>
<td>-0.06</td>
<td>0.11</td>
</tr>
<tr>
<td>Knee</td>
<td>0.19</td>
<td>-0.05</td>
<td>0.02</td>
<td>0.04</td>
<td>0.26</td>
<td>0.11</td>
</tr>
<tr>
<td>Hip</td>
<td>0.19</td>
<td>-0.13</td>
<td>0.07</td>
<td>-0.11</td>
<td>-0.03</td>
<td>0.11</td>
</tr>
<tr>
<td>Generalized osteoarthritis</td>
<td>0.11</td>
<td>-0.09</td>
<td>0.13</td>
<td>-0.08</td>
<td>-0.05</td>
<td>0.08</td>
</tr>
</tbody>
</table>

*p<0.05. **p<0.01. ^p<0.001. d=p<0.0001.*
rence showed significant correlation between hypertension and hand, knee and hip osteoarthritis (30), but the connection was weaker after adjustment in weight.

Several epidemiological studies have shown that smokers had a lower risk for osteoarthritis (31,32). The Chingford study (33) and our results did not confirm this proposal.

Our results support the hypothesis proposed by Dieppe and Kirwan (1) that osteoarthritis is a disease spectrum. Some disease subsets are systemic in their nature (including the concept of generalized osteoarthritis), whereas others are mostly biomechanical in their etiology. We showed that the polyarticular form of osteoarthritis disease could not be explained by the increasing age and that tendency to multiple joint involvement was of systemic nature, probably influenced by genetic (11,34), metabolic (26,35), or immunologic (36,37) mechanisms.

References
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