University of Iceland
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The use of digital photographs for the diagnosis of hand osteoarthritis

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Háskóli Íslands
Læknadeild

Notkun stafrænna ljósmynda við mat á slitgigt í höndum

Guðrún Pálína Helgadóttir

Ritgerð lögð fram til meistaragráðu

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ABSTRACT

Objective. The aim of this study was to develop a standardised grading system for the diagnosis of hand osteoarthritis from high quality hand photographs and to examine the relationship between hand osteoarthritis pain in the elderly and different assessment methods with particular reference to hand photography.

Materials and methods. This was an ancillary study of randomly selected subjects from the AGES-Reykjavik study. 160 males and 221 females aged 69-92 participated.

All participants had high quality photographs taken of both hands. A photographic scale was then developed to measure the visible signs of the presence of hand OA, such as hard tissue enlargement, deformity and visible soft tissue swelling. Additionally, a clinical examination for structural osteoarthritis changes (not pain) and standard radiographs were taken of the hands of all participants. Pain was documented by a questionnaire.

Results: According to the photographic method, 60,4% of males had at least one affected hand joint, 85,5% had radiographic OA and 74,2% clinically diagnosed OA in at least one of the 18 hand joints. In females, the percentages were 66,2%, 93,7% and 82,4%, respectively. Females were more likely to report pain than males. The prevalence of ever having hand pain lasting at least one month (the ACR criterion for diagnosis of hand OA) was 20,0% (10,7% in males and 27,0% in females).

Sixteen males (10,1%) and 92 females (41,4%) reported intermittent pain. and when pain was present, the number of painful joints was greater in females than in males. Intermittent pain in individual joints and joint rows was significantly associated with the severity of OA assessed by all three methods.

Conclusions. Hand osteoarthritis is common in the elderly. Agreement between the three methods is better in females than in males in this age group. Radiography is more sensitive than either the photographic method or clinical examination. In the majority of cases, the three methods are identifying the same individuals as having severe hand OA.

Hand joint pain is relatively rare in elderly males compared to females in this age group and shows a consistent relation to the severity of hand OA in individual joints and joint groups.

ÁGRIP

Markmið. Markmið þessarar rannsóknar var að þróa aðferð við að greina handarslitgigt af hágæða ljósmyndum og bera hana saman við klíníska skoðun og röntgengreiningu við mat á handarslitgigt í eldra fólki. Jafnframt var ætlunin að skoða tengsl sársauka í höndum við þessar þrjár greiningaraðferðir.

Efni og aðferðir. Þátttakendur voru 381, 160 karlar og 221 konur á aldrinum 69-92, sem valdir voru af handahófi úr AGES-Reykjavík rannsókninni. Teknar voru hágæða ljósmyndir af höndum allra þátttakenda og aðferð þróuð til að meta sjáanleg merki handarslitgigtar af ljósmyndunum. Einnig voru teknar röntgenmyndir af höndum allra þátttakenda og klínísk skoðun framkvæmd. Lagt var mat á upplifun sársauka með spurningalista.

Niðurstöður. Samkvæmt ljósmyndaaðferðinni höfðu 60,4% karla og 66,2% kvenna slitgigt í a.m.k. einum handarlið. 85,5% karla og 93,7% kvenna greindust með handarslitgigt skv. röntgen og klínísk skoðun greindi 74,2% karla og 82,4% kvenna með handarslitgigt.

Konur reyndust líklegri til að kvarta yfir verkjum og sársauka í handarliðum, en 20% þátttakenda (10,7% karla og 27,0% kvenna) sögðust einhvern tímann hafa fundið fyrir verkjum í að minnsta kosti mánuð og 10,1% karla og 41,4% kvenna fundu stundum fyrir sársauka í höndum. Verkir frá einstaka liðum reyndist tengjast alvarleika slitgigtar samkvæmt öllum þremur greiningaraðferðunum.

Ályktanir. Handarslitgigt er algeng hjá öldruðum og í þessum aldurshóp er samræmi milli aðferðanna betra hjá konum heldur en

körlum. Röntgen er næmari aðferð við greiningu handarslitgigtar heldur en ljósmyndaaðferðin og klínísk skoðun en í meirihluta tilfella eru þessar aðferðir sammála um greiningu einstaklingana með alvarlega slitgigt.

Í þessum aldurshóp kvarta færri karlar en konur yfir sársauka frá handarliðum en samband er milli verkja frá einstökum liðum og alvarleika slitgigtar þegar allar þrjár greiningaraðferðirnar eru notaðar.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ACR American College of Rheumatology

BMI Body Mass Index

CMC1 first carpometacarpal (thumb base) joint

COA clinical osteoarthritis

DIP distal interphalangeal joint

HOA hand osteoarthritis

ICC Intraclass correlation coefficient

K-L Kellgren-Lawrence scoring system

OA osteoarthritis

POA photographic osteoarthritis

PIP proximal interphalangeal joint

ROA radiographic osteoarthritis

GPH Guðrún P. Helgadóttir

1. INTRODUCTION

Osteoarthritis is the most common form of arthritis among the elderly and one of the leading causes of chronic disability in Western countries (Felson, 1988; March and Bachmeier, 1997). The magnitude of this problem is increasing with the aging of the population in many countries. Osteoarthritis can arise in any synovial joint in the body, but most often in the hand, knee, and hip joints. A single joint can be involved, but more commonly multiple joints are affected.

1.1 Definition

The term osteoarthritis (OA) describes a common, age-related, heterogeneous group of disorders that are defined:

"OA diseases are a result of both mechanical and biological events that destabilize the normal coupling of degradation and synthesis of articular cartilage chondrocytes and extracellular matrix, and subchondral bone. Although they may be initiated by multiple factors, including genetic, developmental, metabolic, and traumatic, OA diseases involve all of the tissues of the diarthrodal joint. Ultimately, OA diseases are manifested by morphologic, biochemical, molecular, and biomechanical changes of both cells and matrix which lead to a softening, fibrillation, ulceration, loss of articular cartilage, sclerosis and eburnation of subchondral bone, osteophytes, and subchondral cysts. When clinically evident, OA diseases are characterized by joint

pain, tenderness, limitation of movement, crepitus, occasional effusion, and variable degrees of inflammation without systemic effects." (Kuettner, 1995)

1.2 Pathogenesis of osteoarthritis

The view of osteoarthritis and its pathogenesis continues to change. Previously, OA was considered a degenerative disease, and simply an inevitable part of ageing. Now, however, OA is increasingly viewed as a dynamic process, one that is metabolically active, with the process of the disease involving both destruction and repair that may be triggered by a variety of biochemical as well as mechanical insults. Hand OA commonly affects the distal interphalangeal (DIP) joints, proximal interphalangeal (PIP) joints and the carpometacarpal joint of the thumb (CMC1). The Heberden node is characterized by osteophyte formation on the dorsal and lateral aspects of the DIP joint. Bouchard nodes occur adjacent to the PIP joints and are pathoanatomically similar to Heberden´s nodes, but occur less frequently.

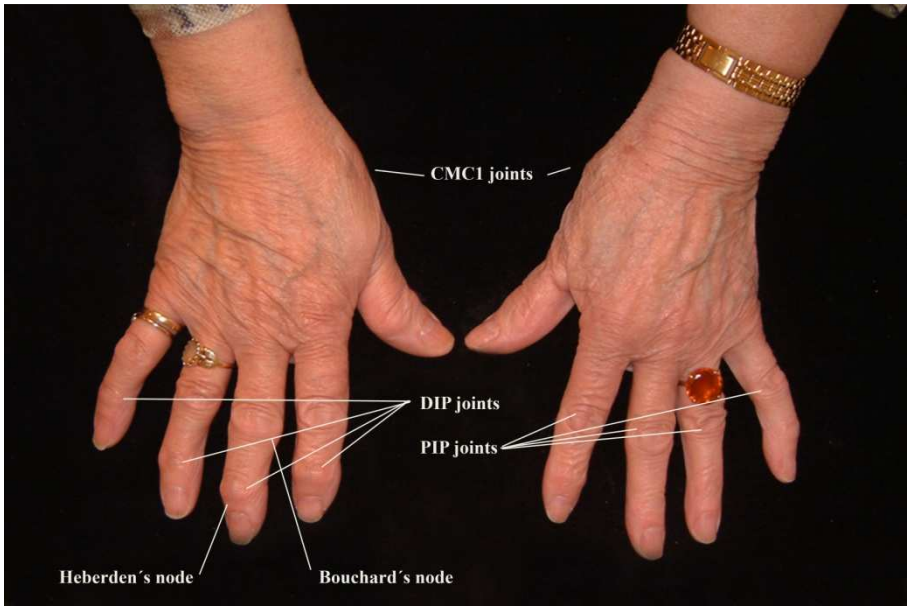


Figure 1. The Heberden node is characterized by osteophyte formation on the dorsal and lateral aspects of the DIP joint. Bouchard nodes occur adjacent to the PIP joints.

The characterics of the osteoarthritic joint is shown in Figure 2. A number of pathogenic features consistent with osteoarthritis are shown. Osteoarthritis involves the entire joint organ, including the subchondral bone, menisci, ligaments, periarticular muscle, capsule, and synovium.

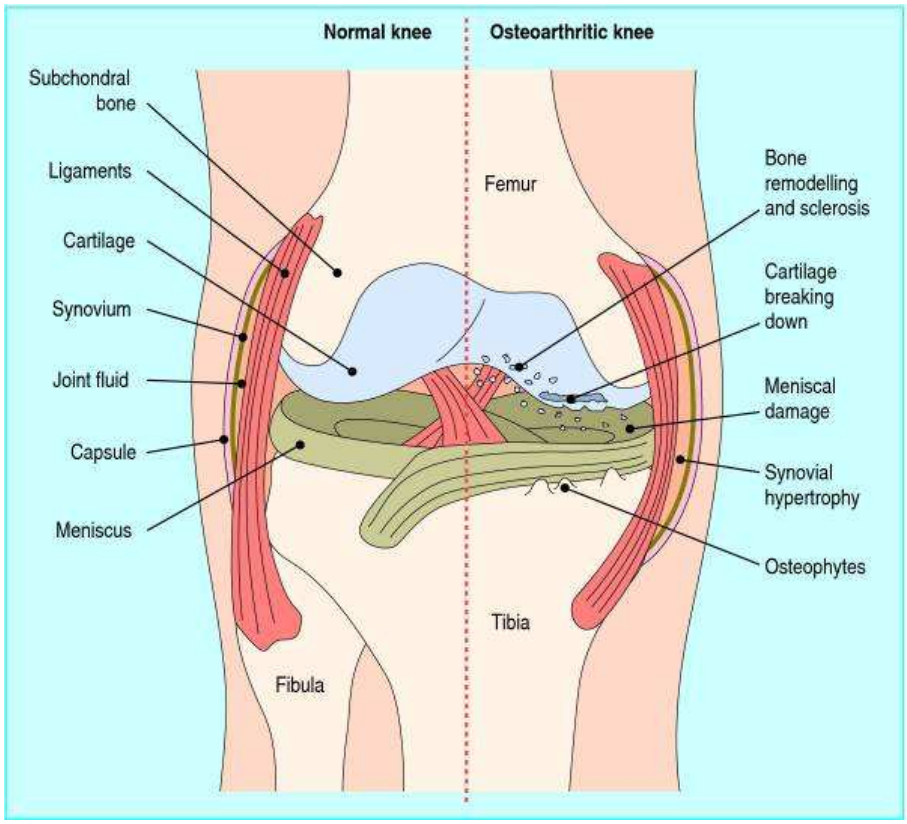


Figure 2. Pathogenic features consistent with osteoarthritis (Hunter and Felson, 2006).

1.3 Prevalence

The prevalence data available on hand OA depends on the diagnostic criteria used and the age of the study population. Although point prevalence of radiographic OA (ROA) is reported to be as high as 28.9% to 76% in population-based studies, the prevalence of symptomatic hand OA is much lower with a point prevalence of 4% to 6.2%. (Niu *et. al.*, 2003; Van Saase *et. al.*, 1989).

The prevalence of radiographically diagnosed hand OA increases steadily with age. Radiological studies have shown that in the age group older than 70, up to 90% of women and 80% of men are affected. It is likely that these figures overestimate the real clinical burden of hand OA, as studies suggest that the prevalence of symptomatic hand OA in subjects older than 65 years is only 15% (Mannoni *et. al.*, 2000).

1.4 Risk factors

Risk factors for development of osteoarthritis include age, female sex, a positive family history, previous trauma, occupation (Kalichman and Hernández-Molina, 2009), and joint hypermobility (Jonsson *et. al.*, 2009a). Some investigators have reported a negative association with osteoporosis (Haugen *et. al.*, 2007). A strong association has been described between high BMI and the presence of knee OA (Manek *et. al.*, 2003; Nisha *et. al.*, 2003) and body weight has also been shown to be a predictor of incident osteoarthritis of the hand (Kalichman *et. al.*, 2009; Oliveria *et. al.*, 1999).

Conflicting results have been reported on the relationship that smoking shares with OA, with some researchers finding a protective effect of smoking (Haara *et. al.*, 2003; Jones *et. al.*, 2001) while others have found no clinically significant protection (Wilder *et. al.*, 2003).

1.5 Defining hand OA and standard approaches to the diagnosis

Defining hand OA is important to advance the investigation of the disease and to document its presence as a marker of a systemic predisposition towards OA.

The phenotype of hand osteoarthritis is usually defined by pathologic examination of affected joints, by evaluation of clinical signs and symptoms, or by examination of radiographic characteristics of the joints, as pathological changes associated with osteoarthritis are usually visible on plain radiographs.

Unfortunately, defining hand OA is still problematic because of lack of an absolute clinical, radiological, or pathological standard that the epidemiology of hand OA can be compared to. Thus, epidemiological studies using symptoms questionnaires, clinical criteria, radiographs or bone scintigraphy have tended to display heterogeneous results. Currently, both clinical and radiographic criteria have their advocates for use in epidemiological studies. The radiographic criteria are considered more robust, but disadvantages include cost, radiation and availability of equipment and trained readers. Furthermore the radiographic changes develop over a considerable length of time, possibly underdiagnosing the youngest and often most symptomatic group of hand OA patients which constitute a future target group in the event of preventive treatment. Clinical criteria have worked well in certain settings, but among the main disadvantages are the availability of expert examiners and that standardization has proved difficult (Mejjad and Maheu, 1995).

In addition, despite advances in our understanding of the disease, a discrepancy remains between structural markers of pathology and the clinical syndrome of osteoarthritis typified by joint pain and disability. Zhang and colleagues reported that symptomatic hand osteoarthritis limits several daily functional activities in the Framingham study (Zhang *et. al.*, 2002). A modest association has been reported between the presence of ROA and the presence of pain and disability in a population with diagnosis of hand osteoarthritis (Fautrel *et. al.*, 2005; Jones *et. al.* , 2001).

Clinical diagnosis is usually based on the presence of joint symptoms and evidence of structural changes seen on radiographs. The American College of Rheumatology (ACR) has established a diagnostic criteria for OA of the hand. The ACR criteria call for

- hand pain, aching or stiffness lasting at least a month,
- nodal enlargement in at least two of ten joints (bilateral first CMC and the second and third DIPs and PIPs),
- swelling of fewer than three MCP joints, and
- nodal enlargement of at least two DIP joint or deformity of two or more of the 10 selected joints (Altman *et. al.*, 1990)

The limitations of the ACR criteria for epidemiological studies have been mentioned (Hart *et. al.*, 1994), they seem good for identifying cases of persistent symptomatic disease but previous epidemiologic and genetic studies have largely targeted radiographic OA. While symptomatic hand OA should be a focus of studies because it causes disability, few studies have been conducted to study symptomatic

hand OA, especially in the elderly. Little data is available on pattern of joint involvement and risk factors for symptomatic hand OA as most persons with radiographic OA do not have persistent symptoms. A study of an elderly population in Iceland based on the ACR classification criteria (Aspelund *et. al.*, 1996) found that the prevalence of symptomatic hand OA was 3% in men and 7% in women. The symptoms criterion, however, showed considerable variation with time and thus the symptomatic OA group was not stable.

1.5.1. Radiology

Radiological changes are most commonly used to grade hand OA. At present, several different radiographic classification systems are used but the Kellgren-Lawrence (K-L) scale for grading of radiological changes has been most widely used in the past (Kellgren and Lawrence, 1957) but there is no agreement on the best threshold for the definition of generalized HOA(Hart and Spector, 1995). In a review by Marshall and colleagues in 2008 it was reported that in 1996-2005 thirty epidemiological studies, all using the K-L scale, used 13 different cut-off points for diagnosis of systemic HOA (Marshall *et. al.*, 2008). Comparison and harmonization of these systems is desirable to facilitate comparison between prevalence studies.

Also, radiographic findings do not necessarily correlate well with symptoms, as studies have shown limited correlation between

radiological changes and the presence of symptoms such as pain and impaired function of the joint (Sowers, 2001). Not all people with radiological evidence of osteoarthritis have symptoms, and not all people with symptoms have radiological evidence of osteoarthritis (Lachance *et. al.*, 2001).

Therefore, the appropriateness of radiology in clinical and large population-based studies has been questioned (Kallman *et. al.*, 1989; Lane *et. al.*, 1993).

1.5.2. Photography as a method of diagnosing hand OA

For a relatively common disease like hand OA, large population-based studies can be very expensive and labor-intensive. It would be useful to be able to utilize an inexpensive screening system to select those individuals appropriate for further study from the general population.

In recent years, the use of photography to diagnose hand OA has been considered by many investigators (Stern *et. al.*, 2004). In one instance, the presence of 'bony prominence or deformity' read from a photograph was utilized for the diagnosis of OA (Hirsch *et. al.*, 2000); However, no assessment for accuracy or precision was reported. (Hirsch *et. al.* , 2000)

Acheson and colleagues assessed the relative value of a photographic presence of any bony deformity (including nodes), compared with symptoms, as a screening tool for assessing the presence of hand OA in a population study (hand OA defined as Kellgren-Lawrence grades

2-4 in corresponding joints). For all adults included, the sensitivity of photographic evidence of bony deformity of the DIP joints was between 50-60%, while specificity was between 76.74% and 81.6% when compared to radiography (Acheson *et. al.*, 1969).

1.6 Pain

The most common symptom of osteoarthritis is joint pain, and stiffness and functional impairment is also often present. Arthritis pain is the most common cause of pain in elderly populations (Linaker *et. al.*, 1999) and arguably the most debilitating aspect of OA.

Usually, pain is associated with joint use and relieved by rest. For many patients, a circadian pattern can be seen (Bellamy *et. al.*, 1990). As the disease progresses, many patients experience more persistent pain that can occur at night and when resting, causing trouble with sleep.

Studies show that hand OA leads to variable degrees of pain and disability (Fautrel *et. al.*, 2005; Niu *et. al.*, 2003). A recent review by Dahaghin and colleagues revealed that the strength of the association between radiographic hand OA and pain varies widely in the published studies (Dahaghin *et. al.*, 2006). It is apparent that a discrepancy remains between structural markers of pathology and the clinical syndrome of osteoarthritis typified by joint pain and disability (Ding *et. al.*, 2007; Elliott *et. al.*, 2007).

Gender differences in pain are well described (Keefe *et. al.*, 2000), and many studies suggest that women are more likely to report pain than men (Davis, 1981; Unruh, 1996). The reasons for those differences are not well understood.

1.7 Aims of the study

The aim of this study was to develop a simple, inexpensive screening method to diagnose hand OA. In this study, we suggest the use of high quality hand photographs as a method for diagnosing hand osteoarthritis. We also took the first step towards standardization of a reproducible scoring system. If it were possible to standardize the taking and reading of hand photographs to an acceptable level, it would open a number of epidemiological possibilities, including comparisons of populations and possible associations with other diseases.

Secondly, the aim of this study is to compare in the same sample of patients the precision and the sensitivity of three different scoring methods; photographic, radiographic and clinically diagnosed hand OA to assess the severity of structural changes in hand OA. Also, we wish to enlarge the evidence concerning the prevalence and pattern of osteoarthritis in the hand joints in the elderly and to investigate the association between photographic, radiographic as well as clinically diagnosed hand OA in the hand and self-reported pain in this age group.

2. MATERIALS AND METHODS

2.1 Subjects

All participants were enrolled in the Age, Gene/Environment Susceptibility-Reykjavik (AGES-Reykjavik) Study (Harris *et. al.*, 2007) between February and June of 2005. Subjects were asked to participate in an ancillary study that involved radiographs being taken of both hands. Of the total 800 participants in the AGES study during that timeframe, 389 agreed to have a hand radiograph taken. Other diseases affecting visual assessment or the development of hand OA were recorded (e.g. inflammatory arthropathies, Dupuytren´s contracture, neuropathies, post-traumatic) and those subjects disqualified.

Among 381 eligible participants there were 160 males and 221 females. Males ranged in age from 69 to 90, with a mean age of 76, and females ranged in age from 69-92 with mean age of 75 years.

2.2 Finger joint pain assessments

Participants were asked about hand symptoms with the following questions:

- Have you ever had pain lasting at least one month in the joints of your hands or wrist? (The ACR criterion for diagnosis of hand OA)

- In the past 12 months have you had pain lasting at least one month in the joints of your hands or wrist?
- Do you sometimes have pain in the joints of your hand or wrist?
- If participants answered the third question positively, they were asked to fill out a diagram showing where the pain was located. The diagram is shown in Figure 22 in Appendix 1.

2.3 Radiographic procedure

Standard radiographs were taken of both hands. All radiographs were examined by two experienced radiologists (Guðmundur J. Elíasson and Ásbjörn Jónsson) and interreliability was found to be excellent (ICC=0,87). Consensus scores reached at a second sitting. The degree of radiographic OA in individual joints was graded using the Kellgren-Lawrence scoring system (Kellgren *et. al.*, 1963) (0=absence; 1=doubtful; 2=mild; 3=moderate; 4=severe). Grade 2 or higher was considered a definite sign of radiographic OA.

2.4 Clinical examination

All subjects were examined by an experienced clinician (Helgi Jónsson). Individual hand joints were scored on a 0-3 scale as follows: 0=no evidence of OA, 1=suspected but not definite OA, 2= definite moderate OA, 3= severe OA. Grade 2 or higher was considered a definite sign of clinically diagnosed OA. To measure the

reliability af the clinical examination, a second clinician, Lauren Abbott, reexamined 50 individuals. Interobserver agreement was found to be good (ICC=0,81).

2.5 Photographic reading procedure

All photographs were taken with a Fuji Finepix 6800 zoom camera with images taken at 2800x2200 pixels. The camera was mounted on a tripod with a fixed distance to a velvet board with markers for thumb positioning. The quality of the digital images is important in order for the readers to be able to visually assess the degree of enlargement and deformity.

A photographic scoring system was developed. In preparing the scoring system, a number of variables that were suspected to be related to hand osteoarthritis in each joint were registered. After comparing the results with hand radiographs, the variables most likely to be associated with clinical and radiographic hand OA were determined.

Each individual hand joint was graded separately for the visual signs of the presence of hand OA. Several factors are of importance, such as hard tissue enlargement, visible soft tissue swelling, position and deformity.

The distal interphalangeal (DIP) and the proximal interphalangeal (PIP) joints were scored on a 0-3 scale as follows: 0=no evidence of OA, 1=suspected but not definite OA, 2= definite moderate OA, 3= severe OA.

For the DIP joints, the deformity of a joint without hard tissue enlargement did not justify the diagnosis of hand OA on its own but when deformity was severe (>30°), the recorded score was raised by one (1) unit (to a maximum of 3).

Reference photographs for the grading of DIP and PIP joints are shown in Figures 3 and 4. For uniformity of presentation the right second DIP and third PIP joints are shown.

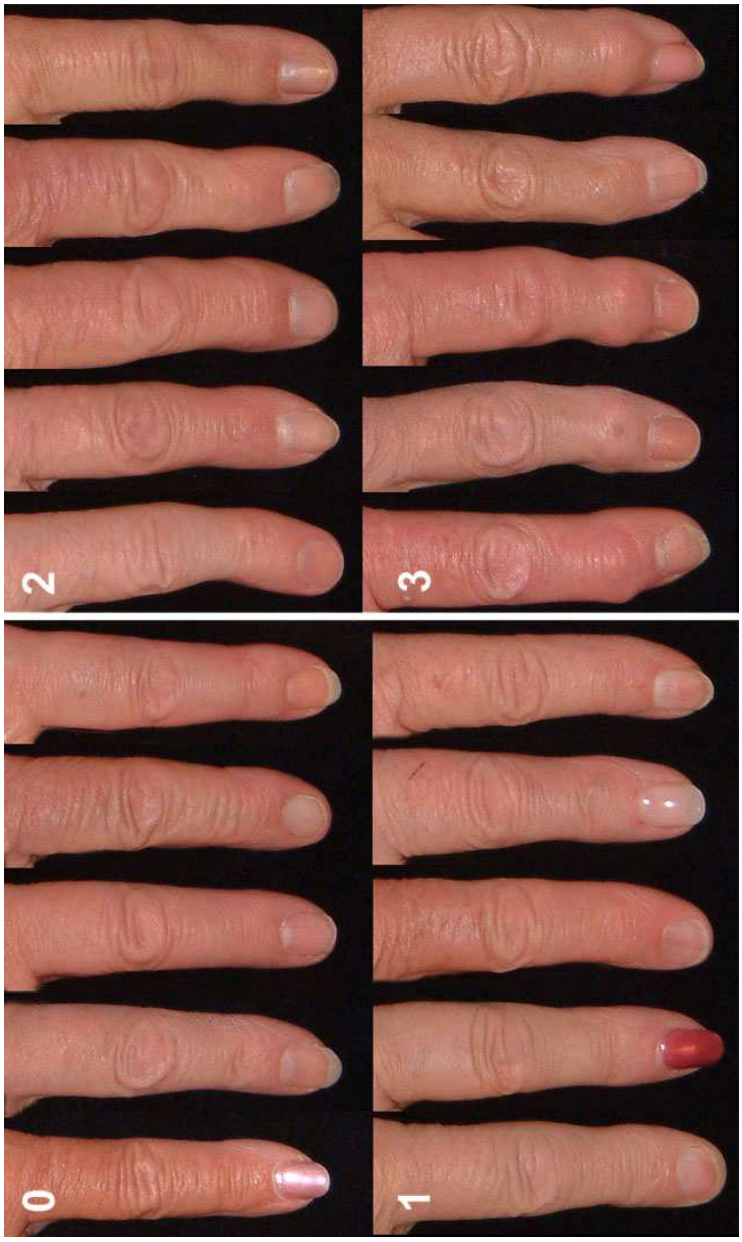


Figure 3. Reference photographs showing osteoarthritis of the right second DIP. The joint is given a score (0-3) for hard tissue enlargement (Heberden´s nodes) and deformity of the joint.

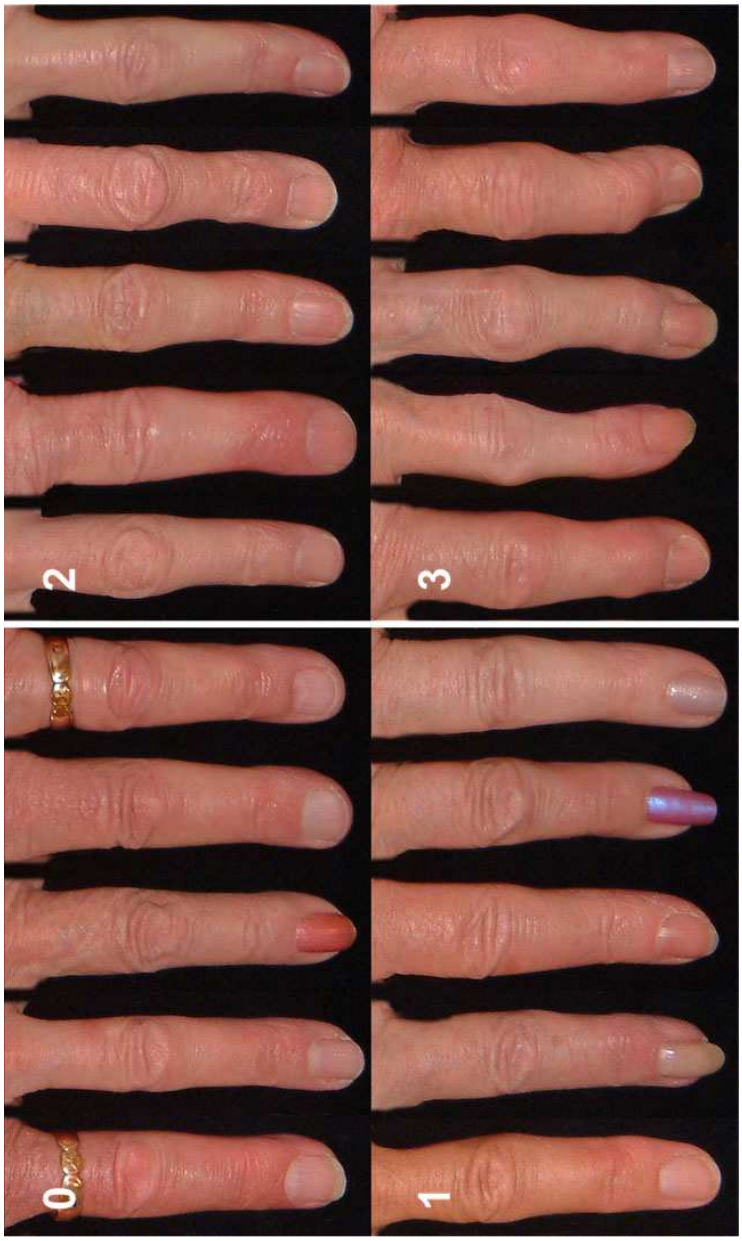


Figure 4. Reference photographs showing osteoarthritis of the right third PIP. The joint is given a score (0-3) for hard tissue enlargement and deformity of the joint.

For assessment of OA of the first carpometacarpal (CMC1) joints, a slightly different approach was needed. Two different findings, enlargement of the joint and abnormal positioning, were related to OA in that joint. Abnormal positioning reflects palmar migration of the base of the first metacarpal bone and is reflected on photography by a number of factors, including disappearance of the normal configuration of the CMC1 joint, medial rotation of the thumb showing increased folding of the skin over the first metacarpal joint (MCP1) and sometimes hyperextension of that joint.

Both enlargement and position were scored on a 0-3 scale, (0=no evidence of OA, 1=suspected but not definite OA, 2= definite moderate OA, 3= severe OA.) and subsequently added, giving a score of 0-6 which was translated into a 0-3 score as follows: (0= Normal joint, 1= Doubtful OA, 2-3= Definite OA and 4+= Severe OA). Reference photos for the CMC1 joints are shown in Figure 5.

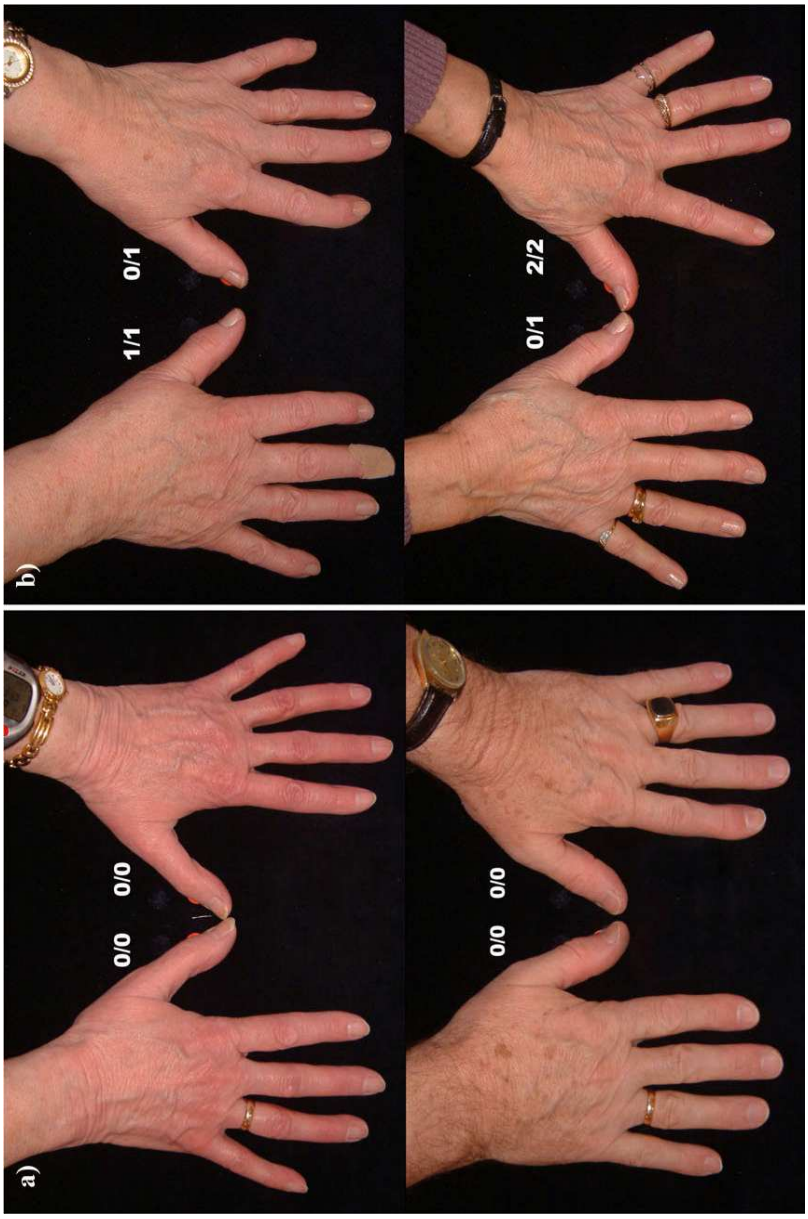


Figure 5. Reference photographs showing osteoarthritis of the CMC1 joint. The number on the left is the score for enlargement of the joint (0-3) and the number on the right represents position/subluxation of the thumb (0-3). a) Healthy CMC1 joints. b,c,d) Increasing osteoarthritis of the CMC1 joints

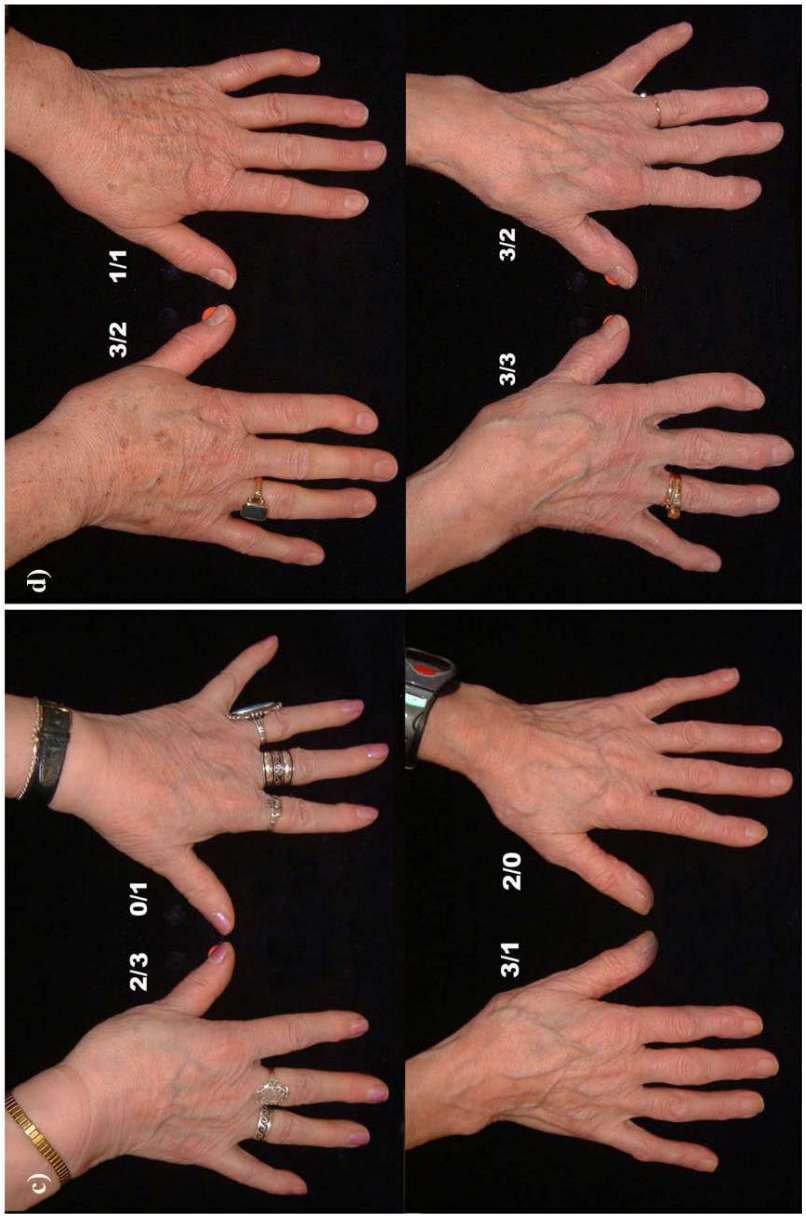


Figure 5. Continued.

Two observers, Guðrún P. Helgadóttir and Helgi Jónsson, assessed the hand joints of every participant. Initially the observers read small samples. Radiography and clinical examination were used to help determine the visual factors of importance and to define the role of deformity of joints and/or enlargement and whether it could be attributed to OA. It was found that deformity of the DIP joint had to be substantial (>30°) for it to be relevant to the score and in the case of the CMC1 joint, both the positioning of the thumb and enlargement of the joint were relevant.

For measurement of intraobserver correlation, the photographic reading of 50 individuals was repeated by GPH with a minimum time interval of one month between readings.

2.6 Statistics

All statistical analyses were carried out with SPSS (v. 16.0) and SAS/STAT (version 9.2). Non-parametric statistical methods were used. For estimates of interobserver and intraobserver reliability and agreement for assessment of individual joints Kappa (on/off) (where grade 2 was used as cut-off point) and Average Measure Intraclass Correlation Coefficient (ICC) were used. Kappa (on/off) denotes the percentage of cases where observers agree on the diagnosis of hand OA for each joint. ICC measures the reliability directly.

Due to prevalence differences between the genders, prevalence data were calculated for males and females separately. The associations between reported pain and diagnosis of osteoarthritis by photo,

clinical examination, and radiography were compared with a logistic regression model for the DIP, PIP, and CMC1 joint groups separately. The generalized estimating equation approach, using the exchangeable log-odds association structure, was used to take repeated measures (photo, clinical examination and radiography) of the same subject into account. The analyses were done by sex, with and without adjustment for age, BMI, smoking status, and education level.

3. **RESULTS**

The baseline characteristics of the 381 participants are presented in Table 1. Mean age was 75,8 years with 58,3% females.

Table 1. Baseline characteristics of the study participants.

	All participants (N=381)	Males (N=159)	Females (N=222)
Age	75,8 ± 5,0	76,1 ± 4,4	75,5 ± 5,3
Agegroups %			
<75	49,3	42,8	54,0
75-79,9	30,4	37,7	25,2
80-85	13,4	15,1	12,2
>85	6,8	4,4	8,6
Heigth (cm) mean ± SD	167,2 ± 9,2	175,6 ± 6,4	161,2 ± 5,5
Weight (kg) mean ± SD	76,6 ± 14,0	83,7 ± 13,0	71,5 ± 12,4
Body mass index (BMI)(kg(m^2) mean ± SD	27,4 ± 4,3	27,1 ± 3,9	27,5 ± 4,6
BMI categories (kg/m^2) %			
Normal weight (BMI<25)	25,3	24,1	26,2
Overweight (BMI 25-29,9)	47,2	51,3	44,3
Obese (BMI>30)	27,4	24,7	29,4
Hand joint pain 1 month ever (ACR criteria) %	20,2	10,7	27
Hand pain lasting at leas one month in the past year %	13,1	4,4	19,4
Hand pain sometimes % number of painful joins	28,3	10,1	41,4

For comparison, the characteristics of all the participants in the AGES-Reykjavik Study during the time period is shown in Table 2.

Table 2. Characteristics of all participants in the AGES-Reykjavik Study from February till June 2005.

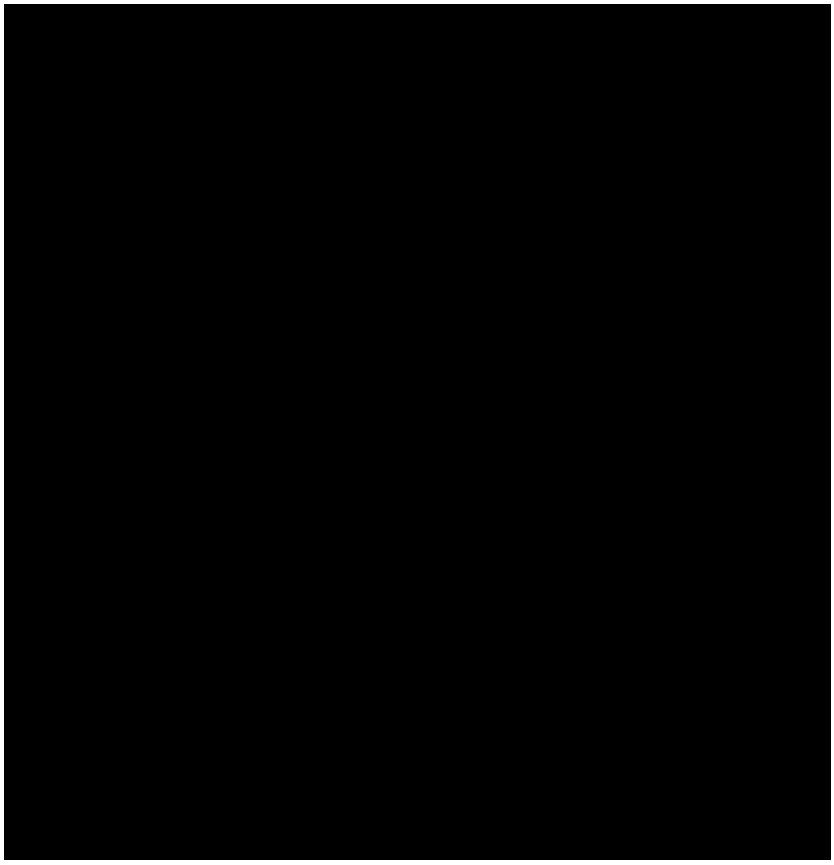
	All participants (N=800)	Males (N=335)	Females (N=465)
Age		76,5 ± 4,9	75,6 ± 5,0
Agegroups %			
<75	46,1	39,4	51,0
75-79,9	33,0	37,3	29,9
80-85	14,0	16,4	12,3
>85	6,9	6,9	6,9
Heigth (cm) mean ± SD			
Weight (kg) mean ± SD		83,1 ± 12,8	71,8 ± 12,6
Body mass index (BMI)(kg(m^2) mean ± SD		27,0 ± 3,9	27,5 ± 4,5
BMI categories (kg/m^2) %			
Normal weight (BMI<25)	30,5	28,8	31,7
Overweight (BMI 25-29,9)	45,9	52,3	41,4
Obese (BMI>30)	23,6	18,9	26,9

Our study population does not differ significantly in age/age distribution or BMI distribution from the entire AGES-Reykjavik Study population during the time interval in question.

3.1 Photographic scoring

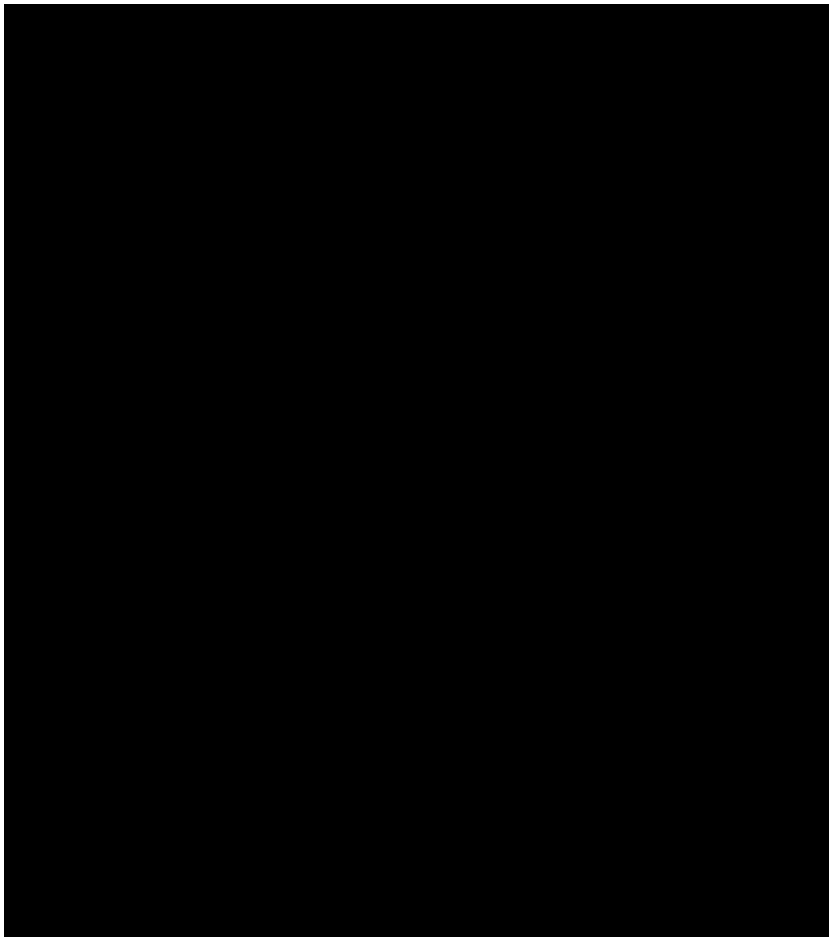
In the first sample comparisons, Average Measure Intraclass Correlation Coefficient (ICC) for assessment of the DIP joints was approximately 0,60 but after repeated blind sample assessments and with the help of a reference photograph collection the agreement between observers improved and rose to above 0,78 (range 0,78-0,85). Agreement between the two observers, measured with Kappa, using 2 as cut-off point was excellent (average 0,87) and the average ICC was 0,83 (see further in Table 3).

The interobserver agreement measured by ICC is now comparable to that reported in radiological studies (Clohisy *et. al.*, 2009; Lane *et. al.*, 1993; Scott *et. al.*, 1993).

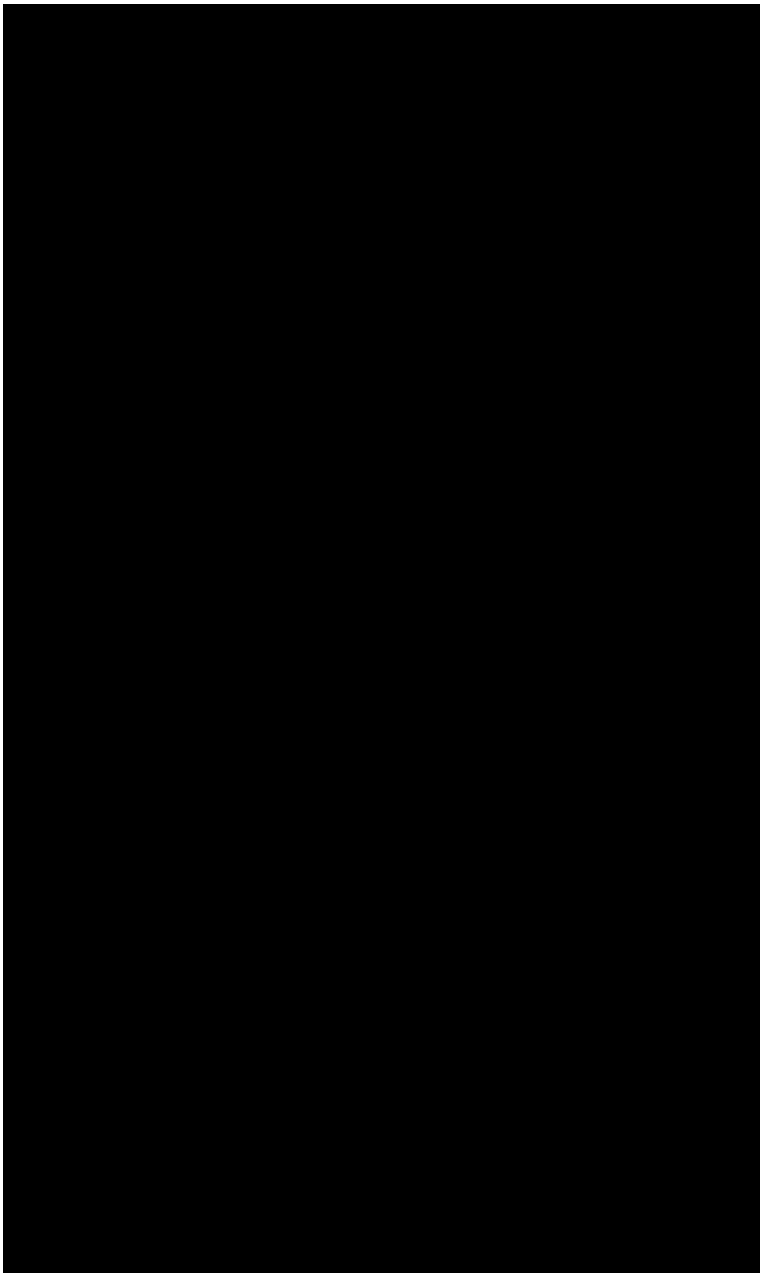


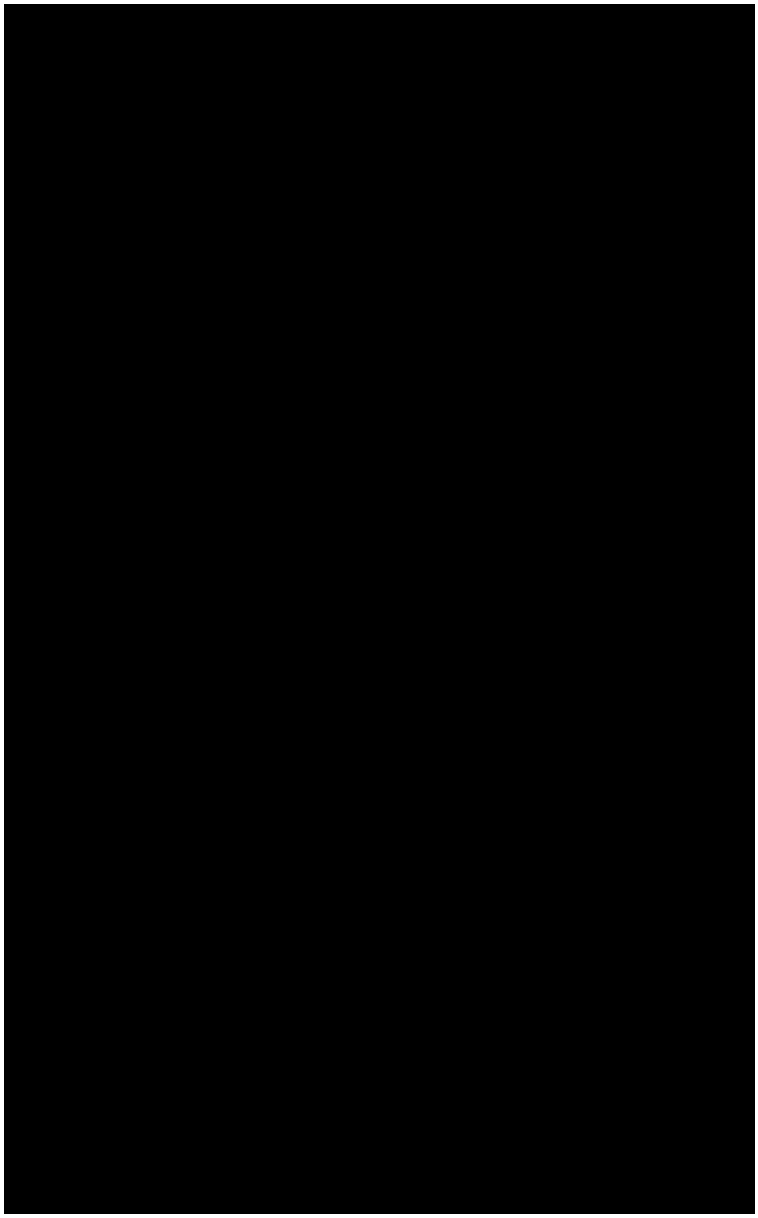
Reliability between readers was excellent for all joints, with the interreader reliability being higher for the PIP joints (mean kappa=0,90) than the DIP joints (mean kappa=0,84).

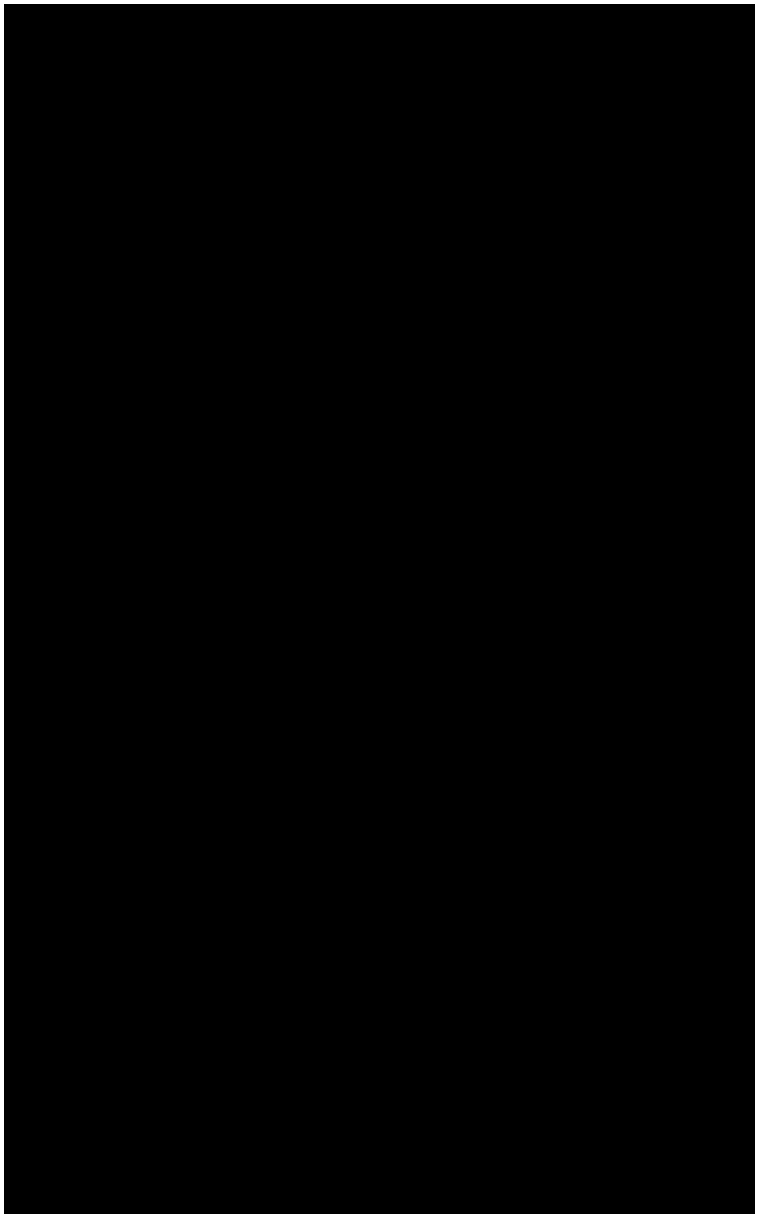
The Average Measure Intraclass Correlation Coefficient (ICC) for each joint between repeated measurements of photographs by the same reader are presented in Table 4.

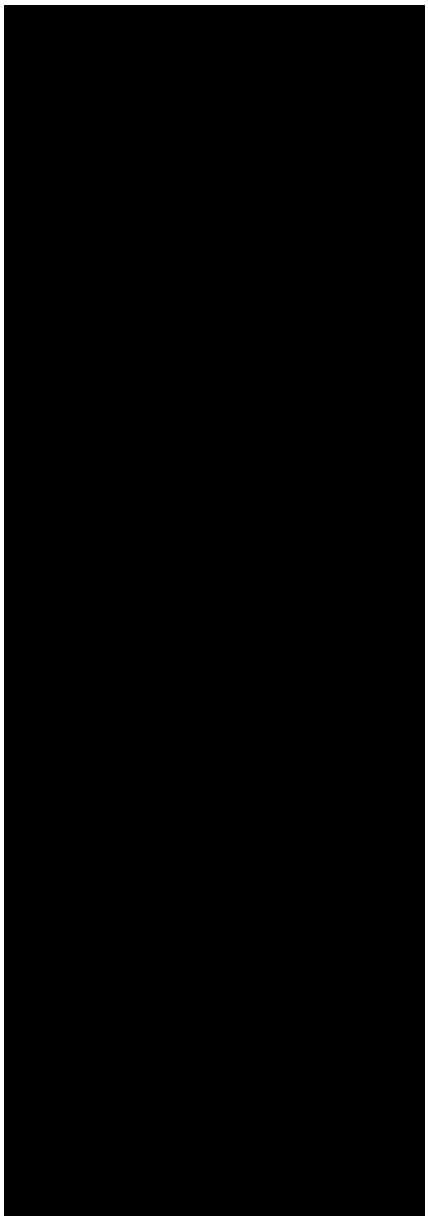


When the method had been established, both readers (GPH and HJ) scored the hand joints of the 381 participants. The distribution of photographic scores by gender for each joint for both readers combined are shown in Tables 5 -8.









The scores for the CMC1 joints that are shown in Table 8 were then translated into a 0-3 score as follows: (0= Normal joint, 1= Doubtful OA, 2-3= Definite OA and 4+= Severe OA).

3.2 Comparison of photographic scoring with clinical examination and radiographic scoring

Osteoarthritis was evaluated for a total of 18 commonly affected joints (4 DIP joints, 4 PIP joints and the CMC1 joint on each hand).

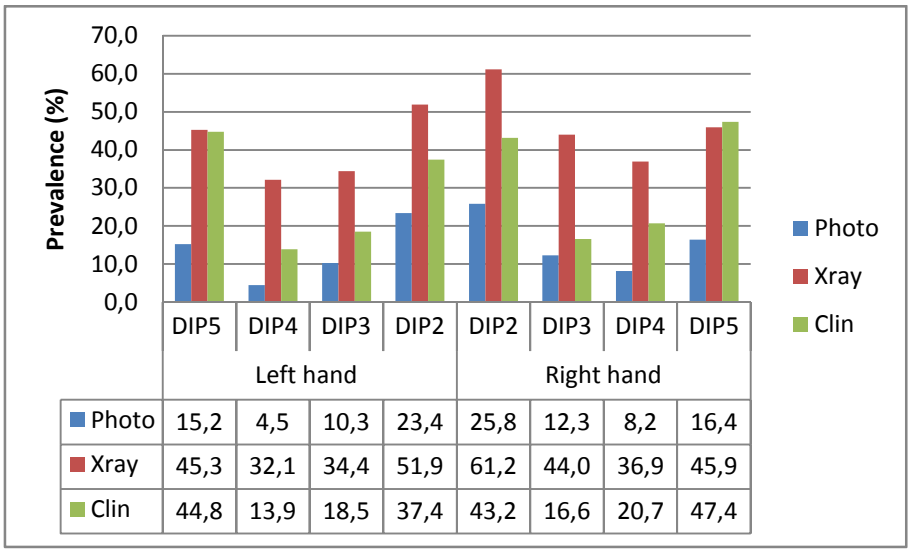
Table 9 shows the point prevalence of osteoarthritis in the hand joint groups of males and females for each of the three methods. Grade ≥2 in one or more joints in the joint group is considered a marker of OA in the joint group.

Of the study participants, 49,3% (males 48,4%, females 50,0%) had photographic OA (score ≥2) in at least one DIP joint, 31,2% (males 36,5%, females 27,5%) had photographic OA in at least one PIP joint and 17,1% (5,7% males and 25,2% females) had photographic OA in at least one of the two CMC1 joints.
For radiography, 87,7% of participants had OA in at least one DIP joint, 60,4% in at least one PIP joint and 31,2% in at least one CMC1 joint. According to the clinical examination, 73,4% had OA in at least one DIP joint, 25,3% in at least one PIP joint and 26,6% in at least one CMC1 joint.

According to the photographic method, 60,4% of males had at least one affected hand joint, 85,5% had radiographic OA and 74,2% clinically diagnosed OA in at least one of the 18 hand joints. In females, the percentages were 66,2%, 93,7% and 82,4%, respectively.

Figures 6 to 10 show the percent prevalence of osteoarthritis in each hand joint examined, according to the three methods. Grade 2 is used as cut-off for each method. Females are more often affected than males using all three methods and according to all three methods, the right hand is more often affected than the left hand in all joint groups in both sexes.
The DIP joints were most frequently affected according to all three methods. Using the photographic method, the PIP joints were more often affected than the CMC1 joint. This was reversed in women,

with CMC1 OA being more prevalent than PIP OA. According to radiography and clinical examination, CMC1 and PIP joints showed similar prevalence in both males and females except CMC1 OA was more prevalent than PIP OA in females using clinical examination.



	DIP5	DIP4	DIP3	DIP2	DIP2	DIP3	DIP4	DIP5
	Left hand				Right hand			
Photo	15,2	4,5	10,3	23,4	25,8	12,3	8,2	16,4
Xray	45,3	32,1	34,4	51,9	61,2	44,0	36,9	45,9
Clin	44,8	13,9	18,5	37,4	43,2	16,6	20,7	47,4

Figure 6. Percent prevalence of OA (score 2+) in the DIP joints of males according to the different methods.

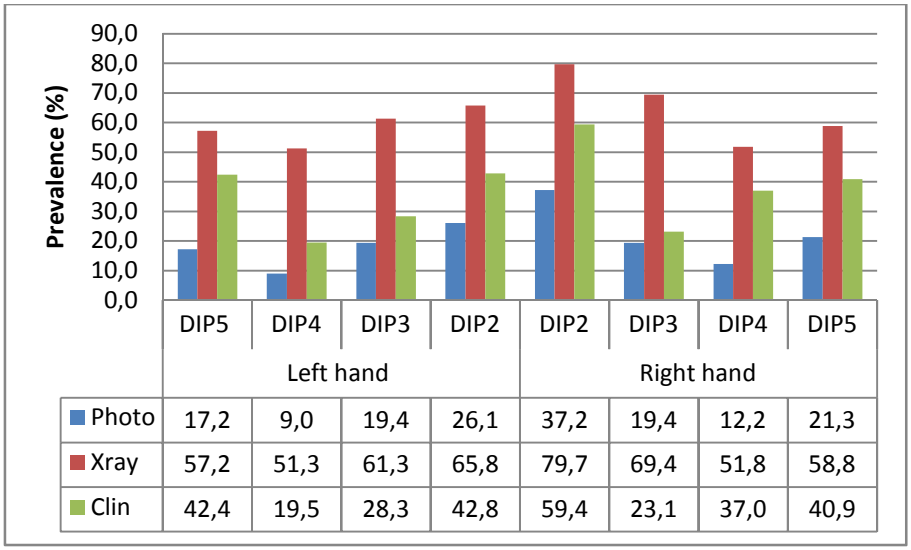


Figure 7. Percent prevalence of OA (score 2+) in the DIP joints of females according to the different methods.

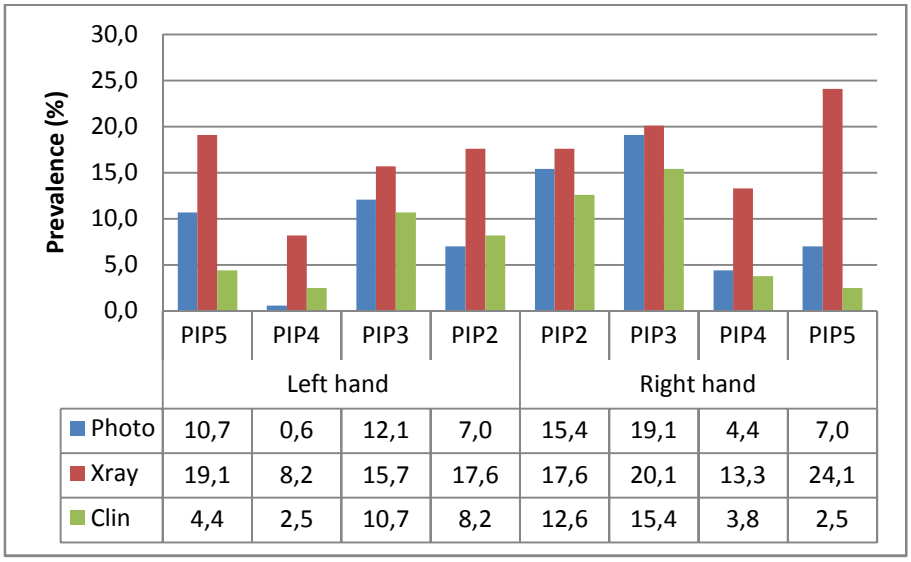


Figure 8. Percent prevalence of OA (score 2+) in the PIP joints of males according to the different methods.

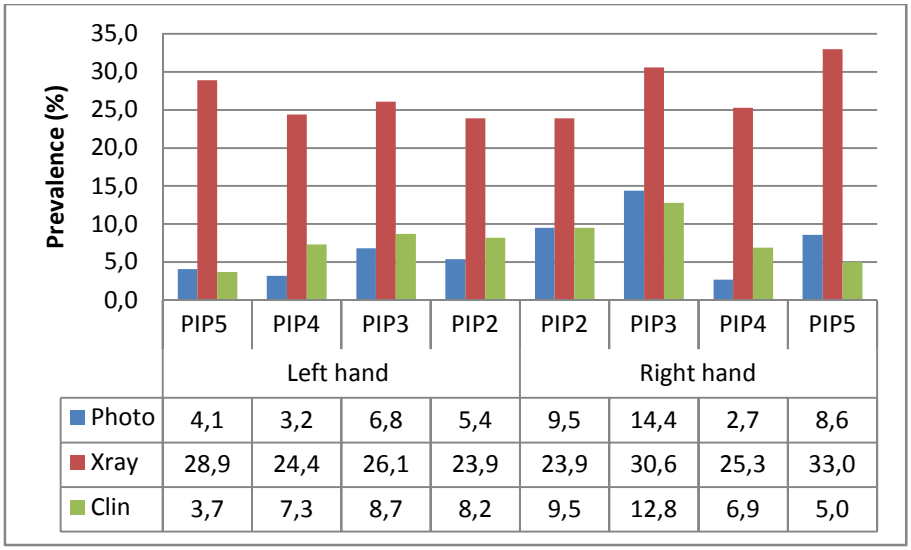


Figure 9. Percent prevalence of OA (score 2+) in the PIP joints of females according to the different methods.

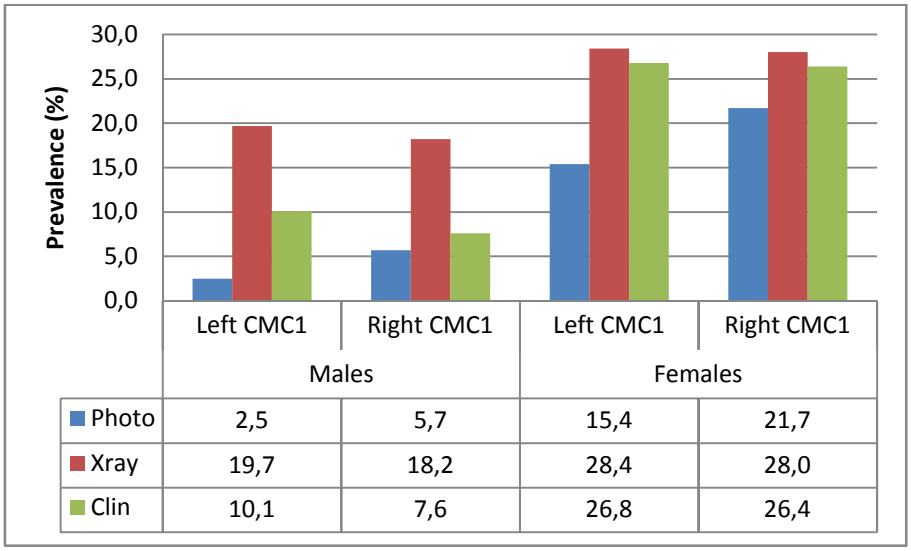


Figure 10. Percent prevalence of OA (score 2+) in the CMC1 joints of males and females according to the different methods.

Figure 11 presents a Venn diagram for individuals in the highest quartile (aggregate scores) for each method. Analyzing quartiles of the aggregate scores revealed that approximately 50% of females in the highest quartile for each method were in the highest quartile for all methods. The corresponding figure for males was 37%. Some participants had low POA and COA scores but high ROA scores.

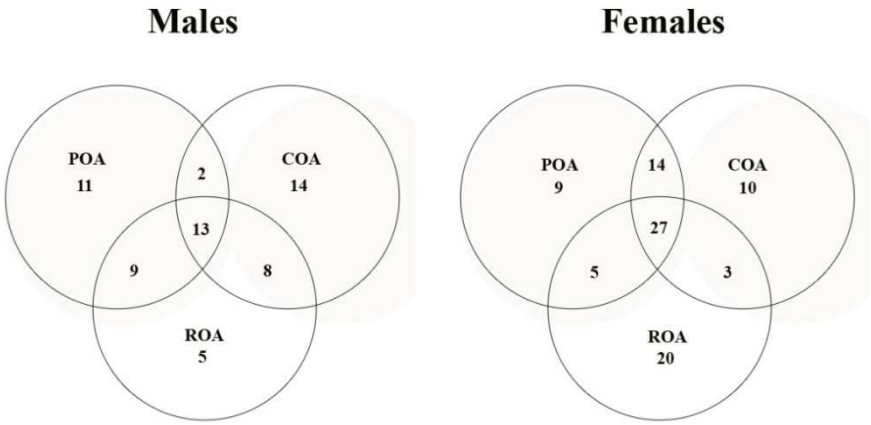
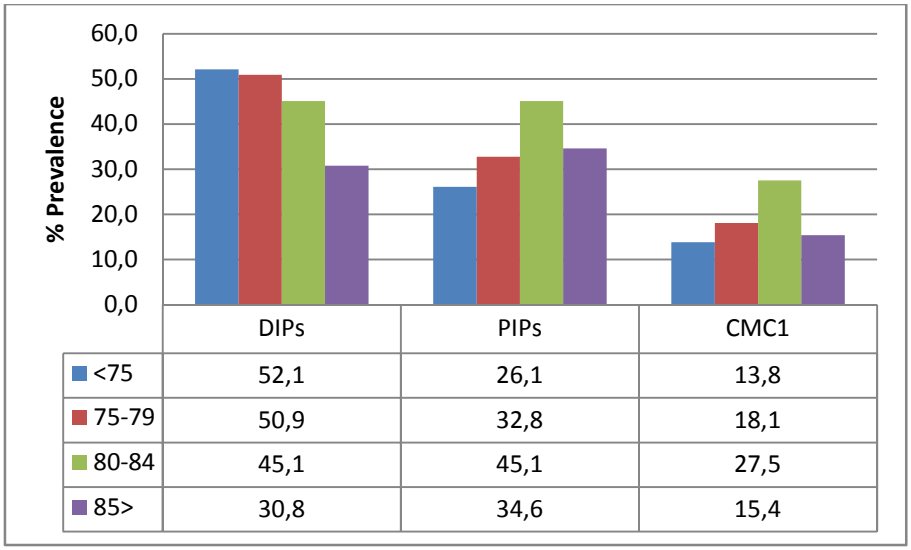


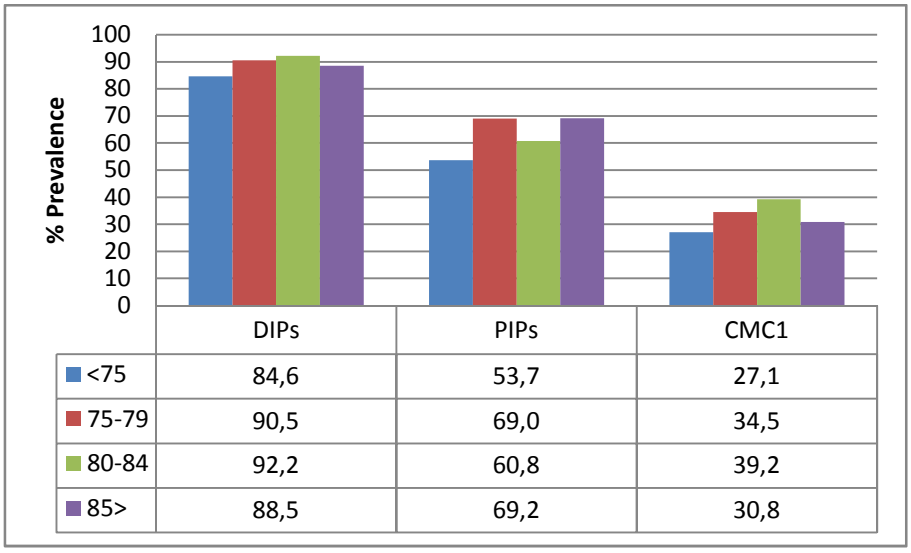
Figure 11. Venn diagram for the highest quartile of each method for males and females.

Figures 12 to 14 present the age specific prevalence of hand OA in each joint group according to the three methods. According to the photographic method, approximately half of the individuals have at least one affected DIP joint except in the oldest age group, where 31% have at least one affected DIP joint. The same was found for the PIP joints and CMC1 joints where we observed a tendency for photographic OA to be less prevalent in individuals in the oldest age group. Clinical and radiographic hand OA showed a similar pattern.



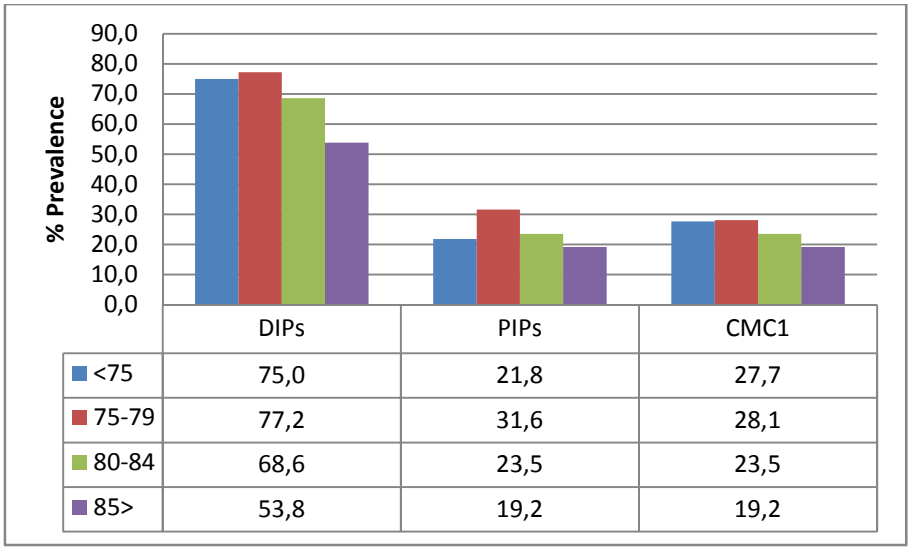
	DIPs	PIPs	CMC1
<75	52,1	26,1	13,8
75-79	50,9	32,8	18,1
80-84	45,1	45,1	27,5
85>	30,8	34,6	15,4

Figure 12. Age specific prevalence (%) of photographic hand OA in each joint group according to age group.



	DIPs	PIPs	CMC1
<75	84,6	53,7	27,1
75-79	90,5	69,0	34,5
80-84	92,2	60,8	39,2
85>	88,5	69,2	30,8

Figure 13. Age specific prevalence (%) of radiographic hand OA in each joint group according to age group.



	DIPs	PIPs	CMC1
<75	75,0	21,8	27,7
75-79	77,2	31,6	28,1
80-84	68,6	23,5	23,5
85>	53,8	19,2	19,2

Figure 14. Age specific prevalence (%) of clinically diagnosed hand OA in each joint group according to age group.

Finally, the prevalence of OA in hand joint groups according to BMI category is presented in Figures 15-17.

Subjects that fall in the obese category (BMI>30) tend to show lower prevalence of OA using the photographic method in all three joint groups than subjects in the normal/overweight range. Using radiography, we observe a tendency for higher prevalence in the DIP and PIP joints in the obese category than in the lower BMI categories, as well as in the CMC1 joints, especially in males. Clinical examination found little difference in prevalence between the BMI categories except in the CMC1 joint, where prevalence of OA in the CMC1 joint increased with increased BMI in both genders.

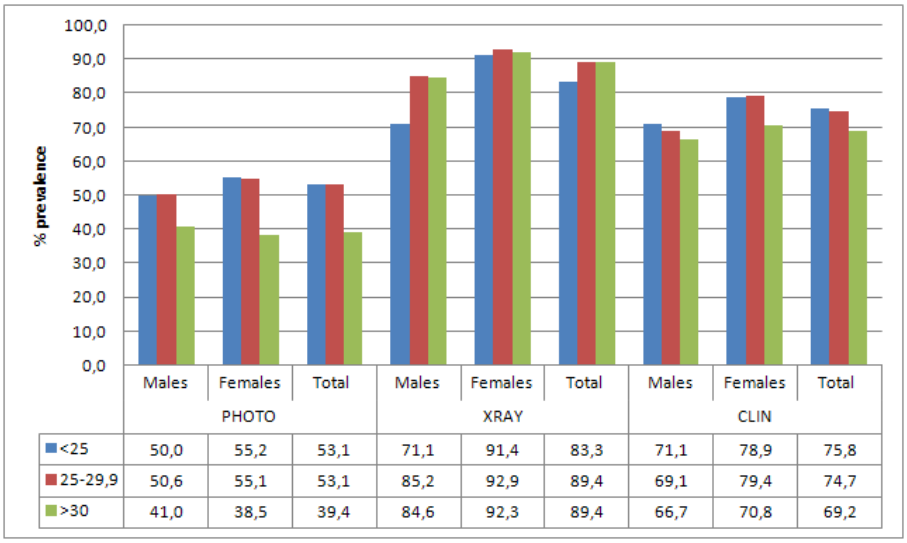


Figure 15. Percent prevalence of OA in at least one DIP joint according to BMI status for all three methods.

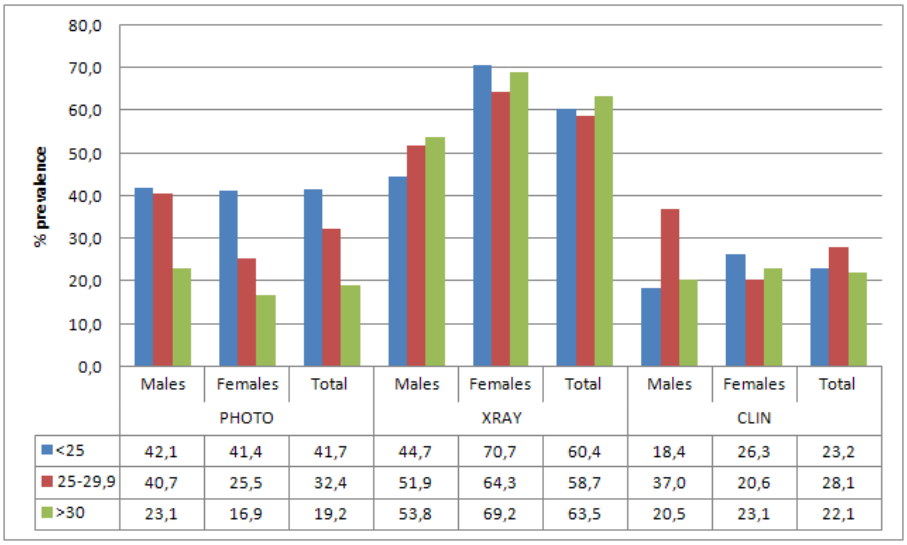


Figure 16. Percent prevalence of OA in at least one PIP joint according to BMI status for all three methods.

	Males	Females	Total	Males	Females	Total	Males	Females	Total
	PHOTO			XRAY			CLIN		
<25	5,3	25,9	17,7	21,1	37,9	31,3	5,3	33,3	22,1
25-29,9	8,6	25,5	17,9	24,7	33,7	29,6	16,0	37,1	27,5
>30	0,0	24,6	15,4	33,3	33,8	33,7	15,4	38,5	29,8

Figure 17. Percent prevalence of OA in at least one of the two CMC1 joints according to BMI status for all three methods.

3.3. Pain prevalence

The one month period prevalence of ever having hand pain lasting at least one month was 20,0% (77 individuals) with 17 males (10,7%) and 60 females (27,0%). In the previous year, 7 males (4,4%) and 43 females (19,4%) reported having pain lasting at least a month.

16 males (10,1%) and 92 females (41,4%) reported intermittent pain.

Table 10 shows the prevalence of self-reported intermittent pain in the hand joints by gender. Females are more likely to report pain than males. Very few males reported having intermittent pain, with almost none reporting DIP pain. In females, the CMC1 is most often painful, followed by the PIP joints and the DIP joints.

3.4 Comparison of the three methods in relation to pain

3.4.1. ACR pain criterion in relation to the three methods

A receiver operating characteristic (ROC) curve analysis was performed for accuracy of the three methods in predicting pain lasting at least a month, which the ACR criterion for diagnosis of hand OA calls for.

Figure 18. ROC curve analysis of the accuracy of the three methods (aggregate scores in the 18 joints by each method) in detecting pain of at least one months duration in males.

As shown in Figure 18, with only 13 males having data for all three methods reporting pain lasting at least a month, no significant association was found.

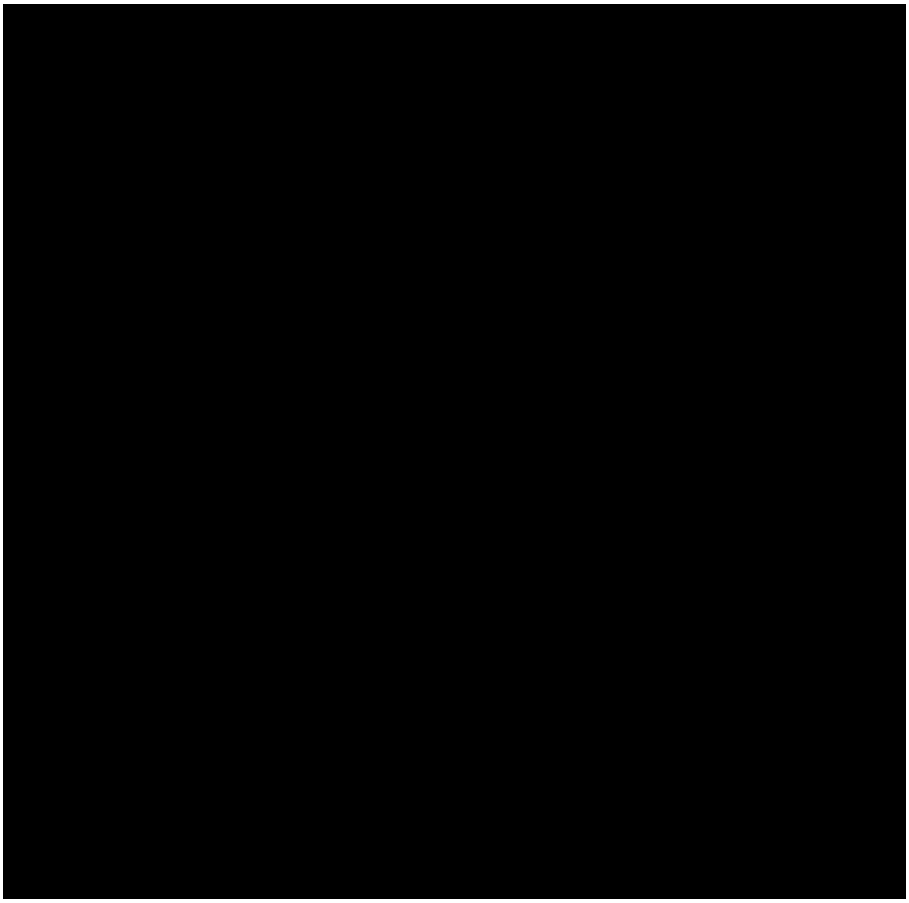


Figure 19. ROC curve analysis of the accuracy of the three methods (aggregate scores in the 18 joints by each method) in detecting pain of at least one months duration in females.

In females, the photographic method and clinical examination were able to predict pain lasting at least a month with statistical significance (Figure 19). No statistically significant association was found for the radiographic method. It is probable, however, that the

radiographic method would reach significance with a larger sample size.

3.4.2. Intermittent pain and joint pain distribution in relation to the three scoring methods

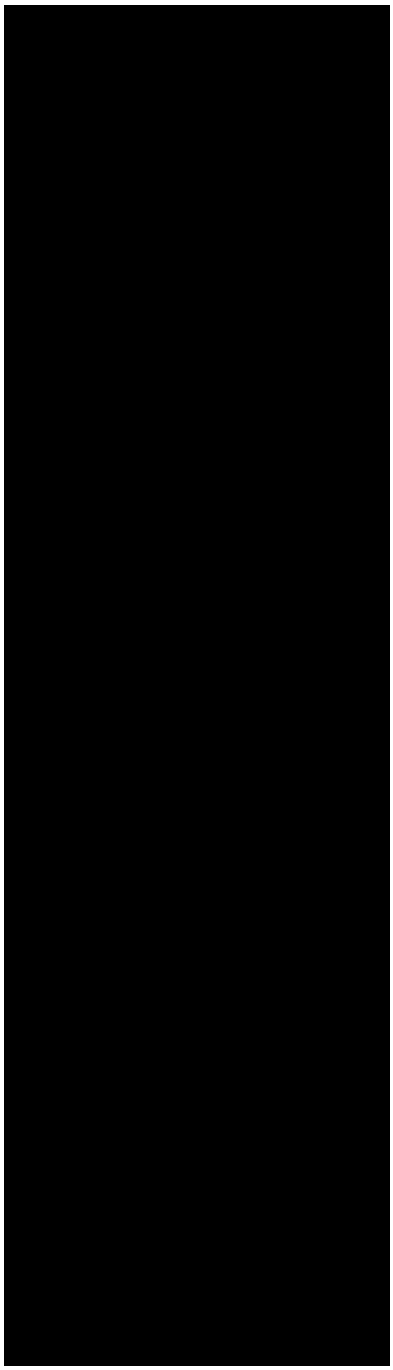
Intermittent pain in individual joints and joint rows was significantly associated with the severity of OA assessed by all three methods. The strongest associations were seen for the CMC1 joints and the interphalangeal joints of the second and third fingers.

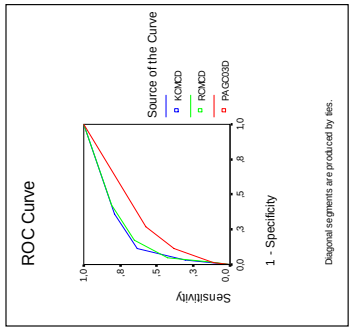
Table 11 presents the associations between the diagnosis of OA using the different methods and pain in the respective joint for the second DIP, third PIP and CMC1 joint of the right hand in females. In the DIP2 and the PIP3 joints, the difference in association between OA and pain between the methods is not statistically significant (P-value 0,57 and 0,91, respectively). In the CMC1 joint however, the association between osteoarthritis of the joint and pain is stronger for radiography and clinical examination than for the photographic method (P-value 0,018).

Table 11. Associations between the diagnosis of definite OA using the different methods and pain in the respective joint in females.

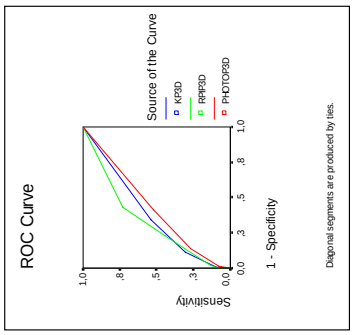
	% reporting pain having OA in the joint	% reporting pain that do not have OA in the joint	Unadjusted Odds ratio and 95% CI	Chi-square	P value	Adjusted Odds ratio*	Chi-square	P value
Right DIP2								
Photo	29,3	11,6	3,2 (1,6-6,4)	10,8	0,001	3,1 (1,5-6,5)	9,13	0,0025
Xray	21,5	4,4	5,9 (1,4-25,4)	7,0	0,008	5,7(1,3-24,3)	5,45	0,0195
Clinical examination	24,0	10,2	2,8 (1,2-6,2)	6,6	0,01	2,8 (1,2-6,5)	6,07	0,014
Average using all methods			3,2 (1,7-6,0)		0,0004	3,2 (1,6-6,2)		0,0006
Right PIP3								
Photo	34,4	13,7	3,3 (1,4-7,6)	8,4	0,004	2,6 (1,2-5,8)	5,69	0,017
Xray	27,9	11,7	2,9 (1,4-6,0)	9,0	0,003	2,9 (1,5-6,0)	9,13	0,0025
Clinical examination	35,7	14,1	3,4 (1,4-8,1)	8,2	0,004	3,16 (1,4-7,2)	7,64	0,0057
Average using all methods			2,8 (1,6-5,0)		0,0004	2,6 (1,5-4,7)		0,0011
Right CMC1								
Photo	41,7	16,7	3,6 (1,8-7,2)	13,7	<0,0001	3,3 (1,6-6,8)	10,5	0,0012
Xray	51,6	10,6	9,0 (4,4-18,2)	43,6	<0,0001	8,7 (4,2-18,0)	33,4	<0,0001
Clinical examination	53,4	10,5	9,8 (4,8-20,1)	46,2	<0,0001	9,8 (4,7-20,3)	36,9	<0,0001
Average using all methods			6,6 (3,7-11,8)		<0,0001	6,7 (2,8-11,7)		<0,0001
* Adjusted for age, BMI, smoking status and education level.								

In Table 12, the associations between the diagnosis of OA using the different methods and pain in the respective joint for the third PIP and CMC1 joint of the right hand for males are shown. Due to the fact that few males reported intermittent pain, we were unable to compute odds ratios for the second DIP joint as well as adjusted odds ratios for all three joints. Males seem to have less association between OA and pain than females except in the case of the clinical diagnosis of osteoarthritis of the CMC1 joint.

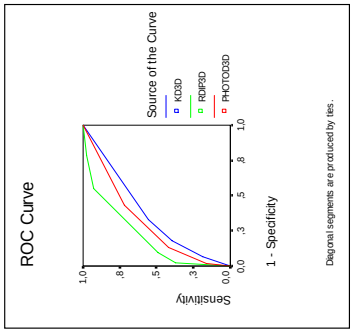




Area Under the Curve	
Test Result Variable(s)	Area
PAGC03D	0,68
RCMCD	0,78
KCMCD	0,79



Area Under the Curve	
Test Result Variable(s)	Area
PHOTOP3D	0,58
RPIP3D	0,67
KP3D	0,63



Area Under the Curve	
Test Result Variable(s)	Area
PHOTOD3D	0,69
RDIP3D	0,80
KD3D	0,63

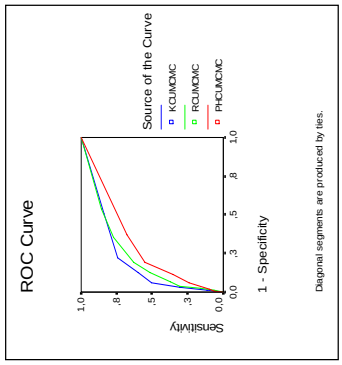
Figure 20. ROC curves for accuracy of the three methods in predicting pain in three commonly affected joints in females.

A receiver operating characteristic (ROC) curve analysis was performed for accuracy of the three methods in predicting pain in

three commonly affected joints on the right side, DIP2, PIP3 and CMC1 in females as shown in Figure 20.

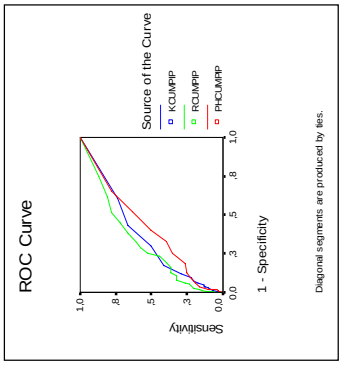
The analysis indicates that XRAY has the highest accuracy for the prediction of pain in the DIP joint with CLIN and PHOTO showing similar accuracy. In predicting pain in the PIP joint, XRAY had the highest accuracy while CLIN and XRAY perform similarly for predicting pain in the CMC1 joint.

Figure 21. presents ROC curves showing how pain from joint rows correlates with pain from the respective joint group in females.



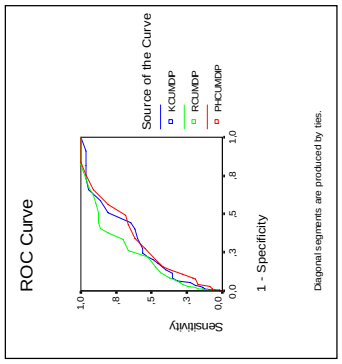
Area Under the Curve

Test Result Variable(s)	Area
PHCUMCMC	0,70
RCUMCMC	0,77
KCUMCMC	0,80



Area Under the Curve

Test Result Variable(s)	Area
PHCUMPIP	0,59
RCUMPIP	0,68
KCUMPIP	0,64



Area Under the Curve

Test Result Variable(s)	Area
PHCUMDIP	0,70
RCUMDIP	0,78
KCUMDIP	0,71

Figure 21. ROC curves showing how pain from joint rows correlates with pain from the respective joint row in females.

Hand joint pain in females in this age group is much more prevalent and shows a consistent relation to the severity of HOA in individual

joints and joint groups. This study indicates that hand photography can be used to assess the severity of HOA but is less accurate than radiographs in predicting pain, particularly in the PIP joints.

4. DISCUSSION

4.1 Photographic reading system

In this study we present a photographic scoring system to assess the prevalence of hand osteoarthritis in clinical and epidemiological study samples. The method is simple and time- as well as cost efficient compared to the methods most commonly used for the diagnosis of hand OA. Given the central role of hand OA in genetic studies of OA and its relation to the presence and prognosis of OA at other sites, this may be a step forward in osteoarthritis research.

The proposed scale is based on the visual evidience of OA on digital photographs. Nine individual joints are scored on each hand (four DIP joints, four PIP joints and the CMC1 joint). Initially, the first IP joints were incuded as well. These 20 joints were selected because they are shown to be most often affected by OA and also because they have been used in conjunction with knee or hip OA as a marker for the presence of generalized OA. However, we found the IP joints hard to read and ended up focusing on the remaining 18 joints.

First results of the use of photographic readings for diagnosis of hand OA are promising. After repeated assessments and with use of standardization photographs it is possible to achieve agreement similar to that between radiology readings between two experienced readers (Clohisy *et. al.*, 2009; Lane *et. al.*, 1993). However, this

photographic index of osteoarthritis has only been used in the elderly and requires further validation in other populations.
This scale is very efficient and therefore interesting for investigations on hand OA in large patient samples.

The results of our study also suggest that it may be sufficient to have only one trained reader for photographic studies of hand OA, because inter-rater reliability is good. On the other hand, there are potential problems with a single reader. One reader scoring all of the photographs might display a trend bias and may be less reproducible when reading routinely compared to an experimental situation. To protect against such problems with a single reader, intra- and inter-reader reliability needs to be evaluated frequently. Obtaining a consensus among multiple readers on all photographs may be an accurate and reproducible method, but is not always feasible in epidemiologic studies with very large numbers of photographs. Thus, one approach could be to screen large samples of photographs for positive osteoarthritic joints and to subject the potential cases to more detailed scrutiny by multiple readers.

4.2 Prevalence of hand osteoarthritis

There is no absolute clinical, radiological, or pathological standard against which epidemiological definitions of hand OA can be tested. We decided to compare the photographic method to the most

commonly used methods for the diagnosis of hand OA, radiography and symptomatic clinical diagnosis.

We have presented extensive data on the prevalence of both radiographically, clinically as well as photographically diagnosed osteoarthritis in an elderly population including both genders. The results of this study confirmed that hand OA is a frequently occurring disease in the elderly, especially in females. Therefore, the disease burden of hand OA affects a large percentage of the aging population. Research efforts that further our understanding of hand OA may contribute towards interventions that impact a rapidly growing segment of our population.

In our study, 60,4% of males and 66,2% of females were diagnosed with OA in at least one of the hand joints using the photographic method. Using radiographic OA, 85,5% of males and 82,4% of females had OA and using clinical examination 74,2% of males and 82,4% of females in at least one joint of the hand. This high frequency of ROA and it being more frequent in females confirmed previous findings (Kalichman *et. al.*, 2004; Van Saase *et. al.*, 1989).

According to all three methods, there is a tendency for the right hand to be more often affected than the left hand in all joint groups. This is in agreement with the results of others (Caspi *et. al.*, 2001; Wilder *et. al.*, 2006). Dahaghin et al found a higher prevalence of CMC1 OA in the left hand (Dahaghin *et. al.*, 2005).

In all age groups, the DIP joints are most often affected joint group. The PIP joints are relatively less affected in each age group. Pattern of joint involvement in our study is comparable with other findings (Egger *et. al.*, 1995; Kalichman *et. al.*, 2009).

Interestingly, there are a number of individuals who have high ROA scores and low POA and COA scores (non-nodal hand OA). This subgroup will be the subject of further studies.

4.2.1. Prevalence in different age groups

Our data suggest a ceiling effect with regard to age and the prevalence of hand OA. In the oldest age group we observed a slight decrease in the prevalence of hand OA using all three methods, exept in the case of radiographic PIP OA. It is possible that this is at least partly due to the fact that relatively few individuals were in the oldest age group. However, it has previously been reported by other investigators that incidence and prevalence of symptomatic osteoarthritis seem to level off or to decline at around 80 years (Bagge *et. al.*, 1991; Van Saase *et. al.*, 1989).

Wilder et al. reported opposing findings, that the prevalence of radiographic OA increased with age in both the DIP and PIP joints, being more prevalent in the >80 year age group than in the 70-79 year old group (Wilder *et. al.*, 2006).

The reason for this discrepancy is unclear and calls for further research. However, when we take into consideration that osteoarthritis is a chronic disease, we could argue that disabled persons are less

likely to participate in the study and possibly that the selection of healthy survivors is an explanation.

4.2.2. Hand OA prevalence and body mass index (BMI)

Obesity has been viewed as a possible risk factor for osteoarthritis through mechanical loading of weight-bearing joints with the relationship of BMI and knee as well as hip OA being well described (Manninen *et. al.*, 1996). Data regarding the association of obesity with hand osteoarthritis are conflicting, with some studies not finding any association (Hochberg *et. al.*, 1993) while other studies do show an association of obesity with hand osteoarthritis (Oliveria *et. al.*, 1999; Wilder *et. al.*, 2006), suggesting that obesity is associated with development of OA not only through increasing mechanical loading, but also that being obese is a systemic risk factor for OA, especially in women.

Using radiography, we observe a tendency for higher prevalence of OA in the DIP and PIP joints, as well as in the CMC1 joints (especially in males) in the obese category than in the lower BMI categories,. Clinical examination found little difference in prevalence between the BMI categories except in the CMC1 joint, where prevalence of OA in the CMC1 joint increased with increased BMI in both genders.

Using the photographic method, subjects that fall in the obese category (BMI>30) show lower prevalence of OA in all three joint groups than subjects in the normal/overweight range. It is possible that this is due to the effect that excess fat on the hands make it harder to visually detect signs of osteoarthritis.

4.3 Pain prevalence and relation to the three scoring methods

4.3.1 Pain according to the ACR criteria

The prevalence of ever having hand pain lasting at least one month (the ACR criterion for diagnosis of hand OA) was 20,0% (10,7% in males and 27,0% in females).

Sixteen males (10,1%) and 92 females (41,4%) reported intermittent pain.

Females reported having more frequent pain than males and when pain was present, the number of painful joints was greater in females than in males. Previous studies have reported similar findings, that men and women differ in the factors associated with musculoskeletal pain in older ages (Dahaghin *et. al.*, 2005; Keefe *et. al.*, 2000; Leveille *et. al.*, 2005).

Receiver operating curve analysis was used to assess accuracy of the three methods in predicting pain. The best possible prediction method would yield a point in the upper left corner or coordinate (0,1) of the ROC space, representing 100% sensitivity (no false negatives) and

100% specificity (no false positives). How close the ROC curve is to the upper left corner and therefore the accuracy of the test is reflected by the area under the curve and is shown for each method below each ROC curve.

With so few males reporting pain lasting at least a month we lacked the statistical power to assess the association between the different methods and reported pain. In females, the photographic method and clinical examination were able to predict pain lasting at least a month with statistical significance. No statistically significant association was found for the radiographic method. It is probable, however, that the radiographic method would reach significance with a larger sample size. In the case of the ACR pain criterion, we found that the photographic method was comparable to clinical examination in predicting pain.

4.3.2 Intermittent hand pain

Symptomatic osteoarthritis, when present, often involved multiple hand joints, with only 17,6% of those reporting intermittent pain having only one painful joint. The CMC1 joints are most often affected in females and the CMC1 and PIP joints are most often affected in males. Very few males reported having intermittent pain, with almost none reporting DIP pain.

We found that the rate of finger joint pain was higher in the right hand than in the left, in the thumb, index and middle fingers compared with the little finger, which is in concordance with the results of Ding and

colleagues in a study on middle-aged females (Ding *et. al.* , 2007). Ding also found evidence of clear graded association of the severity of ROA with finger joint pain among middle-aged women.

Our data suggest that pain in the hand joints increases with age only up until the mid eight decade. This is in accord with the results of Helme and colleagues who reported that pain increases only up until the seventh decade. (Helme and Gibson, 2001) This may be attributed to a number of factors, such as increased stoicism in older individuals, the possibility of selection bias in our population selection with lower response rate in older/sicker people or possibly to age-related changes in the function of pain pathways.

We confirmed a modest association between hand OA diagnosed using all three methods and intermittent hand pain, the strongest relationship in the case of the base of the thumb, confirming previous findings of Dahaghin et. al (Dahaghin *et. al.*, 2005). Dahaghin also reported a stronger association with hand pain in the presence of radiographic OA in the base of the thumb than with radiographic OA in the other hand joints. Lawrence et al reported similar association between pain and the presence of radiographic OA in the base of the thumb (Lawrence *et. al.*, 1966).

The associations between the diagnosis of OA and intermittent pain in females using all three methods were statistically significant for the

three joints shown (second DIP, third PIP and the CMC1 joint of the right hand). In the DIP2 and the PIP3 joints, the difference in association between OA and pain between the methods is not statistically significant but in the CMC1 joint, however, the association between osteoarthritis of the joint and pain is stronger for radiography and clinical examination than for the photographic method. This suggests that the methods perform similarly in predicting DIP2 and PIP3 pain and that radiography and clinical examination are better predictors of CMC1 pain than photographic reading.

4.4 Advantages and limitations of this study

This study has several advantages. The study population consists of elderly individuals who were living in the community rather than from a clinical series. We developed a mini-atlas of photographs illustrating grades that each reader could refer to as they read the photographs. This contributed to a standardized approach to the readings, and resulted in a grading scale that was shown to be reliable between and within raters for all the individual joints.

On the other hand, this study has several limitations. Subjects were elderly, with the youngest being 69 years old. The prevalence of hand osteoarthritis in this age group is high. It would be interesting to repeat this study using a middle- aged population.

We cannot completely rule out that there may some selection bias in the subgroup used for the analysis of radiographic hand osteoarthritis, due to the fact that radiographs were only available for about 400 individuals out of the 800 total participants of the AGES-Reykjavik study during the spring of 2005. However, the subgroup is not statistically different in composition from the rest of the participants with regards to age, sex and BMI.

Our study on hand pain was based on self-reports and thus reflects different forms of hand pain, including pain not related to osteoarthritis. Also, the intensity of pain was not registered, only given as present/absent. Further investigations are needed to clarify the relationship of hand osteoarthritis and pain in the elderly.

Despite these limitations, this study gives valuable insight into hand osteoarthritis and hand pain and their relationship in an elderly population. The photographic scoring method has now already been used in the whole AGES-Reykjavík Study with the discovery of important associations between hand OA and atherosclerosis (Jonsson *et. al.*, 2009b) and thus the method appears to be a step forward in osteoarthritis research.

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6. **APPENDIX 1**

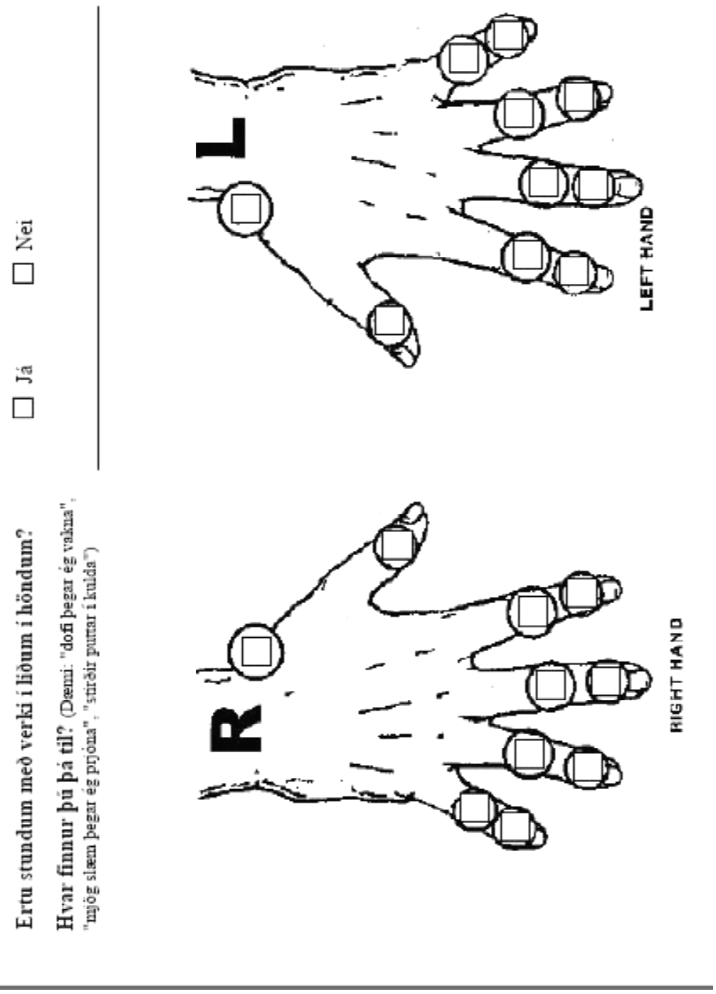

Figure 22. Hand diagram. Participants were asked to mark the location of hand joint pain on a diagram.

Öldrunarrannsókn Hjartaverndar

Upplýsingar vegna þátttöku í rannsókn á handarslitgigt

Handarslitgigt er eitt algengasta form slitgigtar, en hún er mjög arfgeng og hefur sérstöðu að því leyti að hún hefur sterk tengsl við slitgigt í öðrum liðum, þ.e. ef handarslitgigt er til staðar er líklegra að fólk fái slæma slitgigt í aðra liði líkamans.

Þér er boðið sem þátttakandi í Öldrunarrannsókn Hjartaverndar að láta taka röntgenmynd af höndum til að meta og bera saman við ljósmyndir sem teknar voru af höndum þínum. Markmið þessarar rannsóknar er að kanna hvort einstaklingar sem ekki hafa sjáanlegar slitbreytingar í liðum handar hafi slíkt greinanleg með röntgenmynd. Einnig til að sjá samband á milli slitbreytinga í höndum einstaklinga með slitbreytingar sjáanlegar á ljósmynd og á röntgenmynd. Geislun við einfalda röntgenmynd af höndum er mjög lítil og ekki nema örlítið brot af þeim heildargeislaskammti sem fylgir rannsókninni.

Ef þú samþykkir að þetta sé gert, er farið fram á að þu setjir stafi þína hér að neðan..
Við viljum sérstaklega taka fram að þótt þú hafnir þátttöku í þessum hluta rannsóknarinnar mun það engin áhrif hafa á þá þjónustu eða aðrar rannsóknir sem þér standa til boða.

Samþykkisyfirlýsing vegna þátttöku í rannsókn á handarslitgigt með röntgenmynd

já_____ nei_____
Samþykki þátttakanda og/eða forráðamanns (ef forráðamaður undirritar þarf að tiltaka tengsl hans við þátttakanda)

_____
Nafn þátttakanda kennitala dags

_____
Nafn forráðamanns kennitala dags

_____
Staðfesting starfsmanns á að eðli og tilgangur rannsóknar á handarslitgigt með röntgenmynd hafi verið kynntur fyrir ofangreindum þátttakanda og /eða forráðamanni í samræmi við lög og reglur um vísindarannsóknir.

Undirskrift ábyrgðarmanns
Vilmundur Guðnason, forstöðulæknir Hjartaverndar

Figure 23. Informed consent form. All participants in the AGES-Reykjavik Study during the spring of 2005 were invited to have a radiograph of their hands taken for this study.