Prevalence of temporomandibular osteoarthritis and related symptoms in a hand osteoarthritis cohort

Anna-Karin Abrahamsson[1], Margareth Kristensen[1], Linda Z. Arvidsson[1], Tore K. Kvien[2], Tore A. Larheim[1]*, Ida K. Haugen[2]*

[1] Dept. of Maxillofacial Radiology, Institute of Clinical Dentistry, Faculty of Dentistry, University of Oslo, Oslo, Norway

[2] Dept. of Rheumatology, Diakonhjemmet Hospital, Oslo, Norway

*shared last authorship

Corresponding author:
Anna-Karin Abrahamsson, DDS. Dept. of Maxillofacial Radiology, Institute of Clinical Dentistry, Faculty of Dentistry, University of Oslo, PO Box 1109 Blindern, NO 0317, Oslo, Norway. Mail: aka@odont.uio.no

ABSTRACT

Objective:

The prevalence of osteoarthritis (OA) in the temporomandibular joints (TMJs) in hand OA patients is largely unknown. Our aims were to explore 1) The prevalence of TMJ-related symptoms and clinical findings; 2) The prevalence of TMJ OA defined by cone beam computed tomography (CBCT); and 3) The relationship between TMJ-related symptoms/clinical findings and CBCT-defined TMJ OA, in a hand OA cohort.

Methods:

We included 54 hand OA patients (88% women, mean (range) age 71 (61-83) years). We calculated the frequencies of TMJ-related symptoms, clinical findings and diagnosis of TMJ OA by CBCT and clinical examination. Participants with and without CBCT-defined TMJ OA were compared for differences in proportions (95% confidence interval (CI)) of symptoms and clinical findings. Sensitivity and specificity of the clinical TMJ OA diagnosis were calculated using CBCT as reference.

Results:

Self-reported symptoms and clincial findings were found in 24 (44%) and 50 (93%) individuals (93%), respectively, whereas only 7 (13%) had sought healthcare. Individuals with CBCT-defined TMJ OA (n=36, 67%) reported statistically significantly more pain at mouth opening (22%, 95% CI 4-40%), clicking (33%, 95% CI 14-52%) and crepitus (25%, 95% CI 4-46%). By clinical examination, only crepitus was more common in TMJ OA (33%, 95% CI 29-77%). Clinical diagnosis demonstrated low sensitivity (0.42) and high specificity (0.93).

Conclusions:

CBCT-defined TMJ OA was common in hand OA patients, suggesting that TMJ OA may be part of generalized OA. Few had sought healthcare, despite high burden of TMJ-related symptoms and findings. Clinical examination underestimated TMJ OA prevalence.

INTRODUCTION

In osteoarthritis (OA) research and patient management, little focus is given to temporomandibular joint (TMJ) OA, although it may lead to substantial joint pain, dysfunction, dental malocclusion and reduced health-related quality of life.[1] Pain and/or dysfunction in the masticatory apparatus represent a public health problem affecting 5-12% of the population.[2] Clinically it may be challenging to differentiate TMJ OA from other TMJ-related conditions, which may occur in combination with OA. The presence of crepitus that clinically defines TMJ OA can be absent, and the clinical definition of TMJ OA is consistently reported to have low sensitivity when using radiological diagnosis as gold standard.[2] Furthermore, radiological findings and TMJ symptoms are poorly correlated.[3]

The imaging diagnosis of TMJ OA is most reliably assessed by computed tomography (CT).[4] The definition is based on evaluation of bony surfaces including erosions, subcortical cysts, osteophytes, and/or sclerosis.[4] Cone beam CT (CBCT), which has lower radiation exposure than CT, is similarly accurate for detecting TMJ OA.[3]

Proposed risk factors for TMJ OA are in line with those suggested for other joints; age, sex, genetics, infection/inflammation, congenital and developmental abnormalities.[1] Hand OA is often considered a marker of a generalized susceptibility of OA, leading to an increased risk of knee and hip OA.[5]. However, the prevalence of TMJ OA in patients with OA in other joints has been explored in few studies only, of which the majority is summarized by Wolf et al. [6] Most previous studies show no clear association, but the TMJ OA prevalence is likely underestimated due to insensitive imaging modalities. No previous studies have explored the frequency of TMJ OA by CT or CBCT in hand OA patients.

Hence, our aims were to explore 1) The prevalence of self-reported TMJ-related symptoms and clinical examination findings; 2) The prevalence of CBCT-defined TMJ OA; and 3) The relationship between TMJ-related symptoms/clinical findings and CBCT-defined TMJ OA, in a hand OA cohort.

METHODS

Oslo hand OA cohort

At baseline (2001-03), 209 hand OA patients from the rheumatology outpatient clinic at Diakonhjemmet Hospital were examined. Follow-up examinations were performed in 2008-2009 (n=128) and 2013 (n=87).[7] Patients with a diagnosis of inflammatory joint diseases were not invited for participation and excluded if later detected.[7] All examinations were approved by Regional Ethics Committee. Written informed consent was provided by all participants.

In 2013, we included a questionnaire about facial symptoms and a clinical examination of the TMJs and related muscles were included. The CBCT examination of the TMJs were completed by 54/87 participants, who were included in the current study (Online Supplementary Figure I).

Clinical assessment of TMJ and related muscles

Patients completed a questionnaire about facial symptoms the last 30 days, including experience of pain (at rest, mouth opening and chewing), jaw locking and noise (clicking or crepitus) on jaw movement ("yes", "no" and "no, but earlier in life"). The questions were not side specific. A question about previous contact with the healthcare system due to jaw dysfunction and/or facial pain was answered ("yes"/"no"). The questionnaire was developed by the authors based on questions from the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Patient History Questionnaire from the International RDC-TMD Consortium.[8]

One dentist (AKA) performed the clinical examination according to the "Complete specifications (protocol) for Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)" (version: 2013) [9] including bilateral assessment of masseter/temporalis muscle pain at palpation, TMJ pain at palpation and TMJ noises (clicking, crepitus) and maximum unassisted mouth opening. Reduced mouth opening was defined as <40 mm, including vertical overbite. The DC-TMD was used to define clinical TMJ OA,[2] which requires presence of crepitus registered by both examiner and patient (Online Supplementary Table I).

CBCT of TMJ

CBCT was performed at the Department of Maxillofacial Radiology using a ProMax Mid 3D CBCT unit (Planmeca Oy, Helsinki, Finland) (field of view 200x60 mm; voltage 90 kV; tube current 10 mA; spatial resolution 200ϒm). Reconstructed images in axial, oblique sagittal and oblique coronal planes were analyzed in Sectra PACS viewer IDS 5 version on 20 inch monitors. The examinations were interpreted by three maxillofacial radiologists (MK, LZA, TAL) with 3-30 years of relevant experience.

The radiologists performed a pre-evaluation of 12 joints and the results were discussed until consensus was met. Each radiologist then interpreted all 54 CBCT examinations independently, blinded to clinical information except age and sex. The TMJs were classified as OA, no OA or indeterminate for OA according to Ahmad *et al* (Online Supplementary Table II).[4] After 16 weeks 30 joints were re-evaluated. For reliability analysis, joints registered as indeterminate for OA and no OA were pooled. Average kappa values were calculated and evaluated.[10] Inter-observer disagreement was discussed until consensus was met and each joint got a final imaging diagnosis.

Statistical analysis

Using independent samples t-tests and Chi Square tests, we compared, age, BMI, TMJ-related symptoms and clinical examination findings in participants with CBCT-defined TMJ OA (uni-or bilateral) versus participants with no/indeterminate for OA. Differences in proportions of TMJ-related symptoms and clinical examination findings in participants with CBCT-defined TMJ OA versus no/indeterminate for OA were calculated with 95% confidence intervals (CI). We calculated sensitivity and specificity of the clinical diagnosis using CBCT as reference. Analyses were performed using IBM SPSS version 22.0.

RESULTS

Most participants were women (n=48, 88%) with mean (range) age of 71.3 (61.5-83.0) years. Mean (SD) BMI was 27.6 (6.0).

Individuals who underwent CBCT (n=54) were slightly younger than those who did not perform CBCT (n=33) (p=0.04). Otherwise, we found no statistically significant differences in symptoms/ clinical examination findings.

Prevalence of TMJ related symptoms and clinical examination findings

Self-reported symptoms were present in 24 individuals (44%, 95% CI 31-57%) with facial pain at rest (n=17, 31%) and joint sounds (clicking/crepitus)(both n=15, 28%) being the most common. Seven (13%) individuals reported previous contact with the healthcare system due to jaw dysfunction and/or facial pain. Clinical TMJ-related examination findings were observed in 50 participants (93%, 95% CI 86-100%) with masticatory muscle pain at palpation (n=43, 80%) and crepitus (n=31, 57%) being most frequent. The mean (range) mouth opening was 51.2 (39-65) mm. One individual (2%) had a reduced mouth opening (39 mm). The criteria for a clinical TMJ OA diagnosis were fulfilled in 22 individuals (41%, 95% CI 28-54%).

Prevalence of CBCT-defined TMJ OA

Average kappa values for pairwise inter- and intra-observer agreement for CBCT-defined TMJ OA were 0.67 (range 0.61-0.74) and 0.62 (range 0.54-0.66), respectively, representing substantial reliability.

CBCT-defined TMJ OA was present in 36 participants (67%, 95% CI 54-79%), of whom 17 (31%) had bilateral OA. The 19 (35%) individuals with unilateral TMJ OA, had either no OA (n=6) or were classified as indeterminate for OA (n=13) in the contralateral joint. No TMJ OA was found in 10/54 (18%, 95% CI 8-29%) individuals, whereas 8/54 (15%, 95% CI 5-24%) were categorized as indeterminate for OA (n=5 bilaterally and n=3 unilaterally with no OA in the contralateral joint).

Symptoms and clinical examination findings related to CBCT-defined TMJ OA

There were no significant differences in age, sex and BMI in individuals with versus without CBCT-defined TMJ OA (data not shown).

Self-reported TMJ-related symptoms and clinical examination findings were more common in participants with CBCT-defined TMJ OA as compared to no OA or indeterminate for OA (Table I-II). No statistical significant difference in mouth opening was found across individuals with versus without CBCT-defined TMJ OA (mean (SD) 51.5 (6.1) vs. 50.7 (7.1) mm, p=0.67). The sensitivity for the clinical diagnosis was low (0.42, 95% CI 28-55) using CBCT as reference, whereas the specificity was high (0.93, 95% CI 86-99) (Online Supplementary Table III).

Table I. Self-reported TMJ-related symptoms* in 54 patients with hand OA

	Hand OA patients with TMJ OA** (n=36) N (%)	Hand OA patients with no TMJ OA or indeterminate (n=18) N (%)	Differences in proportions (95% CI)
Pain‡ at rest	14 (39)	3 (17)	22 (-1, 46)
Pain‡ at mouth opening	10 (28)	1 (6)	**22 (4, 40)**
Pain‡ at chewing	5 (14)	1 (6)	8 (-7, 24)
Experience of locking	3 (14)	0 (0)	8 (-2, 17)
Experience of clicking	14 (39)	1 (6)	**33 (14, 52)**
Experience of crepitus	13 (36)	2 (11)	**25 (4, 46)**

CBCT=cone beam computed tomography*; OA*=osteoarthritis*; CI*=confidence interval
* symptoms in one or both jaw(s) (not side specific) the last 30 days.
** CBCT-defined TMJ OA in one or both joints.
‡ in jaw(s), temple(s) or in front of the ear(s).

Table II. TMJ-related clinical examination findings in 54 patients with hand OA

	Hand OA patients with TMJ OA* (n=36) N (%)	Hand OA patients with no TMJ OA or indeterminate (n=18) N (%)	Differences in proportions (95%CI)
TMJ pain[1]	11 (31)	4 (22)	8 (-16, 33)
Crepitus	27 (75)	4 (22)	**53 (29, 77)**
Clicking	4 (11)	4 (22)	-11 (-33, 11)
Muscle pain[2]	30 (83)	13 (72)	11 (-13, 35)

CBCT=cone beam computed tomography*; OA*=osteoarthritis*; CI*=confidence interval
* individuals with CBCT-defined TMJ OA in one or both joints. In individuals with unilateral disease, we explored whether clinical findings were present in the affected joint. In individuals with bilateral disease, we explored whether clinical findings were present in one or both sides.
[1] reported pain at palpation of TMJs (separate assessment of left and right joint).
[2] reported pain at palpation of one or more muscle sites in temporal and masseter muscles (muscle-zone based) (separate assessment of left and right side).

DISCUSSION

For the first time, we report the prevalence of TMJ OA by CBCT and clinical examination in hand OA patients, representing a population with increased OA susceptibility. CBCT-defined TMJ OA was more frequent than clinically defined TMJ OA and as much as two-thirds (67%) of the hand OA patients demonstrated CBCT-defined TMJ OA.

Almost half (44%) of the individuals reported at least one TMJ-related symptom, which contrasts the proposed reduction of complaints described in ageing populations.[11] We demonstrated much higher frequency than a recent Swedish epidemiological investigation, in which only 12% of the 70-year-old women reported TMJ-related problem(s) on a questionnaire.[12] Additionally, our clinical examination revealed higher frequencies of both crepitus and pain than most previous studies of elderly. [11, 13-15] These results suggest that TMJ OA and related symptoms are more common in hand OA patients, but conclusions cannot be made due to the lack of a control group. Higher prevalence in our study could also be due to different outcome measures and a different study setting with a dedicated examination of the TMJs, which may have increased the awareness of TMJ-related symptoms. It should be kept in mind that also other conditions may contribute to TMJ-related self-reported symptoms and clinical findings. Several individuals with TMJ OA in the present study may have had concomitant myalgia and/or disc displacement that could contribute to the symptoms.

In addition to crepitus and joint pain, TMJ OA is often associated with impaired jaw function.[13] However, in our study reduced mouth opening was almost absent, consistent with results by Schmitter *et al.*[13] Preserved jaw function may be the reason why few individuals (13%) had contacted the healthcare system because of their symptoms. Furthermore, pain in other joints may overshadow facial symptoms.

Among our hand OA patients, 67% had CBCT-defined TMJ OA. In previous observational studies, the populations and imaging criteria of CT/CBCT-defined TMJ OA have differed leading to large variations in OA frequencies. A population-based study of German birth cohorts demonstrated that 70% had TMJ OA by MRI,[13] which is considered as less sensitive than CT/CBCT.[4] The high prevalence can partly be explained by higher age (mean 74.6 years) and the fact that most affected individuals had small/moderate

alterations such as surface flattening and sclerosis,[13] which were interpreted as indeterminate in the present study.[2, 4]

The clinical examination underestimated the prevalence of TMJ OA. Our sensitivity for the clinical diagnosis was low and in line with the DC/TMD.[2] Specificity was higher, but our patient series is too small to draw conclusion on the usefulness of clinical examination as a screening tool for TMJ OA.[2] In clinical care, imaging should always be considered individually based on whether the information will be relevant for the choice of treatment.

Crepitus was the most prominent sign in individuals with CBCT-defined TMJ OA. Frequencies of most TMJ-related clinical findings and self-reported symptoms were much higher in the OA group. However, the frequency of clinical muscle pain at palpation was similar across individuals with versus without TMJ OA, suggesting high prevalence of myalgia in the entire study population. Hand OA patients may demonstrate more fibromyalgia-like symptoms,[16] and an overlap in TMJ-related pain and muscle tenderness in other parts of the body has been shown.[17]

Some study limitations need mentioning. The protocol for the instructions during the clinical examination had a less comprehensive translation procedure than required by the DC/TMD international, which may result in non-comparability of data/diagnoses with those obtained in other languages. Moreover, the sample size is relatively small and a control group is missing to evaluate our frequency of TMJ OA. Hence, larger studies including a control group are needed. Longitudinal studies are warranted to explore whether hand OA patients are at increased risk of developing TMJ OA. Exploration of the association between TMJ OA and hand OA in a general population could also lead to larger external validity of the findings.

In summary, TMJ OA based on CBCT and clinical examination was common in elderly individuals with hand OA, suggesting that TMJ OA may be part of generalized OA. Individuals with CBCT-defined OA exhibited more TMJ-related clinical findings and self-reported symptoms than those without. Clinical crepitus was the most prominent sign for individuals with TMJ OA, even though the sensitivity of the clinical diagnosis was low. Impaired jaw function was almost absent. Our results emphasize the importance of assessing TMJ OA and related symptoms in patients with hand OA.

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Authors contribution

Study design: AKA, MK, LZA, TKK, IKH, TAL.

Collection and assembly of data: AKA, MK, LZA, IKH, TAL.

Analyses and interpretation of data: AKA, MK, LZA, TAL.

Drafting the article: AKA, MK, LZA, IKH, TAL.

Revising the article critically and final approval: A-K A, MK, LZA, TKK, IKH, TAL.

Statistical analyses: AKA, MK.

Obtaining of funding: IKH

Role of the funding source

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Conflicts of interest

None.

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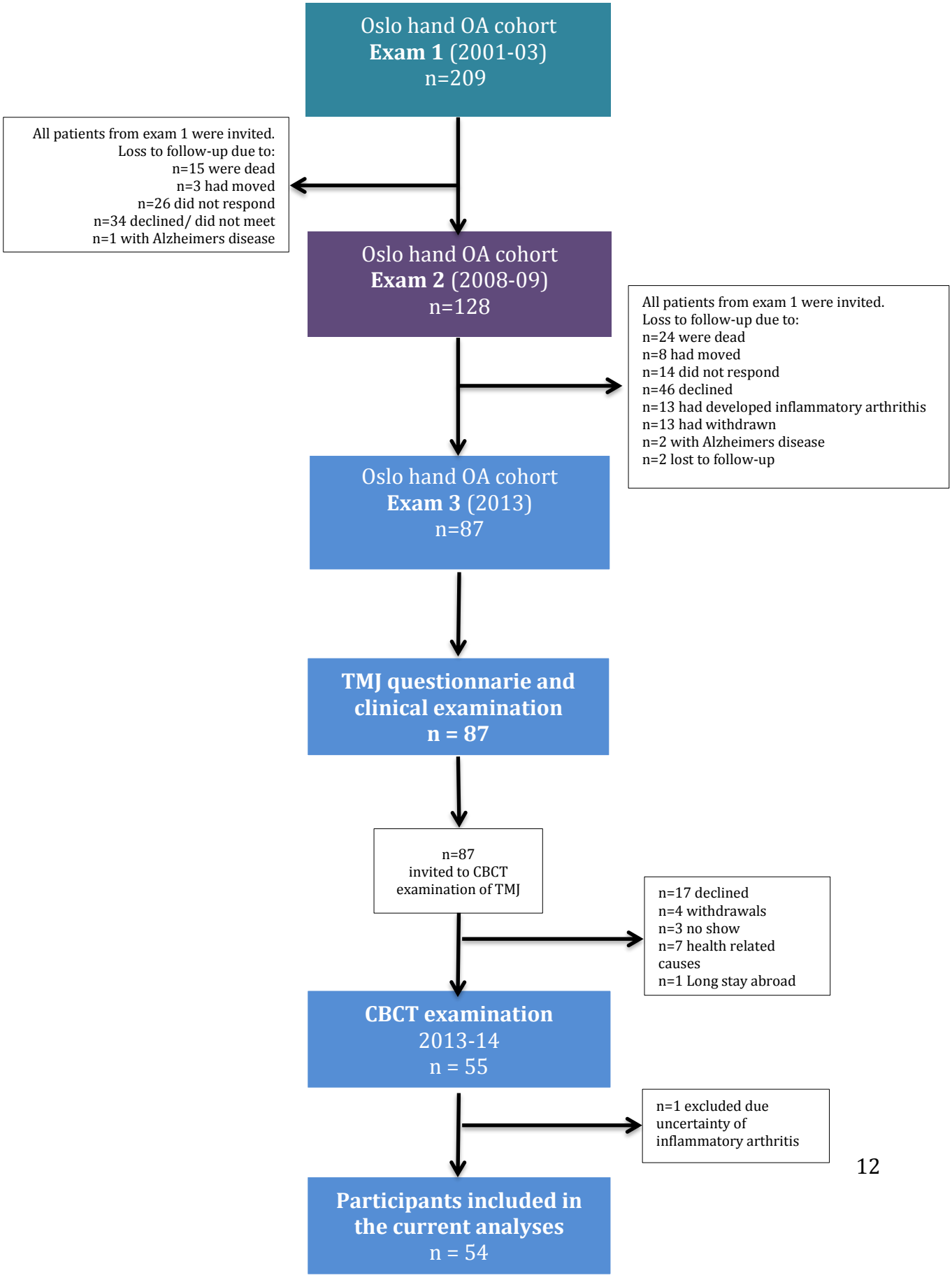
Online Supplementary Figure I: Flow-chart showing the participants in Oslo hand OA cohort included in the TMJ examination at exam 3.



Online Supplementary Table I. Clinical criteria* for TMJ OA‡

Indicated history criteria and examination criteria must be met	
History criteria	Positive for at least one of the following: 1. In the last 30 days, any TMJ noise(s) present with jaw movement or function; OR 2. Patient report of any noise present during the examination.
Examination criteria	Positive for the following: 1. Crepitus detected with palpation during at least one of the following: opening, closing, right or left lateral, or protrusive movement(s).
TMJ, temporomandibular joint *OA,* osteoarthritis *According to the Diagnostic Criteria for Temporomandibular Disorders ‡ Nomenclature in Diagnostic Criteria for Temporomandibular Disorders: Degenerative joint disease	

Online Supplementary Table II. CT criteria for TMJ OA*

No OA	Normal relative size of the condylar head; AND No subcortical sclerosis or articular surface flattening; AND No deformation due to subcortical cyst, surface erosion, osteophyte or generalized sclerosis.
Indeterminate for OA	Normal relative size of the condylar head; AND Subcortical sclerosis with/without articular surface flattening; OR Articular surface flattening with/without subcortical sclerosis; AND No deformation due to subcortical cyst, surface erosion, osteophyte or generalized sclerosis.
OA	Deformation due to subcortical cyst, surface erosion, osteophyte or generalized sclerosis.
CT, computed tomography *TMJ,* temporomandibular joint *OA,* osteoarthritis *According to the criteria of Ahmad et al.	

Online Supplementary Table III. Clinical diagnosis* of TMJ OA related to CBCT diagnosis of TMJ OA**

		CBCT diagnosis			
		OA	Indeterminate for OA/ No OA	Total	
Clinical diagnosis of TMJ OA	Pos	22	4	26	PPV 0.85
	Neg	31	51	82	NPV 0.62
	Total	53	55	108	
		Sensitivity 0.42	Specificity 0.93		

CBCT, cone beam computed tomography
TMJ, temporomandibular joint
OA, osteoarthritis
PPV, positive predictive value
NPV, negative predictive value

* According to the criteria of Diagnostic Criteria for Temporomandibular Disorders
**According to the criteria of Ahmad et al.