

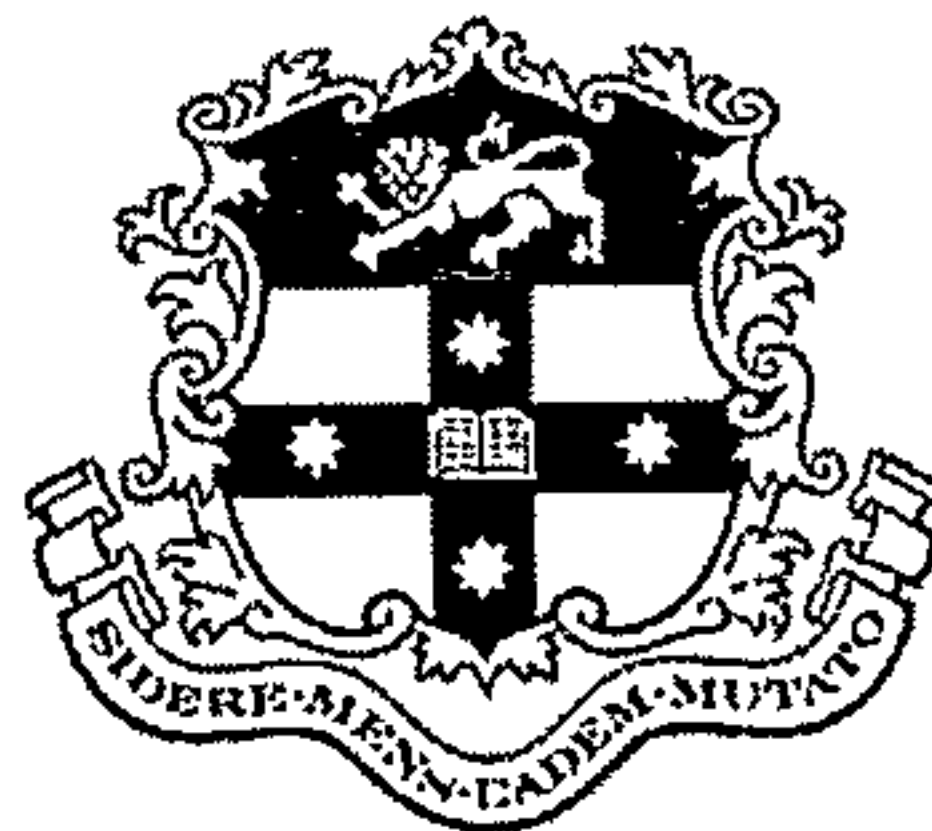
The Oral Health of Rheumatoid Arthritis Patients in Niigata, Japan

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Summary

The oral health of patients suffering from rheumatoid arthritis (RA) has been the subject of many reports. In particular, general oral status, oral hygiene, periodontal disease, xerostomia and swallowing problems, and temporomandibular joint (TMJ) problems have been reported in relation to RA patients. On the other hand, no survey of both oral health and oral health related quality of life in RA patients has been performed.

It was hypothesized that RA impacts unfavourably on the TMJ and on ability to maintain good oral hygiene which together then impact unfavourably on oral status, oral health, and oral health related quality of life. It was the purpose of this study was to investigate the effect of rheumatoid arthritis on oral health and oral health related quality of life.

The study population comprised both the in-patients and out-patients attending the Rheumatoid Arthritis Clinic at Senami Hospital in Niigata, Japan. From April to June 2004, both out-patients and in-patients were invited by a letter of invitation to take part in an oral health survey. They were examined to assess oral status and temporomandibular joint (TMJ) status, and they were also interviewed about oral health, oral health related quality of life, and activities of daily living. Information on rheumatoid arthritis factors and medications was obtained from medical records.

A total of 100 patients with rheumatoid arthritis (RA) took part in this survey. The RA sample comprised 74 out-patients and 26 in-patients. The female to male ratio was 3:1, which is in line with the usual sex distribution seen in RA.

The major points arising from this study are that:

1. Oral health and TMJ health was associated with oral status.
2. Oral health related quality of life was associated with oral health and TMJ status/health.
3. Oral health related quality of life was associated with activities of daily living.
4. Activities of daily living were associated with demographic factors, RA factors, oral health, and TMJ status/health.
5. RA factors were associated with TMJ status/health, ability to maintain good oral hygiene, oral status, and oral health related quality of life.
6. Oral status was not associated with oral health related quality of life or activities of daily living.

It was concluded that, RA impacted unfavourably on the TMJ and on ability to maintain good oral hygiene which together then impact unfavourably on oral status, oral health, and oral health related quality of life.

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List of Abbreviations

RA	Rheumatoid arthritis
TMJ	Temporomandibular joint
DMFT	Decayed, missing, and filled teeth
OHQoL	Oral Health related Quality of Life
ADL	Activities of daily living
m-HAQ	The modified Stanford Health Assessment Questionnaire
CRP	C-reactive protein
RF	Rheumatoid factor
ARA	American Rheumatism Association
n	Number
OR	Odds Ratio
mg	milligram
dl	decilitre
IU	International Unit
ml	milliliter
mm	millimetre
IIO	Inter Incisor Opening

PART 1
REVIEW OF LITERATURE

1. Review of Literature

1.1 Oral status and rheumatoid arthritis

Laurell L *et al.* (1989a). General oral status in adults with rheumatoid arthritis. *Community Dentistry and Oral Epidemiology* 17(5):230-233.

This study compared the oral status of an adult population with rheumatoid arthritis (RA) with that among an age and sex-matched random sample without RA. The aims of this study were to describe the general state of the temporomandibular joint (TMJ) in subjects with RA and to compare it with the non-rheumatic control (CTR) group.

Subjects in this study were recruited as follows: a letter of invitation for an oral examination was sent to 204 patients attending the Department of Rheumatology at the Center Hospital, Jonkoping, Sweden; 194 (148 females and 46 males) responded to the invitation of this study. All patients were classified as RA according to the criteria of the American Rheumatism Association; a majority of them belonged to 50 to 70 year age group; their RA duration ranged from 1 to 28 years, with the mean of 13 years. In addition, 204 age and sex-matched members of a control group without RA received the letter of this study and 153 (112 females and 41 males) participated in the oral examination. The participants were examined by two calibrated dentists. In addition to an oral examination, radiographic examinations were taken. The variables of the oral examination were recorded as follows: subjective and clinical TMJ disorders; the prevalence of edentulousness; the number of remaining teeth excluding the third molars; and the prevalence and quality of fixed, removable partial, and complete dentures.

First, more RA group members had symptoms of TMJ disorders compared with the non-RA group individuals. For instance, pain during chewing or mouth opening was found in 18 percent of subjects with RA relative to 4 percent of those without RA. Also, tenderness to palpation of the TMJ was reported by 23 percent and 8 percent in RA group and CTR group respectively. Severely reduced mouth opening capacity (< 30 mm) and moderately reduced capacity (30-39 mm) were experienced by 7 percent and 1 percent, 30 percent and 15 percent in the RA group and non-RA group respectively. Crepitus from the TMJ was reported in 30 percent of RA patients compared with 12 percent among the non-RA subjects.

Second, the prevalence of edentulousness in the RA group and the non-RA group was 17 percent and 19 percent respectively; there were thus no remarkable differences between the two groups. The mean number of remaining teeth in the two groups was almost equivalent; 20 in the RA group and 21 in the non-RA group.

Third, unsatisfactory function of the removable partial denture was reported by 75 percent of the RA group relative to 25 percent in the CTR group. There were no large differences in unsatisfactory function of the fixed partial dentures or complete dentures between the two groups.

Arneberg P *et al.* (1992). Remaining teeth, oral dryness and dental health habits in middle-aged Norwegian rheumatoid arthritis patients. *Community Dentistry and Oral Epidemiology* 20(5):292-296.

The aims of this study were to investigate the oral health and status and dental health habits among middle-aged Norwegian rheumatoid arthritis (RA) patients, to identify risk factors

for tooth loss, and to compare the number of teeth in RA patients with that in the general Norwegian population.

The RA patients were recruited from two main hospital departments of rheumatology in Norway. A total of 138 (115 females and 23 males) patients were selected and data were obtained from 125 patients aged 44 to 56 years; this was a 91 percent response rate. Data utilized for the general population were taken from a published study (Bjertness, 1990). Data in this study were collected using a questionnaire. The questions sought information on sociodemography; oral health status including the number of remaining teeth counted and recorded by the participants themselves and the number of decayed teeth; the prevalence of removable dentures or fixed bridges; periodontal problems; the subjective symptoms of dry mouth; medications; dental health habits; and the difficulties of dental health performance due to RA. Clinical data were obtained from medical records and a physical dysfunction index was recorded utilizing the method of Sullivan *et al.* (1987).

The mean number of remaining teeth in the RA patients from Oslo was 25, which was similar to that found in the general Oslo population at age 50 years. The prevalence of removable partial dentures and fixed bridges was reported by 8 percent and 26 percent respectively among the RA patients.

Having more than two cavities annually was experienced in about one fifth of the RA patients. Periodontal problems were reported by the same proportion of these RA subjects; recorded as "loose tooth due to gum disease" (9 percent) and "lost tooth due to gum disease" (9 percent). Both caries and periodontal problems were significantly associated with reduction in tooth number; $p < 0.05$ and $p < 0.001$ respectively.

Dry mouth symptoms were reported by more than half of the RA patients; “frequent or constant” by 24 percent and “periodical” by 29 percent. There were no significant relationships between these symptoms and the number of teeth, RA duration, physical dysfunction, sex, or age. On the other hand, a statistically significant relationship between reduction in number of teeth and regular use of Paralgin Forte (a codeine paracetamol pill) was found ($p < 0.01$). This pill is the most common medication for relief of severe RA pain, and is reported to be associated with the side effect of dry mouth. The number of RA medications used daily ranged from 0 to 13, with the mean number of 4.6.

Daily use of fluoride toothpaste was reported by all RA subjects except one, and a majority of them reported daily flossing, and some reported using special oral hygiene aids such as electric toothbrushes, handle enlargers and dental floss holders, and chlorhexidine rinsing solutions.

More RA patients had reduction in arm and hand function compared with that of the lower limbs, according to the physical dysfunction index. It was claimed that these hand problems made oral hygiene performance difficult.

1.2 Oral health and rheumatoid arthritis

Treister N, Glick M (1999). Rheumatoid arthritis: a review and suggested dental care considerations. *Journal of the American Dental Association* 130(5):689-698.

The authors conducted an extensive review regarding rheumatoid arthritis (RA) and dental care. The aim of this review was to comprehend oral manifestations and conditions of RA

patients and the role of the dental provider in the overall treatment of RA patients. MEDLINE searches, based on such keywords as “rheumatoid arthritis “and “dental care” and subsequent appropriate subheadings, identified 200 articles from 1975 onwards. In addition, medical and seven dental textbooks were selected to seek further information on the medical status and oral health of RA patients.

RA has been reported to have an influence on oral health due to the effects of medications and inflammatory processes in joints and bones. Sjogren’s syndrome is also associated with RA. Many drugs have been used to control RA, pain relief, and to reduce joint inflammation. The current main drugs are non-steroidal anti-inflammatory drugs (NSAIDs) and disease-modifying antirheumatic drugs (DMARDs); NSAIDs initially treat RA symptoms whereas DMARDs have the potential to reduce disease activity. Long-term use of these drugs can cause several oral changes. For instance, it has been reported that DMARDs can cause stomatitis and Cyclosporine may cause gingival over-growth. On the other hand, NSAIDs have been reported to have a protective influence on gingivitis and periodontitis due to their anti-inflammatory effect. Thus, it is essential for a dentist to assess RA patients’ medications.

Temporomandibular joint (TMJ) involvement in RA patients has been well documented. Treatment in the TMJ may include a soft diet and local physical therapy. Tegelberg and Kopp (1996) demonstrated that physical therapy of the TMJ brought RA patients long-term benefits. In addition to TMJ involvement in RA patients, recent studies have showed that RA patients are more likely to have an increased incidence of periodontal disease, including loss of alveolar bone and teeth (Kaber *et al.*, 1997; Tolo, Jorkjend, 1990). Moreover, it has been reported that a host immune response associated with RA is similar

to that in periodontal disease and therefore may increase the risk of periodontal disease (Snyderman, McCarty, 1982; Yavuzylmaz *et al.*, 1992). Thereby, it was recommended that dentists should recognize and address periodontitis associated with RA disease.

RA patients with secondary Sjogren's syndrome seem to have chronic xerostomia. Russell and Reisine (1998) demonstrated that a reduction in salivary flow, which is associated with xerostomia symptoms, was found in approximately half of RA patients and was also associated with RA severity. Several studies have also reported that the development of reduced salivary flow can result in oral problems, including difficulty in swallowing food, difficulty in speaking, oral soreness and burning, problems with wearing dentures, and an increased caries risk. Atkinson and Wu (1994) described further that dental caries at root and incisal sites may be the first apparent clinical sign in Sjogren's syndrome. Thus, RA patients with Sjogren's syndrome may require additional personal oral care such as preventive treatment, including fluoride and chlorhexidine therapy, treatment for xerostomia, dietary instruction, and more frequent recall (Atkinson, Fox, 1993).

Pokrajac-Zirojevic V *et al.* (2002). Arthritis and use of dental services: a population based study. *Australian Dental Journal* 47(3):208-213.

The aim of this study was to investigate dental services in a group of individuals with rheumatoid arthritis (RA) in order to comprehend better their dental services demands.

Data for this study were obtained from population based data gathered in the 1995 National Health Survey of 53,828 individuals. A total of 1,193 individuals who reported a diagnosis of RA were involved in this study and were asked whether they had had a dental visit in the previous 12 months.

The RA subjects were significantly less likely to have had a dental visit in the previous 12 months compared with the non-RA subjects ($p = 0.001$); 44.5 percent of the RA subjects reported not having a dental visit relative to 28.3 percent in non-RA subjects. RA females showed slightly better dental attendance compared with the males; 42.9 percent and 54.3 percent respectively. With regards to the main reasons for dental attendance, the RA subjects were more likely to consult a dentist for dental problems whereas more non-RA subjects seemed to have a dental visit for a check up. For instance, extractions were more frequently reported by the RA subjects than the non-RA subjects; 8.6 percent and 3.9 percent respectively. Also, more RA subjects reported attending a dental clinic for prosthodontic treatment including denture construction and repairs compared with the non-RA subjects. However, dental visits for preventive treatment were found to be neglected in both groups.

Iwamoto Y *et al.* (2003). Current issues and problem areas with oral care for patients with rheumatoid arthritis. *Journal of Kyushu Rheumatology* 23(1): 123-127.

The aims of this study were to investigate oral health in patients with rheumatoid arthritis (RA) and to assess their quality of life regarding oral health. A total of 124 RA patients (mean age 58.9 years) answered questions on oral health problems, oral care, and quality of life according to the Oral Health Impact Profile (Slade, 1997). Also, all patients were classified according to the Activities of Daily Living (ADL) index.

Oral health problems were reported by 64.5 percent of RA patients. For instance, pain in the temporomandibular joint (TMJ) was experienced by 38.8 percent, neglect of extraction by 37.5 percent, and dry mouth by 30.0 percent. In a comparison between RA patients with

dentures (37.1 percent) and those without dentures (62.9 percent), no significant differences in oral health problems were found between the two groups. Also, it was found that oral health related to quality of life was associated with ADL; RA patients classified as severe on the ADL scale were more likely to have a poorer quality of life regarding oral health compared with those classified as mild or moderate.

1.3 Oral hygiene and rheumatoid arthritis

Read PW *et al.* (1981). Dental study in patients with rheumatoid arthritis. *Rheumatology and Rehabilitation* 20(2):108-112.

The aim of this study was to evaluate the effect of a one month trial, using each of three toothbrush types, on plaque removal and gingival changes in a group of patients with rheumatoid arthritis (RA). The three toothbrushes were as follows: (1) a conventional toothbrush with a modified handle to suit the patient's grip; (2) an electric toothbrush; and (3) a normal toothbrush head attached to a finger-stall.

A total of 21 patients with RA, who had experienced difficulty in brushing their teeth, were recruited from patients attending a rheumatology out-patients clinic. The group comprised 15 females and six males. Their mean age was 55.8 years and the mean RA duration was 14.9 years. Data were eventually obtained from 17 RA patients at the start of the study and subsequently at intervals of one, two, three, and six months. The data included: plaque scores (Greene, Vermillion, 1960) and gingival scores; and RA status as assessed by clinical examination and laboratory tests. Initially, all patients were advised to brush their teeth regularly with a given standard toothbrush for a 'running-in' period of one month. Before and after this period, their teeth were scaled and polished by a dental hygienist.

Subsequently, the subjects were allocated to one of the three toothbrush types during each of the one-month trials in a single blind randomized trial. At the end of the three one-month assessments, all the patients were asked to use the standard toothbrushes once again for another three months.

A significant reduction in mean plaque score among 17 RA patients was found at the first one-month assessment ($p < 0.005$) and this reduction was maintained until the end of this study ($p < 0.001$). In contrast, gingival scores showed a statistically significant reduction only at the six-month assessment compared with the start of the study ($p < 0.005$). Regarding the effect of the three toothbrushes on plaque removal, all toothbrush types resulted in a statistically significant reduction in plaque score during each of the one-month trials compared with the baseline. In a comparison among the three toothbrush types, there was no significant difference in reduction in plaque score among the three toothbrushes. The author therefore recommended, from the cost point of view, a standard toothbrush with a modified grip for RA patients. On the other hand, no remarkable change in gingival score was found in association with any of the three toothbrushes during the one-month trials.

Risheim H *et al.* (1992). Improvement of oral hygiene in patients with rheumatoid arthritis. *Scandinavian Journal of Dental Research* 100(3):172-175.

The aim of this study was to evaluate the effect of three oral hygiene programs on the plaque removal in a group of patients with rheumatoid arthritis (RA). The three oral hygiene programs comprised instruction using: (1) an electric toothbrush; (2) a manual toothbrush with conventional fluoride toothpaste; and (3) using a manual toothbrush with fluoride/chlorhexidine gel. Data were obtained from a total of 14 RA patients consisting of

10 patients who reported difficulties in daily oral hygiene in a dental health survey (Arneberg *et al.*, 1991) and four patients attending the rheumatism hospitals in Oslo. According to a modified Greene and Vermillion Index, plaque scores were recorded at the initial screening assessment, at a two-week control assessment, and at three consecutive two-week experimental assessments. All patients were asked to continue brushing their teeth as usual during the two-week control period and subsequently, were instructed according to the three oral hygiene regimens which they carried out one at a time during the three two-week experimental periods. It was a single blind randomized trial. In addition, arm and hand mobility was assessed.

All three programs showed significant effects on plaque removal, whereas during the control period without instructions in oral hygiene, negligible changes in plaque score were observed. Use of the electric toothbrushes was associated with a slightly reduced plaque score compared with the use of manual toothbrushes. Brushing with the chlorhexidine/fluoride gel showed the greatest reduction in plaque score among the three programs. However, the author explained that it would be difficult to clinically apply the chlorhexidine gel program due to its unacceptable taste and discoloration. Regarding the relationship between impaired arm and finger mobility and oral hygiene, arm and finger function was not significantly related to improvement in plaque removal in any of the three programs.

1.4 Periodontal disease and rheumatoid arthritis

Sjostrom L *et al.* (1989b). Periodontal conditions in adults with rheumatoid arthritis. *Community Dentistry and Oral Epidemiology* 17(5):234-236.

This report relates to the sample described in the previous study of 204 patients with rheumatoid arthritis (Laurell *et al.*, 1989a). The aims of this study were to describe periodontal conditions in adult patients with rheumatoid arthritis (RA) and to compare them with those without rheumatic disease.

Data were obtained from 161 RA patients (119 females and 42 males) and 122 individuals without rheumatic disease (80 females and 42 males). Clinical examinations were carried out by two calibrated dentists regarding diagnostic criteria. In addition, a radiographic examination was undertaken. These examinations sought the following information: the number of teeth; the prevalence of dental plaque, gingivitis, calculus, and deepened periodontal pockets; and the severity of periodontal disease according to the criteria of Hugoson and Jordan (1982).

The number of teeth in the RA group was not significantly different from that in the control group; 20 and 21 respectively, but the prevalence of advanced periodontal disease was slightly different between the two groups; 12 percent in the RA patients relative to 16 percent in the control group. Furthermore, plaque and calculus were less frequently observed among the RA patients than the control group. The author explained that better periodontal conditions seen in this study could be associated with the effect of the long-term use of non-steroidal anti-inflammatory drugs (NSAIDs), which suppress inflammation. Indeed, taking NSAIDs was reported in 86 percent of the RA patients in this

study.

Mercado F *et al.* (2000). Is there a relationship between rheumatoid arthritis and periodontal disease? *Journal of Clinical Periodontology* 27(4):267-272.

The aim of this study was to assess the relationship between rheumatoid arthritis (RA) and periodontal disease. This study was undertaken to test the following two hypotheses: individuals with periodontal disease would have a higher prevalence of RA than those without periodontal disease; and individuals with RA are more likely to have advanced periodontal disease than those without RA.

A total of 1,412 subjects aged 20 to 70 were recruited from patients attending the University of Queensland Dental Hospital, and comprised a group of 809 individuals who were under periodontal treatment (the periodontal group) and a group of 603 individuals attending for a general dental treatment other than periodontal treatment (the general group). Data to identify individuals with RA were obtained from a self-reported health questionnaire and data from dental records including dental radiographs were used to determine the prevalence and severity of periodontal disease according to the modified Hugoson and Jordan (1982) classification.

The individuals in the periodontal group had a higher prevalence of RA compared with the general group; the prevalence of RA identified through the self-report was 4 percent in the periodontal group relative to 1 percent in the general group ($p < 0.05$). Furthermore, in the periodontal group, advanced periodontal disease was observed in 63 percent (20 out of 32) of the individuals with RA compared with 44 percent (340 out of 777) of the general group ($p < 0.05$). It was demonstrated that individuals with RA were 2.1 times more likely to

develop moderate to severe periodontal disease than non-rheumatoid individuals.

Mercado FB *et al.* (2001). Relationship between rheumatoid arthritis and periodontitis. *Journal of Periodontology* 72(6):779-787.

This study compared the severity of periodontal disease in a group of patients with rheumatoid arthritis (RA) with that in an age and sex-matched control group. The aim of this study was to evaluate the correlation between the severity of periodontitis and RA amongst a population of RA patients.

A total of 65 patients with rheumatoid arthritis (RA) attending a rheumatology clinic were assessed for the severity of periodontitis. An examination for periodontitis sought information on probing depths, attachment loss, plaque score, bleeding scores, number of missing teeth, and radiographic bone loss. Measures for RA included swollen joint analysis, health assessment questionnaire (HAQ), and levels of C-reactive protein (CRP). The correlation between periodontal bone loss and indicators of RA activity was evaluated, and periodontal bone loss in the RA patients was also compared with that in the non-rheumatic individuals.

No significant differences in the plaque scores and bleeding scores were found between the RA group and the control group. In contrast, the RA group had deeper probing depths and more severe periodontal bone loss than the control group. The RA patients were more than twice as likely to develop deep probing depths compared with the control group (OR = 2.47; 95% CI = 1.17, 5.21). Similarly, the RA patients were more than twice as likely to develop moderate to severe bone loss (P2 to P3) compared with the control group (OR = 2.27; 95% CI = 1.10, 4.60). Furthermore, the RA group had more missing teeth than the

control group; 11.6 and 6.7 respectively ($p = 0.000$).

In a comparison between periodontal bone loss (that was used as an indicator of the severity of periodontitis) and indicators of RA activity, it was found that swollen joints, HAQ, and levels of CRP were associated with severity of periodontitis. First, the RA patients with moderate to severe periodonitis had more swollen joints ($P < 0.05$). Second, a significant association between the degree of functional debilitation due to RA and the severity of periodontal disease was found ($OR = 2.37$; 95% $CI = 1.04, 5.44$). Third, as the CRP level increased by every 1mg/l, the odds of having moderate to severe periodontitis increased by 1.14 ($P = 0.001$; 95% $CI = 1.07, 1.20$).

The author concluded that this study further demonstrated the relationship between periodontitis and RA, which was found in their previously published study (Mercado *et al.*, 2000), that is, that patients with RA are more at risk of severe periodontitis.

1.5 Xerostomia and swallowing problems and rheumatoid arthritis

Geterud A *et al.* (1991). Swallowing problems in rheumatoid arthritis. *Acta Oto-Laryngologica* 111(6):1153-1161.

The aims of this study were: (1) to evaluate the prevalence of xerostomia and swallowing problems in a group of patients with rheumatoid arthritis (RA); and (2) to investigate the associations between RA severity and swallowing problems, xerostomia, and salivary flow rate.

A total of 29 female RA patients and a control group of 30 female individuals participated in this study. The mean age was 55 years and 53 years in the RA group and control group respectively. The mean RA duration was 15 years. RA severity was classified according the American Rheumatism Association (ARA) classification; four patients belonged to Class I, 14 to Class II, 11 to Class III, and no patients belonged to Class IV. Data were obtained from a questionnaire regarding swallowing problems and xerostomia symptoms and from both stimulated saliva flow and laboratory tests.

More RA patients reported subjective symptoms regarding swallowing problems and xerostomia than the control group; 83 percent in the RA group compared with 20 percent in the control group ($p < 0.001$). Xerostomia was reported by 21 percent of the RA patients relative to none in the control group. Similarly, swallowing problems occurred in 28 percent of the RA patients compared with 3 percent of the control group. Xerostomia was associated with a low stimulated saliva flow ($p < 0.05$), whereas swallowing problems had no significant association with decreased stimulated salivary flow.

In contrast, RA severity was significantly associated with swallowing problems ($p < 0.05$), but not xerostomia. It was also found that there was no significant association between swallowing problems and xerostomia. No significant difference in age or RA duration was found between patients with xerostomia and patients without xerostomia. Similarly, there was no significant difference in age or RA duration between patients with swallowing problems and those without swallowing problems.

Risheim H *et al.* (1992). Oral sugar clearance and root caries prevalence in rheumatic patients with dry mouth symptoms. *Caries Research* 26(6): 439-444.

This study investigated relationships among root caries, dry mouth, salivary flow rate, and oral sugar clearance in a group of 22 rheumatic patients. The study group comprised 20 patients with rheumatoid arthritis (RA) and two with a diagnosis of primary Sjogren's syndrome. The age of the 22 subjects varied from 40 to 72 years with a mean of 57 years; the mean duration of their rheumatic disease was 13.5 years. All participants in this study had dry mouth symptoms and were examined for root caries, salivary flow rate, and salivary sugar clearance. The subjects were divided into the 'low' caries group (0-2 root lesions) and the 'high' caries group (> 2 root lesions).

Root caries occurred in approximately 70 percent of the subjects with dry mouth symptoms. Most subjects also had a high number of root fillings. The subjects in the high caries group were older and had longer oral sugar clearance time compared with those in the low caries group. Moreover, the prevalence of root caries was positively correlated with age in the patients with dry mouth symptoms (Kendall's rank correlation coefficient = 0.40, $p < 0.01$). Similarly, oral sugar clearance time increased with age whereas resting salivary flow rate decreased with age.

The author therefore concluded that root caries in rheumatic subjects with dry mouth is likely to increase with age due to declining resting salivary flow rate and increasing oral sugar clearance time. In contrast, it was found that the number of teeth was not significantly correlated with age, root caries, resting salivary flow rate, or oral sugar clearance time.

Reisine S, Tanzer JM (1994). Xerostomia and its effect on well being in patients with rheumatoid arthritis. *Journal of Rheumatology* 21(2):378-380.

The aims of this study were to assess the prevalence of xerostomia, and to investigate the effect of xerostomia on the well-being of patients with rheumatoid arthritis (RA). A total of 614 patients with RA were selected in this study. It was confirmed that all participants did not have diagnoses of primary or second Sjogren's syndrome or take xerogenic medications. The mean age among the RA patients was 50.2 years and the percentage of the females was 75 percent. Data in this study included information on dry mouth symptoms and well-being characteristics that were measured by indices of depressed mood (Radloff, 1977).

The presence of troubles caused by dry mouth was reported by about 30 percent of the RA patients. According to a multiple regression analysis, a very small percentage of the variation in depressive symptoms was explained by dry mouth ($p < 0.001$). The author concluded that xerostomia is likely to affect well-being in patients with RA.

Russell SL, Reisine S (1998). Investigation of Xerostomia in patients with rheumatoid arthritis. *Journal of the American Dental Association* 129(6): 733-739.

This study was conducted to assess the prevalence of xerostomia in a group of subjects with rheumatoid arthritis (RA), and to investigate the relationship between reduced salivary flow symptoms and clinical and medical characteristics.

A total of 988 patients with RA were recruited from 56 private practices selected at random by members of the American College of Rheumatology. Data were obtained from 604

patients. All participants in this study were interviewed by telephone regarding dry mouth symptoms using Fox's questionnaire, physical disability utilizing Health Assessment Questionnaire (HAQ), and medications. In addition, clinical data were obtained from physicians. All patients were classified according to RA severity level as measured by radiographic stage; 46 percent of the subjects belonged to Stage III or IV, 34 percent to Stage II, and 14 percent to Stage I. The mean subject age was 56 years, mean RA duration was 16 years, the proportion of female was 80 percent, and the mean HAQ score was 1.2.

Fox *et al.* (1987) had previously demonstrated that only three questions out of a possible nine concerning subjective xerostomia symptoms were sufficient to measure dry mouth objectively. Subjects in this study, therefore, were classified as those who had a salivary dysfunction when they answered yes to having any one of the three symptoms: the need to sip liquids to aid in swallowing dry foods; experience dry mouth when eating a meal; and experience difficulties in swallowing any foods. Decreased salivary flow, according to Fox's criteria, was found in 43 percent of the RA patients - one xerostomia symptom was experienced in 26 percent, two symptoms in 11 percent, and all three symptoms in 6 percent. In the subjects with decreased salivary flow, the need to sip liquid to aid in swallowing dry foods was reported by 90 percent, dry mouth when eating was experienced by 34 percent, and difficulties in swallowing any foods by 27 percent.

In a comparison between a group of subjects with xerostomia symptoms and a group of subjects without any symptoms, subjects experiencing dry mouth during eating were younger and had higher HAQ scores than those without dry mouth during eating. Subjects who reported the need to sip liquids to aid in swallowing had higher HAQ scores compared with subjects without the need to sip liquid in swallowing. Moreover, it was found that the

RA patients reporting these xerostomia symptoms (in other words, the patients with salivary gland dysfunction according to Fox's criteria) were more likely to take a greater number of medications and have higher HAQ scores than the non-RA patients.

Regular use of medications was reported by 58 percent of the RA patients. Some patients reported taking more than one medication. Use of antihypertensives was reported by 23 percent, antihistamines by 11 percent, antidepressants by 7 percent, diuretics by 16 percent, heart medications by 11 percent, and gold sodium thiomalates by 18 percent.

Nederfors T *et al.* (2002). The relation between xerostomia and hyposalivation in subjects with rheumatoid arthritis or fibromyalgia. *Swedish Dental Journal* 26(1):1-7.

The aim of this study was to evaluate the association between the symptoms of xerostomia and hyposalivation in a group of patients with rheumatoid arthritis (RA). A total of 100 subjects attending the hospital for rheumatic disease comprised 75 patients with RA and 25 females with fibromyalgia. The mean age of the 84 females was 56 years; this was similar to that of the 16 males. Data regarding xerostomia were obtained by questionnaire, and unstimulated and stimulated salivary flow rates were obtained from a secretion test; each salivary test was conducted in the morning before breakfast and again two hours later.

Xerostomia was reported in 74 percent of the subjects. The subjects reporting xerostomia had lower salivary secretion rates compared with those who did not report xerostomia ($p < 0.001$) according to both the unstimulated and stimulated tests. Furthermore, it was found that xerostomia was more highly associated with the unstimulated salivary secretion rate in the morning before breakfast. The author thereby concluded that by asking the simple

question regarding xerostomia, "Does your mouth usually feel dry?", it was possible to predict hyposalivation, especially in the unstimulated condition.

1.6 Temporomandibular joint (TMJ) involvement and RA

Larheim TA *et al.* (1983). Temporomandibular joint involvement and dental occlusion in a group of adults with rheumatoid arthritis. *Acta Odontologica Scandinavica* 41(5):301-309.

This study included a group of 49 patients with RA (40 females and 9 males) and compared TMJ disorders in the dentate group of 24 patients with those in the edentulous group of 25 patients. The aims of this study were to assess the prevalence of temporomandibular joint (TMJ) symptoms and occlusal changes in a group of adults with rheumatoid arthritis (RA), and to investigate the relationship between TMJ disorders and type of dentition.

Data in this study were obtained from: (1) an interview on TMJ pain and occlusal changes; (2) a clinical examination of crepitus, maximum mouth opening capacity, and anterior open bite; and (3) a radiographic examination of condylar motion and TMJ abnormalities. The mean age at RA onset was 36 years and the mean RA duration was 22 years.

Previous or current TMJ pain, impaired mandibular function, and radiographic TMJ abnormalities occurred in about 80 percent the patients. Occlusal changes with anterior open bite were found in about 30 percent, without regard to type of dentition. Also, there was no difference in the prevalence of previous or current TMJ pain between the dentate group and the edentulous group; approximately 75 percent in both of groups. Similarly, no

difference in the prevalence of radiographic TMJ abnormalities was found between the two groups; more than 80 percent in both. These findings might indicate that type of dentition is unlikely to be associated with the prevalence of occlusal changes, TMJ pain, and radiographic TMJ abnormalities. Interestingly, in both groups, all patients with occlusal changes had radiographic TMJ abnormalities. Some patients with restricted condylar translation demonstrated a satisfactory maximum mouth opening capacity (> 40 mm). The author's explanation for this was as follows: even though the condylar translation was restricted, condylar rotation was retained due to fibrous adhesions within the joint.

Syrjanen SM (1985). The temporomandibular joint in rheumatoid arthritis. *Acta Radiologica Diagnosis* 26(3):235-243.

The aims of this study were to assess the prevalence of clinical and radiographic signs in the temporomandibular joint (TMJ) in a group of patients with rheumatoid arthritis (RA), and to compare them with those in a control group. A group of 101 patients with RA were involved in this study. The mean age was 54.1 years and the mean RA duration was 16.3 years. The ratio of females to males was 3.7:1. The rheumatoid factor was seropositive in 60 percent of the RA patients and their disease severity was classified according to the American Rheumatism Association (ARA) classification; ARA I ($n = 38$), ARA II ($n = 36$), and ARA III or IV ($n = 36$). The control group comprised 54 patients with osteoarthritis and 19 other healthy individuals. Their mean age was 56.0 years and the ratio of females to males was 5.6:1.

Data in this study were obtained from: (1) an interview on previous TMJ symptoms; (2) a clinical examination of the TMJ including an assessment of pain, tenderness on palpation of the TMJ, and maximum mouth opening capacity; and (3) a radiographic examination of

TMJ abnormalities.

TMJ pain and tenderness in the past were more frequently experienced in the RA group than the control group; RA 27 percent, control 15 percent ($p < 0.05$). Clinical TMJ symptoms occurred in 34 percent of the RA group compared with 18 percent of the control group. Interestingly, most RA patients had a satisfactory mouth opening capacity ($> 40\text{mm}$) as well as most control group members. Radiographic TMJ abnormalities were observed in 60 percent of the RA group relative to 15 percent of the control group ($p < 0.001$). In the RA group, it was found that the prevalence of radiographic TMJ abnormalities increased with RA duration. Furthermore, severe TMJ abnormalities were observed only among the RA patients and occurred in the late stage of RA.

Mizutani H *et al.* (1985). Rheumatoid arthritis and temporomandibular joint - its clinical course and radiographic changes. *Journal of Japanese Oral Surgery Institute* 31(10): 2421-2431.

The aim of this study was to investigate the prevalence of temporomandibular joint (TMJ) involvement in patients with rheumatoid arthritis (RA). A total of 109 RA patients aged 21 to 76 undertook a clinical examination of the TMJ. Information from radiographic examinations was obtained from 62 RA patients. The mean RA onset was 40.3 years and the mean RA duration was 8.1 years. The ratio of females to males was 3:1.

TMJ symptoms occurred in 62.4 percent of RA patients; crepitus was the most common clinical symptom, followed by TMJ pain, and limitation in mouth opening. Few patients (8.3 percent) reported acute TMJ symptoms. Interestingly, RA patients with TMJ symptoms showed no significant difference in reduction in maximum mouth opening

capacity compared with those without TMJ symptoms; 44 mm and 48 mm respectively. Regarding the relationship between the prevalence of TMJ involvement and RA factors, the high prevalence of TMJ involvement seemed to be associated with early RA onset, long RA duration, and positive serum rheumatoid factor (RF). Also, some patients reported experiencing occlusal changes such as an anterior open bite and posterior repositioning of the chin. Radiographically, TMJ abnormalities were observed in 80 percent of RA patients; surface erosion and flattening in TMJ condyle were the common findings. Furthermore, it was found that TMJ changes tended to develop with RA duration.

Larheim T, Floystrand F (1985). Temporomandibular joint abnormalities and bite force in a group of adults with rheumatoid arthritis. *Journal of Oral Rehabilitation* 12(6): 477-482.

This study compared clinical and radiographic temporomandibular joint (TMJ) signs and bite force in a group of 16 patients with rheumatoid arthritis (RA) with those in the control group of 16 individuals without joint disease. The mean age in the RA patients was 51 years and the mean RA duration was 17 years. The female to male ratio was 7:1. Maximum mouth opening and bite force measurements were taken and a radiographic examination of condylar motion was carried out.

Condylar motion and maximum bite force in the RA group was significantly lower than in the control group. However, the reduction in maximum mouth opening capacity in the RA group was not significantly greater than that in the control group. Also, some patients with satisfactory maximum mouth opening capacity (> 40 mm) had restricted condylar translation. The author therefore concluded that maximum mouth opening capacity seemed to be an uncertain parameter in the estimation of joint function.

Tegelberg A, Kopp S (1987a). Clinical findings in the stomatognathic system for individuals with rheumatoid arthritis and osteoarthritis. *Acta Odontologica Scandinavica* 45(2):65-75.

The aims of this study were: (1) to assess clinical symptoms of the temporomandibular joint (TMJ) in patients with rheumatoid arthritis (RA group) and to compare them with those in individuals without general joint symptoms (control group); (2) to assess dental occlusal disturbances; and (3) to investigate the correlation between clinical TMJ symptoms and occlusal disturbances.

A group of 123 patients participated in this study. All patients in this study were classified as RA according to the American Rheumatism Association (ARA) criteria. An age and sex-matched group of 54 subjects (control group) was recruited from patients attending the Public Dental Clinic in Strangnas, Sweden for regular dental care. The mean age was 57 years in the RA group and 51 years in the control group, and the proportion of females was 80 percent and 75 percent in the RA group and the control group respectively.

Data were obtained from a clinical examination and a questionnaire. The clinical examination sought information on: (1) tenderness on palpation of the TMJ and masticatory muscles; (2) clicking and crepitus of the TMJ; (3) maximum mouth opening capacity; (4) pain during mandibular movements; (5) dental occlusion according to the Eichner index; and (6) anterior open bite. All clinical examinations were carried out by the same examiner. The questionnaire comprised 30 multiple choice-type questions on TMJ disorders, general joint symptoms, medications, dental conditions, dental health habits, and dental attendance.

More RA group members showed symptoms of TMJ disorders than the control group. For

instance, crepitus of the TMJ was found in 75 percent of the RA group compared with in 20 percent of the control group ($p < 0.001$). Furthermore, lateral tenderness of the TMJ was reported by 43 percent of the females in the RA group, but by only 3 percent of the females in the control group ($p < 0.001$).

Also, a statistically significant difference in mean maximum mouth opening capacity was found between the RA female group and in the control female group ($p < 0.001$); 38 mm and 52 mm respectively. In other words, about half of the RA patients had less than 40 mm maximum mouth opening capacity. Within the RA group, there were significant differences between sexes. Lateral tenderness of the TMJ was reported in 43 percent of the females relative to 25 percent of the males ($p = 0.001$). Moreover, the males had greater mean of maximum mouth opening capacities than the females; 45 mm in the males and 38 mm in the females ($p = 0.001$). On the other hand, there was no remarkable difference in TMJ crepitus between sexes; 76 percent of females and 75 percent of males.

More occlusal problems were diagnosed in the RA group than in the control group; the RA group members had less occlusal support, more occlusal interferences, and more frequent prevalence and severity of anterior open bite than control group members.

There was a negative correlation between TMJ pain and maximum mouth opening capacity in the RA group (Spearman's rank correlation coefficient, $R_s = -0.36$, $P < 0.001$). Furthermore, it was found that the maximum mouth opening capacity in the RA group was positively correlated with the number of remaining teeth ($R_s = 0.18$; $P < 0.05$), and negatively correlated with anterior open bite ($R_s = -0.32$, $P < 0.05$). Also, loss of occlusal support had a positive correlation with TMJ crepitus, and a negative correlation with

maximum opening mouth capacity. This indicates that loss of occlusal support affects TMJ disorders.

Tegelberg A, Kopp S (1987b). Subjective symptoms from the stomatognathic system in individuals with rheumatoid arthritis and osteoarthritis. *Swedish Dental Journal* 11(1-2):11-22.

This report relates to the sample described in the previous study of 123 patients with rheumatoid arthritis (Tegelberg, Kopp, 1987a). The aim of this study was to assess subjective symptoms in the temporomandibular joint (TMJ) and subjective oral status in a group with RA (RA group), and to compare them with those in a population without general joint diseases (control group).

All patients answered a questionnaire comprising 30 multiple choice-type questions on TMJ symptoms, general joint symptoms, medications, dental status, dental health habits, and dental attendance.

Previous or current TMJ symptoms were more frequently reported in the RA group compared with the control group; 35 percent in the RA group and 16 percent in the control group. For instance, pain in the TMJ during mouth opening or chewing occurred in 54 percent of the RA group relative to 4 percent in the control group ($p = 0.001$). Difficulties in mouth opening were found by 62 percent in the RA group and 12 percent in the control group ($p = 0.001$). In addition, more RA group members had severe TMJ symptoms and these were experienced for longer durations than those among the control group ($P = 0.001$).

In the RA group, TMJ pain was more frequent in females than in males ($p = 0.018$). It had a negative correlation with age (Spearman's rank correlation coefficient, $R_s = -0.18$, $p = 0.043$), and a positive correlation with difficulties in mouth opening ($R_s = 0.54$, $p = 0.001$) and TMJ sounds ($R_s = 0.26$, $p = 0.002$). Difficulties in mouth opening was also positively correlated with TMJ sounds ($R_s = 0.18$, $p = 0.028$) and duration of TMJ symptoms ($R_s = 0.19$, $p = 0.003$). These TMJ symptoms started later in females than in males ($p = 0.022$). Interestingly, one third of the RA patients claimed that these TMJ symptoms started during the early phase of RA. Bilateral symptoms in the TMJ were more frequent than unilateral TMJ symptoms; 43 percent had bilateral symptoms and 27 percent had unilateral symptoms. Moreover, the severity of TMJ symptoms were positively correlated with the number of the general joints symptoms experienced ($R_s = 0.25$, $p = 0.003$). Similarly, the number of general joint symptoms was positively correlated with TMJ pain on chewing ($R_s = 0.29$, $p = 0.001$) and with TMJ sounds ($R_s = 0.25$, $p = 0.003$). Furthermore, the duration of TMJ symptoms was correlated to the duration of general joint symptoms experienced ($R_s = 0.31$, $p = 0.001$).

According to the author, these findings indicate that TMJ disorders increased with severity and duration of RA. Few RA patients, however, complained that TMJ symptoms disturbed their daily activities. This might be explained by the fact that the severe pain in general joints, due to RA, is more likely than TMJ pain to have a negative impact on daily activities.

More RA group members had impaired chewing ability compared with those in the control group; 16 percent in the RA group and 4 percent in the control group. In the RA group, chewing ability was significantly correlated with both RA duration and the number of

general joint symptoms; $R_s = 0.20$, $p = 0.014$ and $R_s = 0.22$, $p = 0.011$ respectively. This indicates that chewing ability deteriorates with increasing RA duration. Furthermore, loss of contact between anterior teeth was reported in 17 percent of the RA group relative to none in the control group. In addition, the prevalence of anterior open bite was positively correlated with both RA duration and the number of general joint symptoms; $R_s = 0.25$, $p = 0.005$ and $R_s = 0.22$, $p = 0.011$ respectively.

Dry mouth was reported by 52 percent of the RA group members compared with 8 percent of the control group. In the RA group, more females had dry mouth than the males ($p = 0.039$). Dental status was considered to be good in 17 percent of the RA group relative to 41 percent in the control group. The author's explanation for this was that more RA patients had difficulties with tooth brushing; 22 percent in the RA group and 2 percent in the control group. In addition, tooth brushing ability was negatively correlated with the duration of general joint symptoms ($R_s = -0.15$, $p = 0.049$), indicating that tooth brushing ability deteriorates with increased duration of RA.

Tegelberg A *et al.* (1987c). Relationship between disorder in the stomatognathic system and general joint involvement in individuals with rheumatoid arthritis. *Acta Odontologica Scandinavica* 45(6): 391-398.

This report relates to the sample described in the previous study of 123 patients with rheumatoid arthritis (Tegelberg, Kopp, 1987a,b); this study compared disorders of the temporomandibular joint (TMJ) in a group with rheumatoid arthritis (RA) with those in an age and sex-matched random group without RA. The aim of this study was to investigate the relationship between TMJ disorders and RA activity as estimated by laboratory tests.

Laboratory tests were performed to estimate the severity of RA, in which C-reactive protein (CRP) and rheumatoid factor (RF) were utilized as indicators of inflammation. Rheumatoid factor (RF) was detected in 61 percent of the RA group compared with 4 percent of the control group. Regular use of non-steroid anti-inflammatory drugs was reported by 94 percent of the RA group.

More RA group members had higher concentrations of CRP and RF than the control group members ($p = 0.001$). In the RA group, the subjects who had current unilateral or bilateral TMJ symptoms had higher serum concentrations of CRP than those who previously had TMJ symptoms but not currently. Also, as CRP in the RA patients increased, TMJ pain was more likely to occur (Spearman's rank correlation coefficient, $R_s = 0.29$; $p = 0.009$) and maximum mouth opening capacity was reduced ($R_s = -0.21$; $p = 0.042$). Moreover, as serum concentrations of RF increased, TMJ transitory mobility was more likely to be reduced ($R_s = -0.21$, $p = 0.038$) and accompanied by more impaired chewing ability ($R_s = 0.20$, $p = 0.046$). The authors concluded that RA severity was positively correlated with the severity of TMJ disorders.

Ettala-Ylitolo UM *et al.* (1987). Functional disturbances of the masticatory system related to temporomandibular joint involvement by rheumatoid arthritis. *Journal of Oral Rehabilitation* 14(5): 415-427.

The aim of this study was to investigate, in a group of patients with rheumatoid arthritis (RA), the relationships among disorders of the temporomandibular joint (TMJ), disorders in the masticatory system, and RA severity. In addition, this study compared TMJ disorders and occlusal problems in RA patients with those in a control group.

A total of 60 patients with RA according to the American Rheumatism Association (ARA) criteria were recruited as the RA group. The mean RA duration was 16.7 years and the ratio of females to males was 4:1. Twenty-two patients belonged to ARA I; 21 to ARA II; and 17 to ARA III or IV, according to ARA classification. The control group comprised 25 patients with degenerative osteoarthritis and 15 healthy individuals. The mean age was 55.3 years in the RA group and 59.8 years in the control group. Data were obtained from: (1) an interview regarding previous TMJ symptoms; (2) a clinical examination of TMJ disorders and occlusal problems; and (3) a radiological examination of the TMJ.

More RA group members had TMJ symptoms than the control group. For instance, crepitus was reported in 21.7 percent of the RA group compared with 2.5 percent of the control group ($p < 0.01$). There was a significant difference in TMJ movement capacity between the two groups; 41.7 percent of the RA group and 17.5 percent of the control group had reduced movement ($p < 0.01$). Restricted mouth opening occurred in 31.7 percent of the RA group relative to 25.0 percent of the control group (not significant). Interestingly, tenderness on palpation of masticatory muscles was more frequent in the control group than in the RA group; 57.5 percent in the control group and 53.3 percent in the RA group, but this difference was not significant. Similarly, more control group members had joint clicking than the RA group; 57.5 percent and 53.3 percent respectively, but this difference was not significant.

In the RA group, less than 40 mm mouth opening capacity was diagnosed in about 30 percent of RA patients. Severe TMJ symptoms occurred most frequently in the young RA patients (29-39 years). Also, there was a relationship between clinical TMJ disorders and RA severity. For example, reduction in TMJ movement was more frequently observed in

those with more severe RA. In contrast, no relationship was found between RA severity and occlusal disturbances.

Tegelberg A, Kopp S (1988). Short-term effect of physical training on temporomandibular joint disorder in individuals with rheumatoid arthritis and ankylosing spondylitis. *Acta Odontologica Scandinavica* 46(1): 49-56.

The aim of this study was to assess the effect of physical training on the temporomandibular joint (TMJ) symptoms in patients with rheumatoid arthritis (RA). A total of 28 patients with RA classified according to the ARA criteria were recruited from the Rheumatism Hospital in Strangnas, Sweden. Baseline information on TMJ status, clinical TMJ symptoms, general joint symptoms, and laboratory tests were obtained.

All participants had TMJ symptoms and were randomly divided into an experiment/treatment group (E-group, $n = 15$) and a comparison/non-treatment group (C-group, $n = 13$). The mean ages were 52 and 58 years in the E-group and in the C-group respectively. The training program entailed the performance of a set of gentle TMJ exercises and it was recommended that they should perform the exercises twice a day. The follow-up study was conducted three weeks later.

A reduction in the severity of TMJ symptoms was reported in nine of the 15 patients in the E-group at the three-week follow-up study ($p = 0.002$). There was a significant increase in the mean maximum mouth opening capacity in the E-group; from 39 mm to 44 mm ($p = 0.001$). Moreover, the individual change in the E-group was greater than the C-group ($p = 0.001$), ranging from 1 to 8 mm in the E-group compared with between -5 to +5 mm in the C-group. There was no significant change in the concentrations of C-reactive protein

(CRP), as the indicator of inflammation. It was concluded that the self-administrated TMJ exercises contributed to an increase in maximum mouth opening capacity.

Yokoyama Y *et al.* (1988). A clinical study of temporomandibular joint in RA patients. *Orthopedics* 39(3): 346-350.

The aim of this study was to assess temporomandibular joint (TMJ) clinical symptoms in patients with rheumatoid arthritis (RA). A total of 130 RA patients were involved in this study and undertook a clinical and radiographic examination of the TMJ. This RA group consisted of 118 females and 12 males and their mean age and RA duration was 58.6 and 9.6 years respectively. The patients were classified according to Steinbrocker's RA stages; 35 patients belonged to stage II, 27 to stage III, and 61 to stage IV.

TMJ symptoms, including TMJ pain and limited mouth opening, were observed in 63.8 percent of RA patients, whereas current TMJ pain was observed in only 25.4 percent. Nearly half of the RA patients had experienced TMJ symptoms within three years after RA onset. Also, the duration of TMJ symptoms was reported as ranging from one week to more than one month. Maximum mouth opening capacity was found to reduce significantly with increasing RA severity ($p < 0.001$). A significant difference in maximum mouth opening capacity was also found between RA patients with TMJ pain and those without TMJ pain; 33.9 mm and 40.5 mm respectively. Moreover, maximum mouth opening capacity tended to decrease with increasing RA activity, as measured by the erythrocyte sedimentation rate (ESR).

Similarly, current TMJ pain was significantly associated with RA activity. Radiographically, maximum mouth opening capacity tended to deteriorate with increasing

bone destruction whereas no relationship between bone destruction and TMJ pain was observed.

Laurell L *et al.* (1989a). General oral status in adults with rheumatoid arthritis. *Community Dentistry and Oral Epidemiology* 17(5):230-233.

This study, reviewed in section 1.1, also referred to TMJ problems, the details of which were included in that section. Briefly, the oral status of an adult population with rheumatoid arthritis (RA) was compared with that among an age and sex-matched random sample without RA. The aim of this study was to describe the general state of the temporomandibular joint (TMJ) in subjects with RA and to compare it with the non-rheumatic control (CTR) group.

Sato H *et al.* (1990). The temporomandibular joint in rheumatoid arthritis – a comparative clinical and tomographic study pre- and post-prosthesis. *Journal of Oral Rehabilitation* 17(2): 165-172.

This study assessed the effect of dental treatment on disorders in the temporomandibular joint (TMJ) in six female patients with rheumatoid arthritis (RA). All participants in this study had TMJ symptoms and occlusal problems. Prior to dental treatment, clinical and radiographic examinations of the TMJ were conducted. The follow-up study was carried out after their occlusions had been stabilized by prosthesis treatment.

All patients reported reduced clinical TMJ pain on movement and improved mouth opening capacity at the follow-up study. Crepitus, however, did not disappear after prosthesis treatment. Desirable radiographic TMJ changes (remodeling) occurred in some patients, whereas no TMJ change was observed in others.

Yokoe H *et al.* (2002). Clinical study for temporomandibular joint disorder in patients with rheumatoid arthritis. *Chiba medical science* 78: 83-86.

The aim of this study was to investigate the prevalence of temporomandibular joint (TMJ) involvement in patients with rheumatoid arthritis (RA). A total of 117 RA patients undertook a clinical and radiographic examination in the TMJ. The ratio of females to males was 6:1; their mean age was 49.8 years and the mean RA duration was 12.7 years.

Symptoms of TMJ disorders were reported in 42.7 percent of RA patients. Crepitus in the TMJ was the most common symptom, followed by pain on palpation of the TMJ, and difficulties in mouth opening. Also, onset of TMJ disorders in the early stage of RA (around two years after RA onset) was most reported and 70 percent of RA patients had experienced TMJ disorders within five years after RA onset. Furthermore, most patients reported that the duration of TMJ symptoms was less than one month. In contrast, no remarkable occlusal disturbance, including open bite, was found.

According to the radiographic examination, it was found that mandibular condyle destruction tended to deteriorate with RA duration. On the other hand, no significant relationship between the bone destruction and TMJ pain was observed.

PART 2

**THE ORAL HEALTH OF RHEUMATOID
ARTHRITIS PATIENTS IN NIIGATA**

2. Introduction

2.1 Oral health and rheumatoid arthritis

The oral health of patients suffering from rheumatoid arthritis (RA) has been the subject of many reports. In particular, general oral status, oral hygiene, periodontal disease, xerostomia and swallowing problems, and temporomandibular joint (TMJ) problems have been reported in relation to RA patients (see review of literature).

2.2 Rheumatoid arthritis

“Rheumatoid arthritis (RA) is a chronic systemic inflammatory disorder that may affect many tissues and organs – skin, blood vessels, heart, lungs, and muscles – but principally attacks the joints, producing a nonsuppurative proliferative synovitis that often progresses to destruction of the articular cartilage and ankylosis of the joints.”

“Autoimmunity plays a pivotal role in its chronicity and progression, likening this condition to other so-called connective tissue diseases.”

“About 1% of the world’s population is afflicted by RA, women three to five times more often than men. The peak incidence is in the third and fifth decades of life, but no age is immune.”

“The clinical course of RA is extremely variable. The disease begins slowly and insidiously in more than half of the patients. Initially, there is malaise, fatigue, and generalized musculoskeletal pain, and only after several weeks to months do the joints become involved, sometimes monoarticular, at other times oligoarticular, and in some instances polyarticular (usually symmetrically).”

“The involved joints are swollen, warm, painful, and particularly stiff on arising or following inactivity.”

“Approximately 10% of patients have an acute onset, with severe symptoms and polyarticular involvement developing within a few days. In the typical patient, the onset is insidious with progressive joint involvement over a period of months to years, with initial minimal limitation of motion that, in time, becomes more severe. The disease course may be slow or rapid and fluctuate over a period of years, with the greatest damage occurring during the first 4 to 5 years.”

Cotran RS, Robbins SL, Kumar V (1994). *Robbins pathologic basis of disease, 5th Edition*. Philadelphia: WB Saunders Company.

2.3 Study purpose

Major pathology textbooks, such as *Robbins pathologic basis of disease, 5th edition*, often fail to refer to the TMJ complications of RA in their extensive discussion of RA pathogenesis. However, TMJ related complications of RA significantly impact on oral health.

The purpose of this study was to investigate the effect of rheumatoid arthritis on oral health and oral health-related quality of life. It is a subject that has implications for health promotion.

2.4 Objectives

The specific objectives were to explore:

1. Relationships between (a) oral status, (b) oral health, (c) TMJ status/health, and (d) oral health-related quality of life and the following set of factors *individually*:
 - demographic
 - RA
2. Relationships between activities-of-daily-living and the following set of factors *individually*:
 - demographic
 - RA
 - oral status
 - oral health
 - TMJ status/health
 - oral health-related quality of life
3. *All combinations* of relationships between:
 - oral status
 - oral health
 - TMJ status/health
 - oral health related quality of life

2.5 Hypotheses

It is hypothesized that RA impacts unfavourably on the TMJ and on ability to maintain good oral hygiene which together then impact unfavourably on oral status, oral health, and oral health related quality of life.

2.6 Ethics clearance

Permission for the survey was obtained from the Human Research Ethics Committees of the following organizations:

- The University of Sydney
- Rheumatoid Arthritis Clinic at Senami Hospital in Niigata, Japan

(Ethics approval – Appendix B)

3. Material and Methods

3.1 Study population

The study population comprised both the in-patients and out-patients attending the Rheumatoid Arthritis Clinic at Senami Hospital in Niigata, Japan.

3.2 Recruitment of sample

From April to June 2004, both out-patients and in-patients were invited by a letter of invitation to take part in an oral health survey. Patients who responded favorably were given an information statement which explained the purpose of the study and assured the patients that information provided by them would be confidential. Only patients who gave informed consent were singly interviewed and examined in a private room (*see Appendices C-E for the recruitment letter, information statement, and consent form*).

3.3 The interviews

Questionnaire interviews were conducted to obtain information on oral health related quality of life, activities of daily living, and oral health (*see Appendix F*). Interviews were conducted in Japanese by the author.

3.3.1 Oral health related quality of life

Information on oral health related quality of life was sought utilizing the UK Oral Health related Quality of Life Index questionnaire (McGrath, Bedi, 2001). This questionnaire is based on 16 questions concerning the impact of oral health on quality of life and includes

physical, social, and psychological domains. This index incorporates both positive and negative dimensions of the impact of oral health on quality of life.

The patients were initially asked:

“What effect does the condition of your teeth, gums, mouth, and/or denture have on your (1 of 16 key areas) ? Good, none, or bad ?” They are then asked: “How would you rate the impact of this effect on your overall quality of life ? None, little, moderate, great, or extreme ?”

The score for each question ranges from 1 to 9, where 1 = a ‘bad effect’ of ‘extreme impact’, 9 = a ‘good effect’ of ‘extreme impact’, and 5 = ‘no effect’ of ‘no impact’. These are summed to give an overall score which ranges from 16 (all bad effects of extreme impact) to 144 (all good effects of extreme impact).

3.3.2 Activities of daily living (ADL)

The modified Stanford Health Assessment Questionnaire (m-HAQ) was used to seek information on activities of daily living (Pincus *et al.*, 1983). This questionnaire is composed of eight base questions related to difficulty in performing daily activities such as dressing, walking, and bending down to pick up an object. The response to each question is coded as follows; “without any difficulty” = 0, “with some difficulty” = 1, “with much difficulty” = 2, “unable to do” = 3. Individual m-HAQ scores are summed and the mean is designated as the patient score, ranging from 0 to 3. Higher scores reflect increasing degrees of difficulty in performing daily activities.

3.3.3 Oral health and performance of daily oral hygiene

Information on oral health and performance of daily oral hygiene was obtained from 11 questions covering pain when chewing, experience of pain in the temporomandibular joint

(TMJ), dry mouth symptoms, difficulties in mouth opening, and difficulties in tooth brushing due to RA.

The three questions regarding xerostomia symptoms were taken from the study published by Fox *et al.* (1987). Fox *et al.* (1987) had previously demonstrated that only three questions were sufficient to measure dry mouth objectively. Patients in this study, therefore, were classified as having a salivary dysfunction if they answered yes to any one of the three symptoms: the need to sip liquids to aid in swallowing dry foods; experience of dry mouth when eating a meal; or difficulty in swallowing any foods. The extent of xerostomia is indicated by the number of reported xerostomia symptoms, ranging from zero to three.

3.4 The Clinical Examinations

All patients were examined to assess oral status and temporomandibular joint (TMJ) status. The examinations were carried out by the author who had been calibrated prior to the survey. Intra-examiner reliability was periodically assessed during the survey whereby eight of the 100 patients were reassessed after a three week interval.

3.4.1 Oral clinical examination

An oral clinical examination was conducted using a dental mirror and artificial lights. Patients were examined when seated on a chair and some in-patients were examined in the supine position. Data were gathered in relation to: (1) number of remaining teeth (including the third molars), (2) number of decayed, missing, and filled teeth (DMFT), (3) tooth mobility, (4) number of teeth with cervical caries, and (5) denture possession and

were recorded on an oral examination form (*see Appendix G*).

3.4.2 Temporomandibular joint (TMJ) clinical examination

The TMJ clinical examination comprised: (1) palpation for tenderness of the TMJ and masticatory muscles, (2) pain when opening mouth, (3) clicking, (4) crepitus, and (5) caliper measurement of maximum mouth opening capacity between the maxillary and mandibular teeth incisal edges, adjusted for openbite. Information on TMJ status was recorded on a TMJ clinical examination form (*Appendix G*).

3.5 Medical record of rheumatoid arthritis status

Information on rheumatoid arthritis factors and medications was obtained from medical records. In particular, (1) RA duration, (2) age of RA onset, (3) the number and region of swollen joints, (4) classification of functional status, (5) stage of RA, and (6) results of laboratory tests such as serum concentrations of C-reactive protein (CRP) and rheumatoid factor (RF), was recorded.

3.6 Analysis

Following data entry of the completed questionnaires and clinical examination forms into an electronic database, distributions of variable values were checked for internal consistency. When discrepancies were noted, the questionnaires and clinical examination forms were checked and the database was amended accordingly.

The analysis of the data was conducted utilizing Epi Info for windows (released in February 2004; copyright by the Centers for Disease Control and Prevention, USA) and

the SAS statistical software for windows (Version 8, copyright by SAS institute Inc., Cary, NC, USA).

3.6.1 Analysis purpose

The purpose of the analysis was to explore the effect of rheumatoid arthritis on oral status, oral health, TMJ status/health, and oral health related quality of life. The outcome and potential explanatory variables are given in Tables 1 and 2 respectively. It was also the purpose of the analysis to explore potential relationships between activities of daily living and the oral related variables.

3.6.2 Analysis method

Initially, the relation between each outcome variable was systematically explored in relation to each potential explanatory variable independently in an extensive series of analyses. Only significant associations were considered further, that is, the data presented in the result tables relate to analyses that generated statistically significant outcomes at the initial stage.

Bivariate associations between the continuous measurement type outcome variables and potential explanatory categorical type variables were explored using the analysis of variance method. In addition, many potential explanatory continuous measurement type variables were transformed to ranks. Differences in the outcome measures across the various rank groups were also explored using the analysis of variance method. In these analyses, the strength of significant associations ($p < 0.05$) was assessed through calculations of Spearman's rank co-efficient and the results were graphed.

In addition, linear regression methods were used to explore bivariate associations between

the continuous measurement type variables and continuous type explanatory variables.

Bivariate associations between both binomial and ordinal type outcomes and potential explanatory variables were explored using Chi-square analyses. The strength of any significant ($p < 0.05$) relationships that were identified were investigated further using logistic regression methods. In such cases, ordinal type outcomes were collapsed to binomial type beforehand.

3.6.3 Reliability of measurements

The analysis of the duplicate measurements (intra-examiner) was assessed via the Kappa statistic.

Table 1: Outcome variables

Domain	Outcome variables*
Oral status	Number of remaining teeth Number of DMF teeth Number of decayed teeth Number of teeth with mobility Number of teeth with cervical caries Denture possession
Oral health	Dental pain when chewing Jaw pain when chewing Level of TMJ pain Mouth opening difficulty Xerostomia Swallowing difficulty Tooth brushing difficulty
TMJ health/status	Maximum mouth opening capacity Pain when opening mouth Tenderness of masticatory muscles TMJ tenderness Joint crepitus
Oral health related quality of life	Oral health related quality of life score
Activities of daily living	The modified Health Assessment Questionnaire (m-HAQ) score

*In some analyses, some outcomes were treated as risk factors.

Table 2: Potential explanatory variables

Domain	Potential explanatory variables
Demographic factor	Gender Age Patient status (In-patient/Out-patient)
Rheumatoid arthritis factor	Age of RA onset RA duration Class of functional disability RA stage Number of swollen joints Region of swollen joints C-reactive protein (CRP) Rheumatoid factor (RF) Number of medications taken
Oral health	Dental pain when chewing Jaw pain when chewing Level of TMJ pain Mouth opening difficulty Xerostomia Swallowing difficulty Tooth brushing difficulty
Oral status	Number of remaining teeth Number of DMF teeth Number of decayed teeth Number of missing teeth Number of filled teeth Number of teeth with cervical caries Number of teeth with cervical fillings Number of teeth with mobility

(continued)

Domain	Potential explanatory variables
TMJ health/status	Maximum mouth opening capacity Pain when opening mouth Tenderness of masticatory muscles TMJ tenderness Joint clicking Joint crepitus
Oral health related quality of life	Oral health related quality of life score
Activities of daily living	The modified Health Assessment Questionnaire (m-HAQ) score

4. Results

4.1 The sample

A total of 100 patients with rheumatoid arthritis (RA) took part in this survey (Table 3). All were suffering from RA as classified according to the American Rheumatism Association (ARA) 1987 revised criteria (Frank *et al.*, 1987) (*see appendix H*).

The RA sample comprised 74 out-patients and 26 in-patients. The female to male ratio was 3:1, which is in line with the usual sex distribution seen in RA (Table 3). The patients ranged from 23 to 87 years and the mean age was 65.4 years (SD 10.7). Most patients were aged between 50 and 70 years.

4.2 Rheumatoid arthritis status of the sample

The mean age of RA onset was 50.1 years (SD 13.7) and approximately 75 percent of the patients were diagnosed with RA at ages of more than 40 years (Table 3). Also, nearly 70 percent of the patients have suffered from RA for less than 20 years; the mean RA duration was 15.2 years (SD 12.4).

RA severity was classified according to Steinbrocker's criteria (1949) (*see Appendix I*); about 80 percent of the patients were at Stage III or IV, corresponding to severe and very severe respectively on RA severity scale (Table 3).

Functional disability was classified according to the American College of Rheumatology 1991 revised criteria (Hochberg *et al.*, 1992) (*see appendix J*). Nearly 80 percent of the patients belonged to Class III or IV, corresponding to severely and very severely limited respectively on the RA functional status scale (Table 3).

The number of swollen joints per patient ranged from zero to 15, with the mean of four; only six patients had no swollen joints. More patients had the swollen joints in the upper region of their body than those in the lower. Also, about 30 percent of the patients had swollen joints in both body regions (Table 3).

The concentration of CRP is used as an indicator of inflammation. Approximately 70 percent of the patients had CRP concentrations of more than 0.5 mg/dl, which is considered abnormal. Regarding rheumatoid factor (RF), about 80 percent of the patients had RF concentrations of more than 11 IU/ml, which is also considered abnormal (Table 3).

Only one patient was not on medication whereas nearly 70 percent of the patients were taking from two to five medications (Table 3).

4.3. Oral health related quality of life

The distribution of oral health related quality of life scores is shown in Table 4, where higher scores are associated with better oral health related quality of life. The mean OHQoL-UK score was 72.6 (SD 17.2). Approximately 70 percent of the patients were categorized as having oral health related quality of life scores below the sample's mean value (72.6), which indicates that the patients in this sample are likely to have a poor oral health related quality of life.

This score is based on the results of 16 questions which include physical, social, and psychological domains and the results of these questions are also shown in Table 4. Although not shown in Table 4, eight respondents indicated that their oral health was not affected by any of the 16 questions referred to in the questionnaire. Physical factors were considered to have more impact on quality of life than social or psychological factors (see numbers indicating "none").

Across all of the 16 questions, more patients in the sample perceived that oral health had a negative effect on their quality of life (Table 4). For instance, 47 percent claimed that their oral health status had a negative impact on speech whereas only 7 percent perceived it as having a positive impact on speech; half perceived their oral health status had a negative impact on breath odor whereas 4 percent claimed it had a positive effect on breath odor.

Table 3: The sample (n = 100) - demographic and rheumatoid arthritis factors

Code name	Variable description	Variable values	n
1 SEX	Gender	1 Female	76
		2 Male	24
2(a) AGE	Age	Range = 23 to 87 Mean = 65.4 (SD 10.7)	100
2(b) AGER10	Age distribution	1 20-29	1
		2 30-39	1
		3 40-49	6
		4 50-59	15
		5 60-69	41
		6 70-79	29
		7 80-89	7
3 INOUT	Distribution of in-patient/out-patient	1 Out-patient	74
		2 In-patient	26
4(a) AGEONS	Age of RA onset	Range = 17 to 77 Mean = 50.0 (SD 13.7)	100
4(b) ONSETR10	Distribution of age of RA onset	1 10 - 19	2
		2 20 - 29	9
		3 30 - 39	13
		4 40 - 49	16
		5 50 - 59	35
		6 60 - 69	20
		7 70 - 79	5
5(a) DURAT	Duration in years of RA	Range = 0.50 to 54.3 Mean = 15.2 (SD 12.4)	100
5(b) DUR10	Distribution of duration in years of RA	1 0 - 9	36
		2 10 - 19	36
		3 20 - 29	13
		4 30 - 39	10
		5 40 - 49	2
		6 50 - 59	3
6 CLASS	Class of functional disability	1	1
		2	20
		3	72
		4	7

(Continued)

Code name	Variable description	Variable values	n
7 STAGE	Stage of joint destruction	1	8
		2	13
		3	25
		4	54
8(a) NOJS	Number of swollen joints	Range = 0 to 15 Mean = 4.1 (SD 3.7)	100
8(b) NOJSR5	Distribution of number of swollen joints	1 0 - 4	70
		2 5 - 9	19
		3 10 - 14	8
		4 15 -	3
9 ROJS	Region of swollen joints	0 None	6
		1 Lower	18
		2 Upper	43
		3 Both	33
10(a) CRP	C-reactive protein	Range = 0 to 7.7 (mg/dl) Mean = 1.8 (SD 1.9)	100
10(b) CRPR	Distribution of C-reactive protein	1 0 - 0.4	31
		2 0.5 - 0.9	14
		3 1.0 - 2.9	31
		4 3.0 - 4.9	15
		5 5.0 -	9
11(a) RF	Rheumatoid factor	Range = 10 to 4660 (IU/ml) Mean = 206.7 (SD 513.8)	100
11(b) RFR	Distribution of rheumatoid factor	1 0 -10	17
		2 11 - 99	41
		3 100 - 499	35
		4 500 - 999	2
		5 1000 -	5
12 SUMD	Sum of drugs taken	Range = 0 to 9 Mean = 4.1 (SD 1.8)	100
	Distribution of sum of drugs taken	0	1
		1	7
		2	12
		3	18
		4	21
		5	22
		6	9
		7	8
		8	1
		9	1

Table 4: Oral health related quality of life - OHQoL-UK scores, and responses to the 16 base questions

Code name	Variable description	Variable values	n
QSCORE	Oral Health Quality of Life score, based on 16 questions	Range = 28 to 133 Mean = 72.6 (SD 17.2)	100
QSR30	Distribution of Oral Health Quality of Life score, based on 16 questions	1 20 - 49	11
		2 50 - 79	65
		3 80 - 109	20
		4 110- 139	4
QSR20	Distribution of Oral Health Quality of Life score, based on 16 questions	1 20 - 39	4
		2 40 - 59	14
		3 60 - 79	58
		4 80 - 99	18
		5 100 - 119	3
		6 120 - 139	3
The 16 base questions			
Physical factors			
1(a) QAPPEA	What effect does the condition of your teeth, gums, mouth, and/or denture have on your appearance ?	0 Bad	28
1 None		64	
2 Good		8	
1(b) QAPPEA	How good/ bad ?	1 Extremely bad	7
		2 Very bad	7
		3 Moderately bad	5
		4 A little bad	9
		5 No affect	64
		6 A little good	3
		7 Moderately good	3
		8 Very good	0
		9 Extremely good	2
2(a) QEAT	What effect does the condition of your teeth, gums, mouth, and/or denture have on your eating/enjoyment of food ?	0 Bad	42
		1 None	43
		2 Good	15

(Continued)

Code name	Variable description	Variable values	n
2(b) QEAT	How good/ bad ?	1 Extremely bad	4
		2 Very bad	12
		3 Moderately bad	14
		4 A little bad	12
		5 No affect	43
		6 A little good	4
		7 Moderately good	3
		8 Very good	4
		9 Extremely good	4
3(a) QSPEAK	What effect does the condition of your teeth, gums, mouth, and/or denture have on your speech ?	0 Bad	47
		1 None	46
		2 Good	7
3(b) QSPEAK	How good/ bad ?	1 Extremely bad	8
		2 Very bad	15
		3 Moderately bad	14
		4 A little bad	10
		5 No affect	46
		6 A little good	1
		7 Moderately good	0
		8 Very good	1
		9 Extremely good	5
4(a) QGHEALTH	What effect does the condition of your teeth, gums, mouth, and/or denture have on your general health ?	0 Bad	29
		1 None	64
		2 Good	7
4(b) QGHEALTH	How good/ bad ?	1 Extremely bad	8
		2 Very bad	5
		3 Moderately bad	9
		4 A little bad	7
		5 No affect	64
		6 A little good	1
		7 Moderately good	0
		8 Very good	3
		9 Extremely good	3
5(a) QCOMFT	What effect does the condition of your teeth, gums, mouth, and/or denture have on your comfort ?	0 Bad	35
		1 None	57
		2 Good	8

(Continued)

Code name	Variable description	Variable values	n
5(b) QCOMFT	How good/ bad ?	1 Extremely bad	4
		2 Very bad	14
		3 Moderately bad	7
		4 A little bad	10
		5 No affect	57
		6 A little good	0
		7 Moderately good	1
		8 Very good	3
		9 Extremely good	4
6(a) QBREATH	What effect does the condition of your teeth, gums, mouth, and/or denture have on your breath odor ?	0 Bad	50
		1 None	46
		2 Good	4
6(b) QBREATH	How good/ bad ?	1 Extremely bad	4
		2 Very bad	11
		3 Moderately bad	17
		4 A little bad	18
		5 No affect	46
		6 A little good	1
		7 Moderately good	0
		8 Very good	2
		9 Extremely good	1
Social factors			
7(a) QSOCIAL	What effect does the condition of your teeth, gums, mouth, and/or denture have on your social life ?	0 Bad	26
		1 None	68
		2 Good	6
7(b) QSOCIAL	How good/ bad ?	1 Extremely bad	3
		2 Very bad	11
		3 Moderately bad	7
		4 A little bad	5
		5 No affect	68
		6 A little good	1
		7 Moderately good	0
		8 Very good	1
		9 Extremely good	4
8(a) QROMAN	What effect does the condition of your teeth, gums, mouth, and/or denture have on your romantic relationships ?	0 Bad	23
		1 None	73
		2 Good	4

(Continued)

Code name	Variable description	Variable values	n
8(b) QROMAN	How good/ bad ?	1 Extremely bad	3
		2 Very bad	9
		3 Moderately bad	7
		4 A little bad	4
		5 No affect	73
		6 A little good	0
		7 Moderately good	0
		8 Very good	1
		9 Extremely good	3
9(a) QSMILE	What effect does the condition of your teeth, gums, mouth, and/or denture have on your smiling or laughing ?	0 Bad	38
		1 None	50
		2 Good	12
9(b) QSMILE	How good/ bad ?	1 Extremely bad	8
		2 Very bad	10
		3 Moderately bad	12
		4 A little bad	8
		5 No affect	50
		6 A little good	3
		7 Moderately good	3
		8 Very good	2
		9 Extremely good	4
10(a) QWORK	What effect does the condition of your teeth, gums, mouth, and/or denture have on your work/ ability to do usual jobs ?	0 Bad	16
		1 None	80
		2 Good	4
10(b) QWORK	How good/ bad ?	1 Extremely bad	1
		2 Very bad	6
		3 Moderately bad	6
		4 A little bad	3
		5 No affect	80
		6 A little good	1
		7 Moderately good	0
		8 Very good	1
		9 Extremely good	2
11(a) QMONEY	What effect does the condition of your teeth, gums, mouth, and/or denture have on your finances ?	0 Bad	9
		1 None	90
		2 Good	1

(Continued)

Code name	Variable description	Variable values	n
11(b) QMONEY	How good/ bad ?	1 Extremely bad 2 Very bad 3 Moderately bad 4 A little bad 5 No affect 6 A little good 7 Moderately good 8 Very good 9 Extremely good	0 4 4 1 90 1 0 0 0
Psychological			
12(a) QCONFI	What effect does the condition of your teeth, gums, mouth, and/or denture have on your confidence ?	0 Bad 1 None 2 Good	30 60 10
12(b) QCONFI	How good/ bad ?	1 Extremely bad 2 Very bad 3 Moderately bad 4 A little bad 5 No affect 6 A little good 7 Moderately good 8 Very good 9 Extremely good	6 9 8 7 60 2 2 1 5
13(a) QSLEEP	What effect does the condition of your teeth, gums, mouth, and/or denture have on your sleep / ability to relax ?	0 Bad 1 None 2 Good	23 73 4
13(b) QSLEEP	How good/ bad ?	1 Extremely bad 2 Very bad 3 Moderately bad 4 A little bad 5 No affect 6 A little good 7 Moderately good 8 Very good 9 Extremely good	3 8 5 7 73 0 0 0 4
14(a) QCAREF	What effect does the condition of your teeth, gums, mouth, and/or denture have on your carefree manner ?	0 Bad 1 None 2 Good	22 72 6

(Continued)

Code name	Variable description	Variable values	n
14(b) QCAREF	How good/ bad ?	1 Extremely bad	3
		2 Very bad	5
		3 Moderately bad	7
		4 A little bad	7
		5 No affect	72
		6 A little good	1
		7 Moderately good	1
		8 Very good	1
		9 Extremely good	3
15(a) QMOOD	What effect does the condition of your teeth, gums, mouth, and/or denture have on your mood ?	0 Bad	28
		1 None	66
		2 Good	6
15(b) QMOOD	How good/ bad ?	1 Extremely bad	3
		2 Very bad	7
		3 Moderately bad	13
		4 A little bad	5
		5 No affect	66
		6 A little good	0
		7 Moderately good	0
		8 Very good	1
		9 Extremely good	5
16(a) QPERSN	What effect does the condition of your teeth, gums, mouth, and/or denture have on your personality ?	0 Bad	14
		1 None	80
		2 Good	6
16(b) QPERSN	How good/ bad ?	1 Extremely bad	2
		2 Very bad	3
		3 Moderately bad	4
		4 A little bad	5
		5 No affect	80
		6 A little good	0
		7 Moderately good	0
		8 Very good	1
		9 Extremely good	5

4.4 Activities of daily living

The distribution of m-HAQ scores is presented in Table 5, where higher scores are associated with greater difficulty in performing activities of daily living (ADL). The mean m-HAQ score was 0.88 (SD 0.70). More than half of the patients were classified as having some difficulty in performing ADL. In contrast, approximately 10 percent of the patients were categorized as having great difficulty in performing ADL.

This score is based on the results of eight questions relating to the eight ADL domains and the results of these questions are also shown in Table 5. Most frequently, the patients experienced difficulty in getting in and out of a car (71 percent), in walking (63 percent), and in washing their body (62 percent). Furthermore, the patients claimed to be unable to turn a tap on and off (a quarter), to wash their body (14 percent), and to dress themselves (12 percent). On the other hand, nearly 60 percent claimed to have no difficulty in lifting a cup to their mouth.

4.5 Oral health and performance of oral daily hygiene

The distribution of questionnaire findings regarding oral health and performance of oral daily hygiene is shown in Table 6. Dental pain, when chewing, was reported in nearly half of the patients whereas only 8 percent had current TMJ pain when chewing or shortly after. Nearly half had experienced TMJ pain since RA onset whereas approximately 25 percent of them reported to have experienced TMJ pain in the past six months. However, of the patients who had experienced TMJ pain in the past six months, nearly half of them reported that TMJ pain had lasted for less than one month.

Altogether, half of the patients reported to have had xerostomia symptoms according to Russell and Reisine's criteria (1998). Independently, dry mouth was experienced by 28 percent of the patients; need to sip liquids to aid in swallowing foods was reported by 44 percent and 11 percent reported swallowing problems.

More than half of the patients reported having had difficulty in tooth brushing due to RA. Of this group, moderate or great difficulty in tooth brushing was experienced by more than half. Use of fluoride toothpaste was reported by 45 percent of the patients.

Table 5: Activities of daily living - the modified Stanford Health Assessment Questionnaire (m-HAQ) scores, and responses to the 8 base questions

Code name	Variable description	Variable values	n
MHAQ	Activities of daily living score, based on 8 questions	Range = 0 to 3 Mean = 0.88 (SD 0.70)	100
MHAQR05	Distribution of activities of daily living score, based on 8 questions	1 0 - 0.4 2 0.5 - 0.9 3 1.0 - 1.4 4 1.5 - 1.9 5 2.0 - 2.4 6 2.5 - 3.0	30 29 22 7 11 1
The 8 base questions			
1 DRESS Dressing	Are you able to dress yourself, including tying shoelaces and doing buttons ?	0 Without any difficulty 1 With some difficulty 2 With much difficulty 3 Unable to do	42 31 15 12
2 ARISE Arising	Can you get in and out of bed ?	0 Without any difficulty 1 With some difficulty 2 With much difficulty 3 Unable to do	42 45 11 2
3 EAT Eating	Can you lift a full cup or glass to your mouth ?	0 Without any difficulty 1 With some difficulty 2 With much difficulty 3 Unable to do	58 30 11 1
4 WALK Walking	Can you walk outdoors on flat ground ?	0 Without any difficulty 1 With some difficulty 2 With much difficulty 3 Unable to do	37 41 17 5
5 HYGIEN Hygiene	Can you wash and dry your entire body ?	0 Without any difficulty 1 With some difficulty 2 With much difficulty 3 Unable to do	38 32 16 14
6 REACH Reaching	Can you bend down to pick up clothing from the floor ?	0 Without any difficulty 1 With some difficulty 2 With much difficulty 3 Unable to do	45 33 16 6

(Continued)

Code name	Variable description	Variable values	n
7 GRIP Gripping	Can you turn faucets on and off ?	0 Without any difficulty	39
		1 With some difficulty	31
		2 With much difficulty	15
		3 Unable to do	15
8 OTHER Other activities	Can you get in and out of a car ?	0 Without any difficulty	29
		1 With some difficulty	54
		2 With much difficulty	12
		3 Unable to do	5

Table 6: Oral health and performance of oral daily hygiene - questionnaire findings

Code name	Variable description	Variable values	n
Oral health			
1 PROBT	Are your teeth/gums/dentures painful when chewing ?	0 No	47
		1 Yes	53
2 PROBJ	Does your jaw hurt when chewing or shortly after ?	0 No	92
		1 Yes	8
3(a) PAINLEV	Have you had pain in the face, jaw, in front of the ear, or cheeks in the past 6 months ?	0 None	76
		1 Little	11
		2 Moderate	9
		3 Great	4
		4 Extreme	0
3(b) DUROP	If yes, how long have you had this pain ?	0 ~one week	8
		1 ~one month	5
		2 ~six months	5
		3 ~one year	1
		4 over one year	3
		5 in yawning or laughing	2
4 PAINAFT	Have you had pain in the face, jaw, in front of the ear, or cheeks after onset of RA?	0 No	56
		1 Yes	44
5 OPENM	Do you have any difficulty when opening your mouth ?	0 None	73
		1 Little	7
		2 Moderate	15
		3 Great	5
		4 Extreme	0
6 SWALLOW*	Do you have difficulties swallowing any foods ?	0 No	89
		1 Yes	11
7 DRYM*	Does your mouth feel dry when eating a meal ?	0 No	72
		1 Yes	28
8 SIP*	Do you sip liquids to aid in swallowing dry foods?	0 No	56
		1 Yes	44
9 SXERS*	Score of Xerostomia (the number of answer YES to questions 6,7, and 8)	0	50
		1	23
		2	21
		3	6
* From Russell & Reisine, 1998			

(Continued)

Code name	Variable description	Variable values	n
Performance of oral daily hygiene			
10 PBRUSH	Does your arthritis make it difficult for you to brush your teeth?	0 None	43
		1 Little	14
		2 Moderate	28
		3 Great	9
		4 Extreme	6
11 FLUOP	Do you brush your teeth with fluoride toothpaste ?	0 No	54
		1 Yes	45
		2 Never heard of fluoride	1
12 ATTEND	How often have you visited a dentist in the last 12 months?	0 None	48
		1 Regularly	17
		2 When in pain	33
		3 Not remember	2

4.6 Oral status

The distribution of clinical findings regarding oral status is presented in Table 7. Nearly half of the patients had less than 20 remaining teeth and having more than two decayed teeth was observed in only 10 percent of the patients. About 30 percent of the patients had more than one mobile tooth, classified as 2 mm horizontal mobility or > 2 mm horizontal and/or vertical mobility. Nearly 30 percent had more than one tooth with decayed roots. Use of the partial or complete dentures was observed in more than 60 percent of the patients.

4.7 Temporomandibular joint (TMJ) status

The distribution of clinical findings regarding TMJ status is shown in Table 8. Thirty-five percent of the patients had maximum mouth opening capacities of less than 40 mm, which is considered restricted. Acute TMJ pain was observed by only 5 percent of the patients, whereas tenderness on palpation of the head or face was observed in about 40 percent and, within this group, a majority of them had tenderness on palpation of the masseter. Overall, 66 percent of the patients had TMJ symptoms.

Table 7: Oral status - clinical findings

Code name	Variable description	Variable values	n
1(a) NTEETH	The number of remaining teeth including third molars	Range = 0 to 31 Mean = 16.4 (SD 10.1)	100
1(b) NTR10	Distribution of the number of remaining teeth including third molars	1 0 - 9 2 10 - 19 3 20 - 29 4 30 -	32 20 44 4
2(a) DMFT8	DMFT based on 32 teeth	Range = 8 to 32 Mean = 25.4 (SD 6.4)	100
2(b) DMFTR5	Distribution of DMFT based on 32 teeth	1 5 - 9 2 10 - 14 3 15 - 19 4 20 - 24 5 25 - 29 6 30 -	1 7 15 11 31 35
3(a) D8	The number of decayed teeth including third molars	Range = 0 to 6 Mean = 0.53 (SD 1.2)	100
3(b) D8R1	Distribution of the number of decayed teeth including third molars	1 0 - 1 2 2 - 3 3 4 - 5 4 6 -	88 8 3 1
4(a) M8	The number of missing teeth including third molars	Range = 1 to 32 Mean = 15.6 (SD 10.1)	100
4(b) M8R5	Distribution of the number of missing teeth including third molars	1 0 - 4 2 5 - 9 3 10 - 14 4 15 - 19 5 20 - 24 6 25 - 29 7 30 -	16 21 17 11 8 12 15
5(a) F8	The number of filled teeth including third molars	Range = 0 to 22 Mean = 9.3 (SD 6.3)	100
5(b) F8R5	Distribution of the number of filled teeth including third molars	1 0 - 4 2 5 - 9 3 10 - 14 4 15 - 19 5 20 -	27 22 29 15 7

(Continued)

Code name	Variable description	Variable values	n
6 MOBIL	The number of teeth with mobility	Range = 0 to 13	100
		Mean = 0.86 (SD 1.8)	
	Distribution of the number of teeth with mobility	0	68
		1	12
		2	7
		3	6
		4	3
		5	2
		7	1
		13	1
7 ROOTD	The number of teeth with cervical caries	Range = 0 to 6	100
		Mean = 0.68 (SD 1.2)	
	Distribution of the number of teeth with cervical caries	0	67
		1	14
		2	11
		3	4
		4	1
		5	2
		6	1
8(a) ROOTF	The number of teeth with cervical fillings	Range = 0 to 20 Mean = 3.0 (SD 4.2)	100
8(b) ROOTFR5	Distribution of the number of teeth with cervical fillings	1 0 - 4	75
		2 5 - 9	14
		3 10 - 14	9
		4 15 - 19	1
		5 20 -	1
9 DENTYN	Use of denture Yes / No	0 No	36
		1 Yes	64

Table 8: Temporomandibular joint (TMJ) status - clinical findings

Code name	Variable description	Variable values	n
1(a) MAX	Maximum mouth opening capacity	Range = 23 to 65 mm Mean = 42.7 (SD 8.5)	100
1(b) MAXR10	Distribution of maximum mouth opening capacity	1 20 - 29 2 30 - 39 3 40 - 49 4 50 - 59 5 60 - 69	8 27 48 14 3
2 PAINOW	Do you have pain now when opening your mouth?	0 No 1 Yes	96 4
3 PALPT	Do you feel pain or pressure when I palpate your head or face?	0 No 1 Yes	62 38
3(a) TMJYN	Tenderness on palpation of the TMJ Yes / No	0 No 1 Yes	84 16
3(b) TEMPYN	Tenderness on palpation of the tempolaris Yes / No	0 No 1 Yes	87 13
3(c) MASSEYN	Tenderness on palpation of the masseter Yes / No	0 No 1 Yes	67 33
4 JSOUND	Joint sound when opening mouth	0 No 1 Yes	32 68
4(a) CLICKYN	Clicking Yes / No	0 No 1 Yes	52 48
4(b) CREPYN	Crepitus Yes / No	0 No 1 Yes	78 22
5 TLTMJ	A symptom of TMJ Yes / No (Yes = at least one Yes answer to the following questions PROBJ,PAINLEV,PAINAFT,OPENM,PAINOW,PALPT,and CREPTYN)	0 No 1 Yes	34 66

4.8 Association between variables

A total of 45 variables in Tables 3, 4, 5, 6, 7, and 8 were treated as outcome or explanatory variables in the following analyses. There were 44 potential explanatory variables, 18 of which were continuous type explanatory variables. In order to visualize the data better, the continuous measurements were grouped as ranks and analyzed together with the categorical variables. New variable names were assigned to the grouped measurements. For example, the continuous variable MAX (maximum mouth opening capacity) became MAXR10 (see Table 9), that is, grouped into 10 mm lots.

A multitude of associations between variables were explored, however only significant associations are reported in the following tables, that is, Tables 9-13.

4.8.1 Number of remaining teeth by potential *categorical type* explanatory variables

An analysis of variance of number of remaining teeth (NTEETH) showed that eight of the 44 potential categorical type explanatory variables were significantly associated with differences in the mean number of remaining teeth (Table 9).

The number of remaining teeth was less among those reporting dental pain when chewing and less among those who were older (Table 9). Furthermore, those who had longer RA duration had less remaining teeth and the in-patients had significant less remaining teeth compared with the out-patients. It was also found that those who had greater maximum mouth opening capacities were likely to have fewer remaining teeth. On the other hand, the number of remaining teeth was greater among those who had visited a dentist regularly and greater among those who brushed their teeth with fluoride toothpaste.

4.8.2 Number of decayed teeth by potential *categorical type* explanatory variables

An analysis of variance of number of decayed teeth (D8) showed that seven of the 44 potential categorical type explanatory variables were significantly associated with differences in the mean number of decayed teeth (Table 10).

The patients who experienced difficulty when opening mouth had significantly higher

number of decayed teeth compared with those who did not have mouth opening difficulty (Table 10). Also, the number of decayed teeth was greater among those who had more mobile teeth and greater among those who had more teeth with cervical caries. Interestingly, as serum concentrations of CRP increased, the number of decayed teeth was more likely to increase. On the other hand, the number of decayed teeth was significantly less among those who had visited a dentist regularly compared with those who had not visited a dentist in the previous 12 months.

4.8.3 Number of decayed, missing, and filled (DMF) teeth by potential *categorical type* explanatory variables

An analysis of variance of number of DMF teeth (DMFT) showed that eight of the 44 potential categorical type explanatory variables were significantly associated with mean number of DMF teeth differences (Table 11).

The number of DMFT was greater among those who were older and greater among those who were diagnosed with RA at a later stage of RA onset. The in-patients were more likely to have higher DMFT compared with the out-patients. On the other hand, the number of DMFT was significantly less among those who had brushed teeth with fluoride toothpaste and less among those who had visited a dentist regularly. It was of interest that those who had greater maximum mouth opening capacity were less prone to having DMFT.

Table 9: Distribution of number of remaining teeth and related statistics by potential categorical type explanatory variables. Potential explanatory variables were identified as those showing significant associations (p<0.05) with the outcome variables in ANOVA.

Outcome variable	Unit	Range				
NTEETH The number of remaining teeth including third molars	Number of teeth	0 to 31				
Potential explanatory variables	Category	n	NTEETH Mean	SD	F-Value	P-Value
<u>PROBT</u> Are your teeth/gums/dentures painful when chewing ?	0 No	47	19.2	9.57	7.12	0.009
	1 Yes	53	14.0	10.0		
<u>FLUOP</u> Do you brush your teeth with fluoride toothpaste ?	1 No	55	14.2	10.2	6.36	0.013
	2 Yes	45	19.2	9.43		

(Continued)

Potential explanatory variables	Category	n	NTEETH Mean	SD	F-Value	P-Value
<u>ATTEND</u> How often have you visited a dentist in the last 12 months?	0 None	48	13.3	10.5	4.5	0.005
	1 Regularly	17	22.4	9.47		
	2 When in pain	33	18.3	8.45		
	3 Not remember	2	11.0	4.24		
<u>MAXR10</u> Maximum mouth opening capacity (mm)	1 20 - 39	35	18.7	8.56	3.81	0.026
	2 40 - 49	48	16.8	10.3		
	3 50 - 69	17	10.7	11.0		
<u>ROOTFR5</u> The number of teeth with cervical fillings (Categorical)	1 0 - 4	75	13.6	9.9	16.2	0
	2 5 - 9	14	23.6	4.99		
	3 10 -	11	26.8	1.78		
<u>AGER10</u> Age (Categorical)	1 20-29	1	28.0	0	5.52	0
	2 30-39	1	28.0	0		
	3 40-49	6	27.3	2.66		
	4 50-59	15	22.5	6.22		
	5 60-69	41	16.9	9.42		
	6 70-79	29	11.1	9.65		
	7 80-89	7	9.86	11.1		

(Continued)

Potential explanatory variables	Category	n	NTEETH Mean	SD	F-Value	P-Value
<u>INOUT</u> In-patient/Out-patient	1 Out-patient	74	17.8	10.0	5.32	0.023
	2 In-patient	26	12.6	9.5		
<u>DUR10</u> Years duration of RA (Categorical)	1 0 - 9	36	19.2	8.89	2.97	0.056
	2 10 - 29	49	15.7	10.4		
	3 30 - 59	15	12.1	10.8		

Table 10: Distribution of number of decayed teeth and related statistics by potential categorical type explanatory variables. Potential explanatory variables were identified as those showing significant associations ($p<0.05$) with the outcome variables in ANOVA.

Outcome variable	Unit	Range				
D8 The number of decayed teeth including third molars	Number of teeth	0 to 6				
Potential explanatory variables	Category	n	D8 Mean	SD	F-Value	P-Value
<u>OPENM</u> Do you have any difficulty when opening your mouth ?	1 None	73	0.38	0.95	4.4	0.038
	2 Yes	27	0.93	1.57		
<u>ATTEND</u> How often have you visited a dentist in the last 12 months?	0 None	48	0.92	1.53		0.013
	1 Regularly	17	0.06	0.24	3.78	
	2 When in pain	33	0.24	0.56		
	3 Not remember	2	0	0		

(Continued)

Potential explanatory variables	Category	n	D8 Mean	SD	F-Value	P-Value
<u>MASSEYN</u> Tenderness to palpation of the masseter Yes / No	0 No 1 Yes	67 33	0.73 0.12	1.33 0.55	6.37	0.013
<u>MOBIL</u> The number of teeth with mobility	1 0 2 1 - 2 3 3 - 13	68 19 13	0.22 0.89 1.62	0.64 1.59 1.76	10.7	0
<u>ROOTD</u> The number of teeth with cervical caries	1 0 2 1 - 2 3 3 - 6	67 25 8	0.24 0.8 2.12	0.76 1.35 1.89	12.6	0
<u>NOJSR5</u> Number of swollen joints (Categorical)	1 0 - 4 2 5 - 9 3 10 -	70 19 11	0.4 1.21 0.18	0.91 1.9 0.4	4.44	0.014
<u>CRPR</u> C-reactive protein (mg/dl)	1 0 - 0.9 2 1.0 - 2.9 3 3.0 -	45 31 24	0.31 0.42 1.08	0.85 0.92 1.72	3.83	0.025

Table 11: Distribution of DMFT and related statistics by potential categorical type explanatory variables. Potential explanatory variables were identified as those showing significant associations (p<0.05) with the outcome variables in ANOVA.

Outcome variable	Unit	Range				
DMFT8	Number of teeth	8 to 32				
DMFT including third molars						
Potential explanatory variables	Category	n	DMFT Mean	SD	F-Value	P-Value
<u>FLUOP</u>						
Do you brush your teeth with fluoride toothpaste ?	1 No	55	26.6	5.28	4.67	0.033
	2 Yes	45	23.9	7.31		
<u>ATTEND</u>						
How often have you visited a dentist in the last 12 months?	0 None	48	27.0	5.99	4.94	0.003
	1 Regularly	17	20.9	7.34		
	2 When in pain	33	25.0	5.45		
	3 Not remember	2	31.5	0.71		

(Continued)

Potential explanatory variables	Category	n	DMFT Mean	SD	F-Value	P-Value
<u>MAXR10</u>						
Maximum mouth opening capacity (mm)	1 20 - 29	8	27.4	5.1	2.63	0.039
	2 30 - 39	27	23.9	6.47		
	3 40 - 49	48	25.4	6.65		
	4 50 - 59	14	28.8	3.62		
	5 60 - 69	3	18.3	7.57		
<u>ROOTFR5</u>						
The number of teeth with cervical fillings (Categorical)	1 0 - 4	75	27.2	5.64	10.1	0
	2 5 - 9	14	22.6	4.38		
	3 10 - 14	9	17.8	5.33		
	4 15 - 19	1	19.0	0		
	5 20 -	1	8	0		
<u>AGER10</u>						
Age (Categorical)	1 20-29	1	12.0	0	5.09	0
	2 30-39	1	18.0	0		
	3 40-49	6	18.7	6.53		
	4 50-59	15	21.8	6.16		
	5 60-69	41	25.8	6.01		
	6 70-79	29	27.9	5.34		
	7 80-89	7	29.3	2.98		
<u>INOUT</u>						
In-patient/Out-patient	1 Out-patient	74	24.5	6.58	5.88	0.017
	2 In-patient	26	28.0	5.1		

(Continued)

Potential explanatory variables	Category	n	DMFT Mean	SD	F-Value	P-Value
<u>ONSETR10</u>						
Age of RA onset (Categorical)	1 10 - 39	24	22.6	8.32	4.46	0.014
	2 40 - 59	51	25.6	5.57		
	3 60 - 79	25	27.8	4.8		
<u>STAGE</u>						
Stage of joint destruction	1 1	8	20.3	7.92	2.95	0.057
	2 2 - 3	38	25.9	5.66		
	3 4 - 4	54	25.9	6.42		

4.8.4 Number of teeth with mobility by potential *categorical type* explanatory variables

The number of mobile teeth was less among those who had visited a dentist in the previous 12 months and less among those who had more remaining teeth (Table 12). In contrast, the number of mobile teeth was greater among those who had more than one decayed teeth and greater among those who had more teeth with cervical caries. Those who were classified as Stage III RA severity had a tendency to have more mobile teeth compared with those who were classified as Stage I or II (less RA severity).

4.8.5 Number of teeth with cervical caries by potential *categorical type* explanatory variables

The number of teeth with cervical caries was marginally greater among those who experienced difficulty when opening mouth and significantly greater among those who had acute jaw pain when opening mouth (Table 13). The number was also greater among those who had more than one decayed teeth and greater in those with more mobile teeth. Interestingly, as serum concentrations of CRP increases, the number of teeth with cervical caries had a tendency to increase. Those who were classified as Stage III RA severity had a tendency to have more teeth with cervical caries compared with those who were classified as Stage I or II (less RA severity).

Table 12: Distribution of number of teeth with mobility and related statistics by potential categorical type explanatory variables. Potential explanatory variables were identified as those showing significant associations (p<0.05) with the outcome variables in ANOVA.

Outcome variable	Unit	Range				
MOBIL	Number of teeth	0 to 13				
The number of teeth with mobility						
Potential explanatory variables	Category	n	MOBIL Mean	SD	F-Value	P-Value
<u>ATTEND</u> How often have you visited a dentist in the last 12 months?	1 No	50	1.36	2.39	7.88	0.006
	2 Yes	50	0.36	0.8		
<u>NTRI0</u> The number of remaining teeth including third molars (Categorical)	1 0 - 19	52	1.25	2.34	5.05	0.027
	2 20 -	48	0.44	0.92		
(Continued)						

Potential explanatory variables	Category	n	MOBIL Mean	SD	F-Value	P-Value
<u>D8</u>						
The number of decayed teeth	1 0	75	0.47	1.02	15.7	0
including third molars	2 1-	25	2.04	2.98		
<u>ROOTD</u>						
The number of teeth with cervical	1 0	67	0.43	1.06	14.0	0
caries	2 1 - 2	25	1.12	1.69		
	3 3 - 6	8	3.62	4.1		
<u>STAGE</u>						
Stage of joint destruction	1 1 - 2	21	0.57	1.12	3.84	0.025
	2 3	25	1.72	3.09		
	3 4	54	0.57	1.04		

Table 13: Distribution of number of teeth with cervical caries and related statistics by potential categorical type explanatory variables. Potential explanatory variables were identified as those showing significant associations (p<0.05) with the outcome variables in ANOVA.

Outcome variable	Unit	Range				
ROOTD The number of teeth with cervical caries	Number of teeth	0 to 6				
Potential explanatory variables	Category	n	ROOTD Mean	SD	F-Value	P-Value
<u>OPENM</u> Do you have any difficulty when opening your mouth ?	1 None	73	0.53	1.14	3.91	0.051
	2 Yes	27	1.07	1.38		
<u>PAINOW</u> Do you have pain now when opening your mouth?	0 No	96	0.62	1.2	4.99	0.028
	1 Yes	4	2	1.41		

(Continued)

Potential explanatory variables	Category	n	ROOTD Mean	SD	F-Value	P-Value
<u>PALPT</u> Do you feel pain or pressure when I palpate your head or face?	0 No 1 Yes	62 38	0.87 0.37	1.4 0.82	4.05	0.047
<u>MASSEYN</u> Tenderness to palpation of the masseter Yes / No	0 No 1 Yes	67 33	0.85 0.33	1.36 0.82	4.03	0.047
<u>NTR10</u> The number of remaining teeth including third molars (Categorical)	1 0 - 9 2 10 -	32 68	0.31 0.85	0.74 1.37	4.34	0.04
<u>D8</u> The number of decayed teeth including third molars	1 0 2 1 -	75 25	0.39 1.56	0.88 1.66	20.4	0
(Continued)						

Potential explanatory variables	Category	n	ROOTD Mean	SD	F-Value	P-Value
<u>M8R5</u>						
The number of missing teeth including third molars (Categorical)	1 0 - 9	37	0.57	0.87	4.82	0.01
	2 10 - 19	28	1.25	1.82		
	3 20 -	35	0.34	0.76		
<u>MOBIL</u>						
The number of teeth with mobility	1 0 - 0	68	0.29	0.65	14.4	0
	2 1 - 2	19	1.26	1.73		
	3 3 - 13	13	1.85	1.68		
<u>STAGE</u>						
Stage of joint destruction	1 1 - 2	21	0.62	1.12	3.24	0.043
	2 3 - 3	25	1.2	1.55		
	3 4 - 4	54	0.46	1.04		
<u>CRPR</u>						
C-reactive protein (mg/dl)	1 0 - 0.9	45	0.6	1.07	3.34	0.04
	2 1.0 - 2.9	31	0.39	0.76		
	3 3.0 -	24	1.21	1.77		

4.8.6 Oral health related quality of life by potential *categorical type* explanatory variables

Sixteen of the 44 potential categorical type explanatory variables were significantly associated with mean oral health related quality of life score (QSCORE) differences (Table 14). In order to demonstrate the strengths of these associations, Spearman's rank correlation coefficients were computed (Tables 15-19).

For example, oral health quality of life was significantly related to activities of daily living where the activities of daily living scores were grouped into three ranks: 0.0 - 0.9, 1.0 - 1.9, and 2.0 - 3.0 ($p = 0.038$). The respective mean QSCOREs of the ranked groups were 75.9, 69.5, and 63.5. This trend was also significant (Spearman's rank correlation = -0.29, $p = 0.003$) (Figure 1).

Dental and jaw pain on chewing, and pain in the face or jaw after RA onset, was also significantly related to poor oral health quality of life, as was tenderness on palpation to the temporalis (Table 14).

Pain in the face or jaw in the past six months was strongly related to oral health quality of life. Those who experienced great pain had a mean QSCORE of 57.5 compared with those who had not experienced pain and had a mean QSCORE of 76.0 (Table 14 and Figure 2). Similarly, poor oral health quality of life was significantly associated with difficulty in mouth opening and with toothbrushing (Table 14 and Figures 3 & 4).

4.8.7 Oral health related quality of life by potential *continuous type* explanatory variables

The linear regression analysis of oral health quality of life score (QSCORE) showed that only two out of 18 potential continuous type explanatory variables were significantly associated with QSCORE (Table 15).

QSCORE was negatively correlated with activity of daily living score (MHAQ), indicating that poor oral health quality of life was significantly associated with difficulty in performing activities daily living (Regression coefficient = -6.84, correlation coefficient, $r = -0.28$, $p = 0.005$) (Figure 5); but only minimal variability in quality of life was explained

by activities of daily living (R-square = 0.08). On the other hand, maximum mouth opening capacity (MAX) was positively correlated with QSCORE (Regression coefficient = 0.5, $r = 0.24$, $p = 0.012$) (Figure 6)

4.8.8 Activities of daily living by potential *categorical type* explanatory variables

An analysis of variance of activities of daily living score (MHAQ) showed that 24 out of 44 potential categorical type explanatory variables were significantly associated with MHAQ differences (Table 16).

A noteworthy finding was that having difficulty with tooth brushing (PBRUSH) was significantly associated with higher MHAQ ($p = 0.000$, $R_s = 0.56$), indicating greater difficulty in performing activities of daily living, which is illustrated in Figure 10. On the other hand, maximum mouth opening capacity (MAXR10) was negatively associated with MHAQ ($p = 0.000$, $R_s = -0.39$) (Figure 11). Difficulty in performing activities of daily living was significantly associated with class of functional disability (CLASS) ($p = 0.000$, $R_s = 0.54$) and RA stage (STAGE) ($p = 0.004$, $R_s = 0.32$) and each trend is illustrated in Figures 13 and 14 respectively.

4.8.9 Activities of daily living by potential *continuous type* explanatory variables

The linear regression analysis of activities of daily living score (MHAQ) showed that only four out of 18 potential continuous type explanatory variables were significantly associated with MHAQ differences (Table 17).

MHAQ was negatively correlated with maximum mouth opening capacity (MAX) (Regression coefficient = -0.04, $r = -0.5$, $p = 0.000$) and 25 percent of the variability in MHAQ was explained by MAX. This relation is illustrated in Figure 16. Similarly, age of RA onset (AGEONS) was negatively correlated with MHAQ (Figure 17), but the correlation was small ($r = -0.2$). On the other hand, RA duration (DURAT) was positively correlated with MHAQ (Regression coefficient = 0.01, $r = 0.24$, $p = 0.012$), which is illustrated in Figure 18.

Table 14: Distribution of oral health related quality of life scores and related statistics by potential categorical type explanatory variables. Potential explanatory variables were identified as those showing significant associations (p<0.05) with the outcome variables in ANOVA.

Outcome variable	Unit	Range				
QSCORE	score	28 to 133				
Oral Health Quality of Life score, based on 16 questions						
Potential explanatory variables	Category	n	QSCORE Mean	SD	F-Value	P-Value
<u>MHAQR05</u> Activities of daily living score, based on 8 questions (Categorical)	1 0 - 0.9	59	75.9	15.6	3.39	0.038
	2 1.0 - 1.9	29	69.5	18.5		
	3 2.0 - 3.0	12	63.5	18.2		-0.29
<u>PROBT</u> Are your teeth/gums/dentures painful when chewing ?	0 No	47	78.9	18.6	13.8	0
	1 Yes	53	66.9	13.6		
Spearman's rank correlation coefficient						
P-value						

(Continued)

Potential explanatory variables	Category	n	QSCORE Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>PROBJ</u> Does your jaw hurt when chewing or shortly after ?	0 No 1 Yes	92 8	73.7 59.1	16.8 16.9	5.56	0.02		
<u>PAINLEV</u> Have you had pain in the face, jaw, in front of the ear, or cheeks in the past 6 months ?	0 None 1 Little 2 Moderate 3 Great 4 Extreme	76 11 9 4 0	76.0 63.0 62.2 57.5	16.4 18.3 12.5 15.1	4.71	0.004	-0.38	0.0001
<u>PAINAFT</u> Have you had pain in the face, jaw, in front of the ear, or cheeks after onset of RA?	0 No 1 Yes	56 44	76.7 67.3	15.7 17.7	7.95	0.006		
<u>OPENM</u> Do you have any difficulty when opening your mouth ?	0 None 1 Little 2 Moderate 3 Great 4 Extreme	73 7 15 5 0	75.5 70.6 61.7 65.2	17.2 15.0 14.7 15.1	3.23	0.026	-0.28	0.005

(Continued)

Potential explanatory variables	Category	n	QSCORE Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>PBRUSH</u> Does your arthritis make it difficult for you to brush your teeth ?	0 None 1 Little 2 Moderate 3 Great 4 Extreme	43 14 28 9 6	77.5 70.3 72.2 65.1 55.2	16.5 13.4 17.3 19.3 14.2	3.17	0.017	-0.26	0.009
<u>ATTEND</u> How often have you visited a dentist in the last 12 months?	0 None 1 Regularly 2 When in pain 3 Not remember	48 17 33 2	70.2 83.8 71.0 60.5	12.9 21.6 18.3 19.1	3.41	0.021	0.01	0.894
<u>MAXR10</u> Maximum mouth opening capacity (mm)	1 20 - 29 2 30 - 39 3 40 - 49 4 50 - 59 5 60 - 69	8 27 48 14 3	57.3 70.5 75.7 70.9 88.3	19.6 9.98 18.1 19.0 17.0	2.98	0.023	0.18	0.078
<u>TEMPYN</u> Tenderness on palpation of the temporalis Yes / No	0 No 1 Yes	87 13	73.9 63.3	17.0 15.9	4.48	0.037		

(Continued)

Potential explanatory variables	Category	n	QSCORE Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>CLICKYN</u>								
Clicking Yes / No	0 No 1 Yes	52 48	69.2 76.2	19.2 13.9	4.23	0.042		
<u>CREPYN</u>								
Crepitus Yes / No	0 No 1 Yes	78 22	74.8 64.5	14.7 22.7	6.55	0.012		
<u>AGER10</u>								
Age (Categorical)	1 20-29 2 30-39 3 40-49 4 50-59 5 60-69 6 70-79 7 80-89	1 1 6 15 41 29 7	74.0 48.0 80.2 79.3 67.7 71.8 86.4	0 0 25.3 16.4 16.2 9.88 28.9	2.45	0.03	0.06	0.558
<u>ONSETR10</u>								
Age of RA onset (Categorical)	1 10 - 29 2 30 - 59 3 60 - 79	11 64 25	60.9 75.5 70.1	13.8 18.7 11.1	3.95	0.023	0.04	0.715
(Continued)								

Potential explanatory variables	Category	n	QSCORE Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>NOJSR5</u> Number of swollen joints (Categorical)	1 0 - 4	70	74.8	18.6	4.3	0.041		
	2 5 -	30	67.2	11.8				
<u>TLTMI</u> A symptom of TMJ Yes / No	0 No	34	77.7	14.5	4.88	0.029		
	1 Yes	66	69.9	17.9				

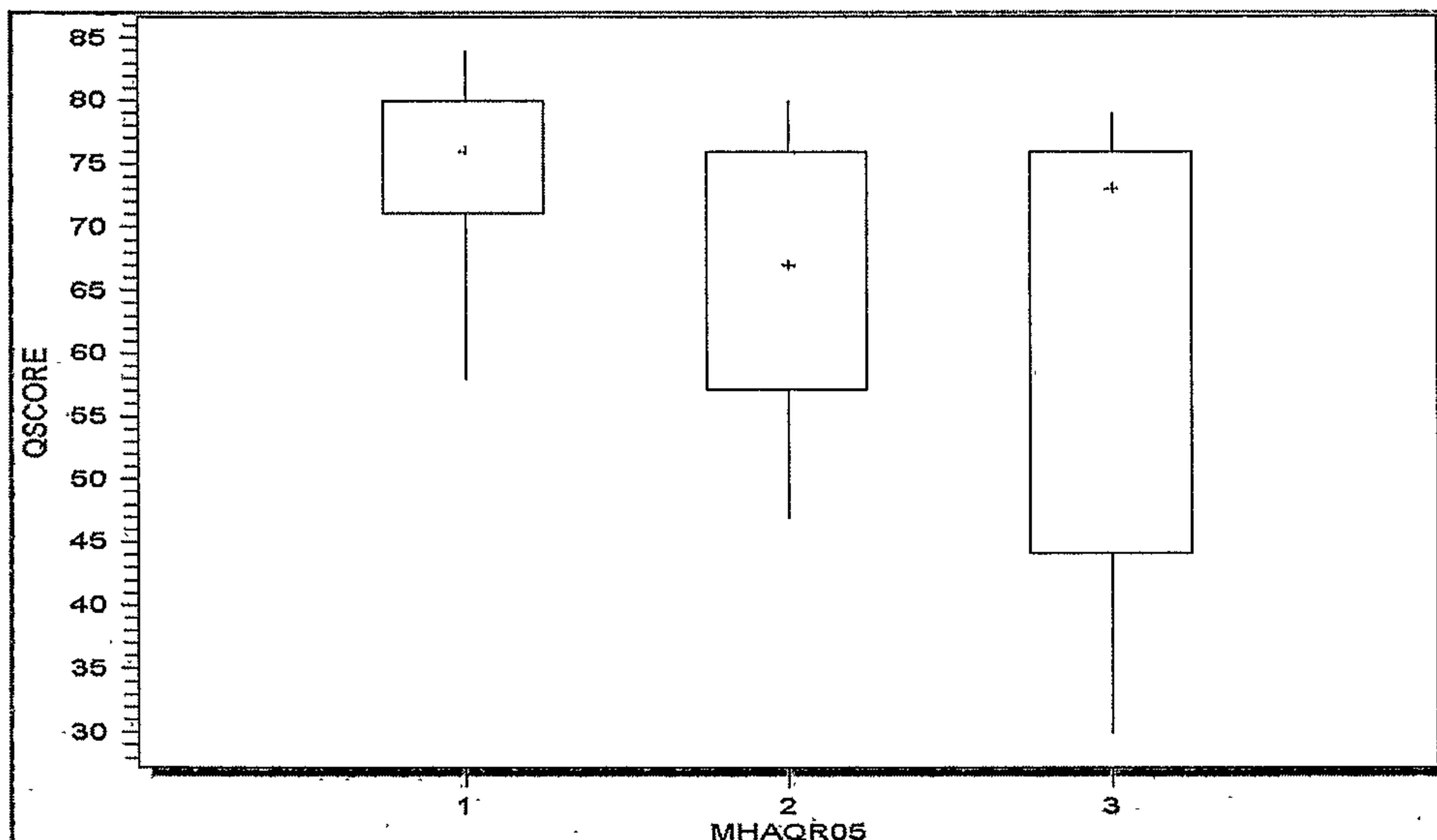


Figure 1: Box-whisker* plot of oral health related quality of life score (QSCORE) by activities of daily living score (MHAQR05) where 1 = scores 0 - 0.9, 2 = scores 1.0 - 1.9, 3 = scores 2.0 - 3.0. *Central + defines the median, box ends define the 25th & 75th percentiles, and whiskers define 10th & 90th percentiles. Spearman's rank correlation coefficient (R_s) = -0.29, p-value = 0.003

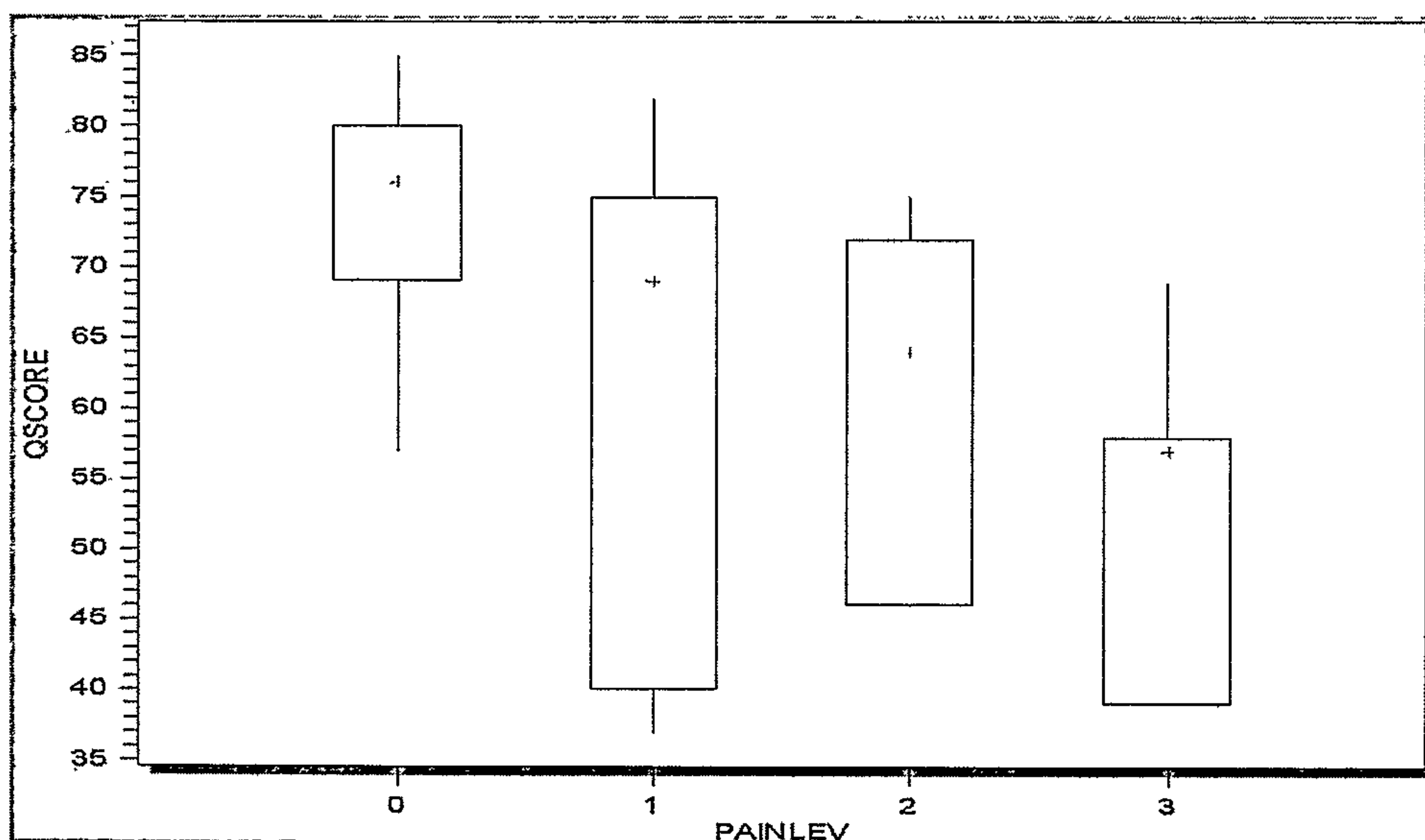


Figure 2: Box-whisker* plot of oral health related quality of life score (QSCORE) by pain experienced in the face, jaw, in front of the ear, or cheeks in the past six months (PAINLEV) where 0 = none, 1 = little, 2 = moderate, 3 = great pain. *Central + defines the median, box ends define the 25th & 75th percentiles, and whiskers define 10th & 90th percentiles. Spearman's rank correlation coefficient (R_s) = -0.38, p-value = 0.0001

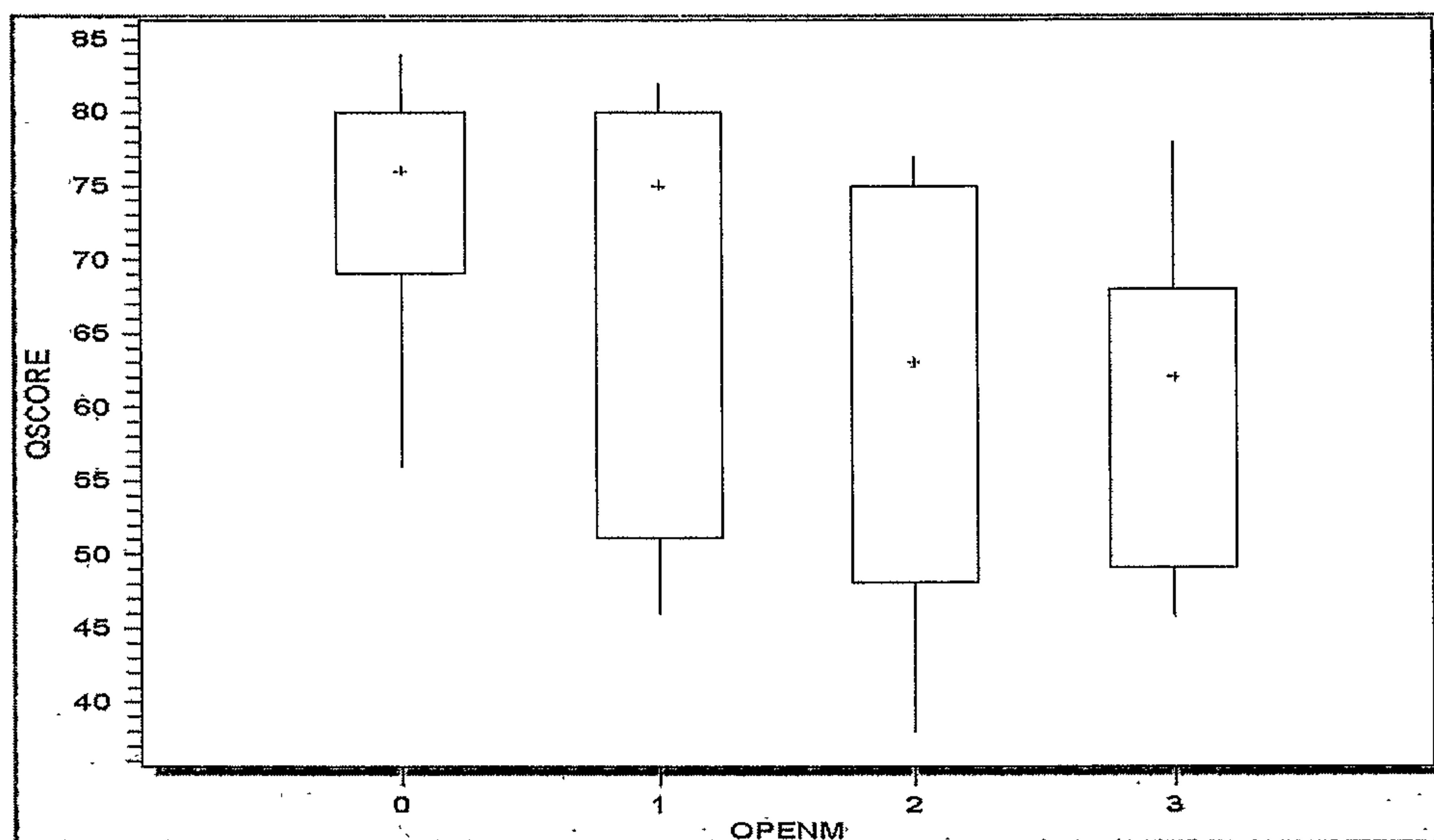


Figure 3: Box-whisker* plot of oral health related quality of life score (QSCORE) by difficulty experienced in opening mouth (OPENM) where 0 = none, 1 = little, 2 = moderate, 3 = great. *Central + defines the median, box ends define the 25th & 75th percentiles, and whiskers define 10th & 90th percentiles. Spearman's rank correlation coefficient (R_s) = -0.28, p-value = 0.005

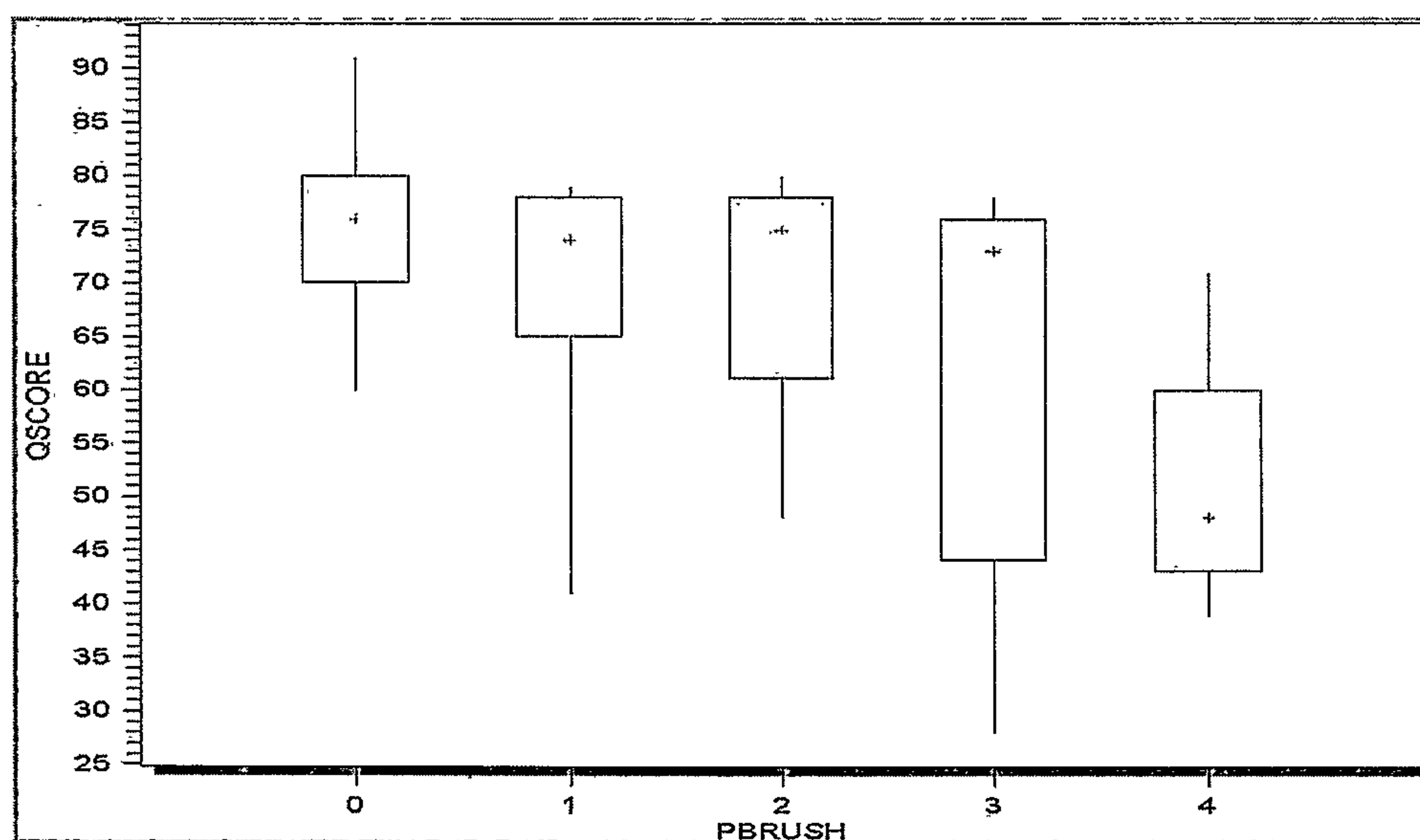


Figure 4: Box-whisker* plot of oral health related quality of life score (QSCORE) by difficulty experienced when tooth brushing (PBRUSH) where 0 = none, 1 = little, 2 = moderate, 3 = great, 4 = extreme. *Central + defines the median, box ends define the 25th & 75th percentiles, and whiskers define 10th & 90th percentiles. Spearman's rank correlation coefficient (R_s) = -0.26, p-value = 0.009

Table 15: Distribution of oral health related quality of life scores and related statistics by potential continuous type explanatory variables. Potential explanatory variables were identified as those showing significant associations (p<0.05) with the outcome variables in linear regression analyses.

Outcome variable	Unit	Range				
QSCORE	score	28 to 133				
Oral Health Quality of Life score, based on 16 questions						
Potential explanatory variables	Unit	Regression Coefficient	R-square	Correlation Coefficient	F-Value	P-Value
<u>MHAQ</u>	score	-6.84	0.08	-0.28	8.16	0.005
Activities of daily living score, based on 8 questions						
<u>MAX</u>	mm	0.51	0.06	0.24	6.55	0.012
Maximum mouth opening capacity						

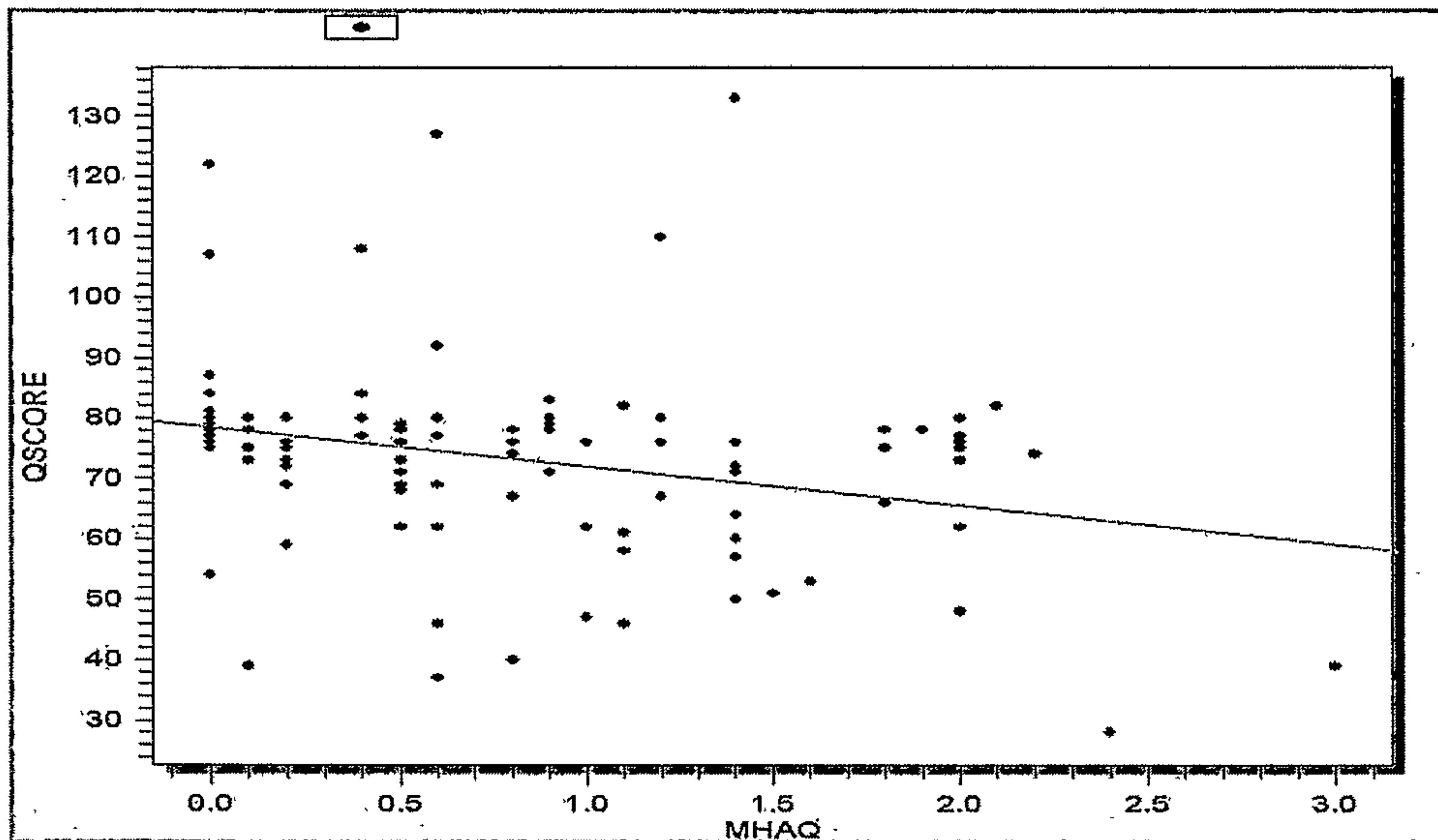


Figure 5: Scatter diagram of oral health related quality of life score (QSCORE) versus activities of daily living scores (MHAQ). Correlation coefficient = -0.28, p-value = 0.005

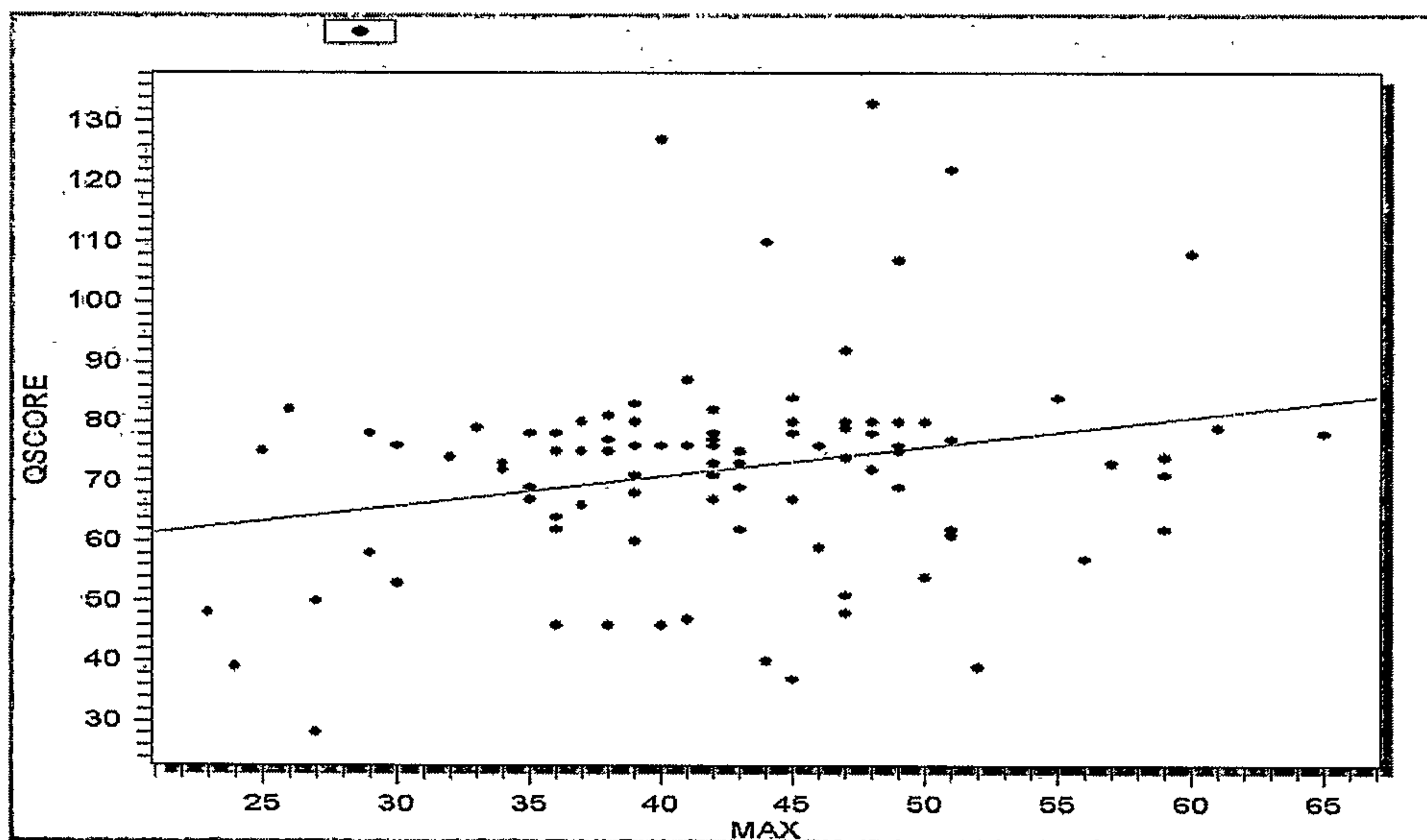


Figure 6: Scatter diagram of oral health related quality of life score (QSCORE) versus maximum mouth opening in mm (MAX). Correlation coefficient = 0.24, p-value = 0.012

Table 16: Distribution of activities of daily living scores and related statistics by potential categorical type explanatory variables. Potential explanatory variables were identified as those showing significant associations (p<0.05) with the outcome variables in ANOVA.

Outcome variable	Unit	Range
MHAQ	score	0 to 3
Activities of daily living score, based on 8 questions		

Potential explanatory variables	Category	n	MHAQ Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>PAINLEV</u>								
Have you had pain in the face, jaw, in front of the ear, or cheeks in the past 6 months ?	0 None 1 Little 2 Moderate 3 Great 4 Extreme	76 11 9 4 0	0.8 0.84 1.29 1.5	0.66 0.65 0.7 1.07	2.56	0.06	0.2	0.043
<u>PAINAFT</u>								
Have you had pain in the face, jaw, in front of the ear, or cheeks after onset of RA?	0 No 1 Yes	56 44	0.74 1.05	0.66 0.72	4.84	0.03		

(Continued)

Potential explanatory variables	Category	n	MHAQ Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>OPENM</u> Do you have any difficulty when opening your mouth ?	0 None 1 Little 2 Moderate 3 Great 4 Extreme	73 7 15 5 0	0.75 1.11 1.44 0.68	0.64 0.77 0.74 0.49	5.02	0.003	0.27	0.006
<u>SWALLOW</u> Do you have difficulties swallowing any foods ?	0 No 1 Yes	89 11	0.81 1.37	0.66 0.79	6.65	0.011		
<u>DRYM</u> Does your mouth feel dry when eating a meal ?	0 No 1 Yes	72 28	0.74 1.22	0.6 0.8	10.5	0.002		
<u>SIP</u> Do you sip liquids to aid in swallowing dry foods?	0 No 1 Yes	56 44	0.76 1.03	0.59 0.79	3.94	0.05		

(Continued)

Potential explanatory variables	Category	n	MHAQ Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>SXERS</u> Score of Xerostomia (the number of answer YES to questions 6, 7, and 8)	0 1 2 3	50 23 21 6	0.77 0.6 1.18 1.73	0.6 0.56 0.77 0.74	7.04	0	0.24	0.016
<u>PBRUSH</u> Does your arthritis make it difficult for you to brush your teeth ?	0 None 1 Little 2 Moderate 3 Great 4 Extreme	43 14 28 9 6	0.51 0.64 1.21 1.36 1.8	0.5 0.57 0.61 0.7 0.72	12.9	0	0.56	<0.0001
<u>MAXRIO</u> Maximum mouth opening capacity (mm)	1 20 - 29 2 30 - 39 3 40 - 49 4 50 - 59 5 60 - 69	8 27 48 14 3	1.95 1.01 0.75 0.55 0.4	0.59 0.69 0.6 0.48 0.4	8.55	0	-0.39	<0.0001
<u>PALPT</u> Do you feel pain or pressure when I palpate your head or face?	0 No 1 Yes	62 38	0.69 1.17	0.61 0.74	12.5	0.001		

(Continued)

Potential explanatory variables	Category	n	MHAQ Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>TEMPYN</u> Tenderness on palpation of the tempolaris Yes / No	0 No 1 Yes	87 13	0.81 1.32	0.67 0.7	6.5	0.012		
<u>MASSEYN</u> Tenderness on palpation of the masseter Yes / No	0 No 1 Yes	67 33	0.77 1.1	0.67 0.7	5.17	0.025		
<u>CLICKYN</u> Clicking Yes / No	0 No 1 Yes	52 48	1.07 0.66	0.73 0.6	9.42	0.003		
<u>CREPYN</u> Crepitus Yes / No	0 No 1 Yes	78 22	0.76 1.28	0.64 0.76	10.3	0.002		

(Continued)

Potential explanatory variables	Category	n	MHAQ Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>M8R5</u>								
The number of missing teeth including third molars (Categorical)	1 0 - 4	16	0.97	0.7	3.19	0.007	0.07	0.484
	2 5 - 9	21	0.56	0.5				
	3 10 - 14	17	1.04	0.8				
	4 15 - 19	11	0.69	0.68				
	5 20 - 24	8	1.65	0.65				
	6 25 - 29	12	0.72	0.78				
	7 30 -	15	0.89	0.46				
<u>F8R5</u>								
The number of filled teeth including third molars (Categorical)	1 0 - 4	27	0.8	0.61	2.68	0.036	-0.02	0.846
	2 5 - 9	22	1.24	0.86				
	3 10 - 14	29	0.64	0.58				
	4 15 - 19	15	0.99	0.61				
	5 20 -	7	0.79	0.72				
<u>SEX</u>								
Gender	1 Female	76	0.95	0.71	3.95	0.05		
	2 Male	24	0.63	0.62				
<u>INOUT</u>								
In-patient/Out-patient	1 Out-patient	74	0.7	0.58	23.3	0		
	2 In-patient	26	1.39	0.76				

(Continued)

Potential explanatory variables	Category	n	MHAQ Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>ONSETR10</u>								
Age of RA onset (Categorical)	1 10 - 39	24	1.21	0.67	4.2	0.018	-0.17	0.085
	2 40 - 59	51	0.73	0.66				
	3 60 - 79	25	0.85	0.7				
<u>DUR10</u>								
Years duration of RA (Categorical)	1 0 - 9	36	0.66	0.63	2.42	0.041	0.29	0.004
	2 10 - 19	36	0.87	0.7				
	3 20 - 29	13	1.11	0.59				
	4 30 - 39	10	1.4	0.78				
	5 40 - 49	2	0.55	0.78				
	6 50 - 59	3	1.03	0.84				
<u>CLASS</u>								
Class of functional disability	1	1	0	0	13.8	0	0.54	<0.0001
	2	20	0.33	0.39				
	3	72	0.94	0.63				
	4	7	1.9	0.57				
<u>STAGE</u>								
Stage of joint destruction	1	8	0.75	0.76	4.78	0.004	0.32	0.001
	2	13	0.44	0.39				
	3	25	0.67	0.55				
	4	54	1.09	0.74				

(Continued)

Potential explanatory variables	Category	n	MHAQ Mean	SD	F-Value	P-Value	Spearman's rank correlation coefficient	P-value
<u>ROJS</u>	1 None	6	0.25	0.43	5.39	0.022		
Region of swollen joints	2 Yes	94	0.92	0.69				
<u>TLTMI</u>	0 No	34	0.59	0.51	9.56	0.003		
A symptom of TMJ Yes / No	1 Yes	66	1.02	0.74				