Shoulder and Upper Extremity Impairments, Activity Limitation and Physiotherapeutic Exercise in Women with Rheumatoid Arthritis

A biopsychosocial approach

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**To Robin
and my family**

ABSTRACT

The aim of this thesis was to evaluate both specially-designed and commonly used instruments for measuring impairments, activity limitation and health-related quality of life (overall Sickness Impact Profile (SIP)). The focus was on shoulder and upper extremity. The relationships between concepts according to the International Classification of Impairments, Activity limitation and Participation (ICIDH) were studied. The instruments studied were also used in an evaluation of physiotherapeutic shoulder exercises. Ninety patients with mild or moderate RA were included in the studies. The results showed low clinical reliability and large day-to-day variations when measuring active motion range in the shoulder. A dynamic muscle function test for the shoulder also showed large day-to-day variations. A functional shoulder-arm movement impairment instrument showed satisfactory reliability though day-to-day variations. It correlated significantly (r=0.42-0.68) to pain during shoulder-arm movement, passive shoulder (except passive adduction) and elbow extension motion ranges, and active wrist motion range, isometric shoulder rotational muscle strength, a part of a specially-constructed shoulder-arm activity limitation questionnaire (SDQ), the Health Assessment Questionnaire, parts of the Functional Status Questionnaire, and the physical dimension and overall SIP. The shoulder-arm movement impairment instrument indicated construct and content validity and the SDQ indicated construct validity. The single variables as number of swollen joints in the upper extremity, passive shoulder (except adduction) and elbow motion range, isometric and isokinetic (concentric internal rotation) shoulder rotational strength did not indicate activity limitation or the overall SIP. However, the variables pain (including Ritchie index for upper-body half and shoulder tendalgia), shoulder-arm movement, passive shoulder adduction, and active elbow supination and wrist motion, and shoulder isokinetic eccentric internal rotational strength range did. In combining the variables, shoulder-arm movement, pain during movement and isokinetic eccentric shoulder internal rotation strength explained a rather large proportion (61.4 %) of the SDQ 1, covering predominantly personal hygiene activities. Still, the shoulder and upper-extremity variables indicated activity limitation and overall SIP to a rather small extent (11.3-50.2 %). Static and dynamic shoulder rotator endurance training in a group of women (n=37) were compared in a randomised study and measurements were taken at start, after 10 weeks training, and after a further 10 weeks. After the training both groups had fewer swollen joints (p=0.02) and less pain during movements (p=0.04) and during dynamic (p<0.002) and static (p=0.02) muscle function test of shoulder. The dynamic exercising group also improved according to the physical dimension (p=0.004) and overall SIP (p<0.002). The results of the studies showed that movement, pain and muscle strength are related to activity limitation and overall SIP but to a rather small extent although shoulder-arm activity limitation, disease-specific and more general activity limitation and health-related quality of life questionnaires were used in the analysis. Threshold levels, the severity of the disease, motivational, emotional and coping factors and impairments in other joints not studied in this thesis might explain the part of variation that our variables did not explain. Thus, it seems that all levels in the ICIDH-model have to be measured if all consequences of the disease are to be understood.

Key words: arthritis, rheumatoid; arm; pain measurement; motion range; movement; function; muscle skeletal; disability evaluation; human activities; health status indicators; exercise

LIST OF PUBLICATIONS

This thesis is based on the following studies, which are referred to in the text by their Roman numerals:

I. Boström C, Harms-Ringdahl K, Nordemar R. Clinical reliability of shoulder function assessment in patients with rheumatoid arthritis. Scand J Rheumatol 1991;20: 36-48

II. Boström C, Harms-Ringdahl K, Nordemar R. Relationships between measurements of impairment, disability, pain and disease activity in rheumatoid arthritis patients with shoulder problems. Scand J Rheumatol 1995; 24: 352-359

III. Boström C, Harms-Ringdahl K, Nordemar R. Shoulder, elbow and wrist movement impairment - predictors of disability in female patients with rheumatoid arthritis. Scand J Rehabil Med 1997;29: 223-232

IV. Boström C. Shoulder rotational strength, movement, pain and joint tenderness as indicators of upper-extremity activity limitation in moderate rheumatoid arthritis. Scand J Rehabil Med 2000; in print

V. Boström C, Harms-Ringdahl K, Karreskog H, Nordemar R. Effects of static and dynamic shoulder rotator exercises in women with rheumatoid arthritis. Scand J Rheumatol 1998; 27: 281-90

Some additional data not previously published have been included under the Material and Methods and the Results sections

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CONTENTS

INTRODUCTION

Physiotherapeutic rehabilitation of rheumatoid arthritis patients with shoulder and upper-extremity impairment

In rheumatoid arthritis (RA), pain (e.g.1), movement limitation (e.g.2) and muscle weakness (e.g.3) are common problems as are limitations in activities of daily living (ADL) (e.g.4) and negative influences on health-related quality of life (HRQL) (e.g.5). The disease often starts in the finger and wrist joints (6) and problems from the upper extremity are frequent (e.g.2). Sixty to ninety % of RA population groups studied have been reported to have problems from their shoulders (7, 8, 9). The shoulder-arm is in focus in this thesis, particularly the shoulder joint and upper-arm but also the elbow and wrist joints. In physiotherapeutic rehabilitation joint motion ranges and/or functional movement are commonly measured and/or assessed as a guide level for further examination, for setting goals for treatment and rehabilitation and for post-intervention evaluation. At the start of the present Studies there were to our knowledge no instruments with satisfactory reliability and validity, focusing on the shoulder-arm in RA, that measured functional movement impairment and ADL.

The International Classification of Impairment, Disability and Handicap (10) and the International Classification of Impairment, Activity limitation and Participation (11) constitute an important conceptual framework for physiotherapeutic rehabilitation. The relationships between impairment and activity limitation in patients with RA are of main interest in this thesis. However, these relationships are ambiguous perhaps partly depending on what instruments are used in the various studies. In this thesis the physical activity limitation part of the disease-specific instrument Health Assessment Questionnaire (HAQ) (12), the physical and social activity limitation parts of the Functional Status Questionnaire (FSQ) (13) and the physical, and psychosocial dimensions and overall Sickness Impact Profile (SIP) (14) were used. In RA patients, pain, movement limitation and muscle weakness are reportedly related to HAQ (15). When the Studies in the present thesis were started, the relationships between impairments and the outcomes of the generic FSQ instrument used here had not been studied in RA. The relationships between the above-mentioned impairments and SIP, a generic instrument initially intended to measure HRQL, have also been studied in RA (16) but not to the same extent as for the relationships between the impairments and HAQ. At the start of the present Studies, there were of our knowledge no reports for RA on the relationships between pain, functional movement and muscle strength in the shoulder-arm region on one hand and the HAQ, the FSQ and SIP on the other.

Physiotherapeutic exercise of the lower extremity and whole-body exercises in RA are well documented and here training and physical activities are considered beneficial without negative effects on the disease (17, 18, 19). However, there are few studies on the effects of exercising the upper extremity (Boström, review 2000, unpublished data).

Thus, the overall aim of this thesis was to construct and evaluate instruments for measuring and assessing impairment and activity limitation outcome in RA patients with shoulder-arm problems. The main foci were the relationships between impairment and activity limitation and/or HRQL and the effects of physiotherapeutic exercises.

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BACKGROUND

Conceptual framework for physiotherapeutic rehabilitation

Classifications of consequences of disease
In Sweden, rehabilitation medicine and physiotherapeutic rehabilitation are areas within public health. In these areas, a dominating framework for understanding consequences of disease is the World Health Organisation's International Classification of Impairment, Activity limitation and Participation (20). The Classification is important to rehabilitation staff as a guide level e.g. when examining patients, setting goals, treating patients and evaluating a health problem. The concepts and their definitions have changed since the first edition in 1980 (10). The 1999 Classification (20) focuses more on abilities than disabilities and the new concepts are not hierarchically dependent on one another. Functional limitations (inability to carry out a basic function of the body or body part) are assimilated to impairments (11). The 1980 (10) Classification included the concepts impairment, disability and handicap and the definitions were as follows *"In the context of health experience, an impairment is any loss or abnormality of psychological, physiological or, anatomical structure or function…a disability is any restrictions or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being…a handicap is a disadvantage for a given individual, resulting from an impairment or a disability, that limits or prevents the fulfilment of a role that is normal (depending on age, sex, and social and cultural factors) for that individual"* (present author's underlining).

In this thesis the two concepts impairment and disability in their above definitions, were used in the majority of the Studies. However, in this Introduction and in Study IV the concepts from the revised ICIDH (11) are used instead, since they were the most relevant when Study IV was being concluded. These concepts run as follows: *"In the context of health condition, impairment is a loss or abnormality of body structure or of a physiological or psychological function. An activity is the nature and extent of functioning at the level of the person. Activities may be limited in nature, duration and quality. Participation is the nature and extent of a person's involvement in life situations in relation to impairments, activities, health conditions and contextual factors. Participation may be restricted in nature, duration and quality"* (present author's underlining).

Another framework for rehabilitation medicine and physiotherapeutic rehabilitation is the *disablement process* presented by Nagi (21). Jette (22) has interpreted Nagi (21) as positing *"a main pathway of consequences of pathology (presence of disease and/or injury). First there is the onset of impairment (anatomic and/or structural abnormalities of organs or body systems) which lead to functional limitations (restrictions in basic physical and mental actions), which ultimately lead to disability (difficulty and/or limitations in performing social roles)"*. This framework has been further developed by Verbrugge et al (23). The disablement process and the ICIDH-model are rather similar although in Nagi's model (21) functional limitation is a separate level which is of interest to physiotherapists who often measure and treat at that level. However, one of the reasons for choosing the ICIDH model in this thesis was its wider acceptance.

Health concepts
The WHO defines health as *"a state of complete physical, mental, and social well-being, and not merely the absence of diseases and infirmity"* (10, 11, 20). However, this definition can be criticised as too idealistic. In Nagi's disablement process (21), the definition is implicit.

Pörn (24) explained the concept of health in a way that does not rely on the concept of disease as the WHO definition does. He presents three basic factors that can be distinguished in the dynamic of the subject's repertoire: skill, environment and goals. Several authors (e.g. 25, 26) in Sweden have found Pörn's health concept useful in physiotherapy.

Another concept used in health and medical care is *health-related quality of life* (HRQL). This concept may incorporate at least the dimensions of physical, social and emotional functioning, and global perceptions of health and well-being (27). The concept is used in the present thesis and in Study V a question about patients' satisfaction with their health is also included.

Movement as a central concept in physiotherapy

According to the World Confederation of Physical Therapy (WCPT), physical therapy is concerned with identifying and maximising movement potential, within the spheres of promotion, prevention, rehabilitation and treatment. It includes assessment, diagnosis, planning, intervention and evaluation within a process of clinical reasoning (28). Some authors have termed this a physiotherapy process (25). Human movement has long been a central concept in physiotherapy (29), and one considerable basis for the discipline is movement science (30). Maximum achievable movement potential, preferred and current movement capability are concepts described by Cott (31). In Sweden Tyni-Lenné (25) has presented the concepts movement prerequisite, movement ability and movement behaviour which are often used. Movement is essential for health and is considered both a means and a goal in physiotherapy (25). The prerequisites for movement and the consequences of movement impairment for activity, HRQL and health are main concerns of physiotherapy.

Impairment and movement prerequisites

Measuring or assessing passive range of motion (ROM) gives, above all, information about the joint structures in a specific joint and measuring or assessing active ROM gives information about both joint and muscle structures (32). Assessing functional movement gives information on joint and muscle structures but may also indicate about problems with activity (33). Passive motion range, but above all functional movements, are of interest in this thesis.

Movement may be influenced by pain from structures in joints and muscles (32, 33). Pain is a multidimensional experience influenced by many biological, psychological and social factors (34). The International Association for the Study of Pain (IASP) has defined pain as an "*unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage*" (35). In this thesis joint tenderness, pain intensity, and night sleep disturbances due to pain were the pain dimensions measured. Although, we focused on shoulder-upper arm pain-at-rest and pain during movement.

Muscular strength- and endurance are prerequisites for movement (36). Muscular strength is defined as the muscle's ability to develop force or moment (torque). Muscular endurance is the muscle's ability to maintain a contraction (specified task) (37). Endurance depends on, among other things, on the level of contraction and the presence and duration of rest periods during the contraction (37, 38). Muscular strength is possibly influenced by pain. Arvidsson et al (39) for example have shown that pain relief plays a significant role in the ability to normally activate quadriceps after open knee surgery. Isometric (static), isotonic (dynamic) and isokinetic (a form of isotonic) muscular strength and endurance can be measured (37). In this thesis isometric and isokinetic

muscular strength were measured using special apparatus while a pulley-apparatus was used for isometric and isotonic muscular endurance training.

Activity

In physical therapy, activity is also a central concept (40) and one way of describing activity is the ICIDH's definition (20). In this thesis, activity is considered as a) physical (assessed with HAQ (12) and the physical dimension of SIP (14)), b) physical and social (the parts of FSQ (13) used), c) psychosocial (SIP) (14) or, d) physical and psychosocial activities (overall SIP) (14). With parts of the FSQ instrument used in this thesis, primarily physical activities are covered but they also include the social activities taking care of other persons, visiting relatives and friends and community participation (termed basic and intermediate (instrumental and secondary) ADL by the creator of the instrument). The psychosocial dimension of SIP includes social interaction, communication, alertness behaviour and emotional behaviour.

Rheumatoid arthritis

RA is a chronic inflammatory, systemic disease which affects the connective tissues of the whole body and especially the joint structures (e.g. 41). The disease has an unpredictable course with periods of exacerbation and remission of disease activity (e.g. 42), heterogeneous disease severity and premature mortality rates (42, 43). The disease has a prevalence of approximately 1% in western countries (44, 45). The majority of these are women (2/3) (e.g. 44) and the onset of disease is at around 30-50 (46) years of age. Its etiology is unclear an no definite cure is known (e.g. 41, 47) but research in this area is intensive. The diagnosis is based on criteria established by the American College of Rheumatology (ACR) (48), earlier called the American Rheumatism Association (ARA).

The reason for pain, restricted movement and muscle weakness in RA are thought to be inflammation-related processes in the joints, muscles and in periarticular connective tissues. These processes lead to changes and to disuse of the neuromuscular system, resulting in decreased voluntary neural activation of the muscles and muscle atrophy (49, 50). The disuse might be a reflex response to pain and some (50, 51) have suggested vicious circles of joint damage - immobilization - muscle wasting - muscle weakness.

Besides the inflammation activity, pain may have other nociceptive reasons as in deteriorating joints, unequal loading or decreased blood circulation as in vasculitis, and this condition might influence the nerves and give neurogenic pain as summarised by Nisell et al (1). Pain is one of the most annoying chronic stressors in RA (52) and has been reported as the main reason for inactivity (53). The many dimensions of pain in RA have been described by among others Leibing et al (54).

Impairments in pain, movement and muscle strength with focus on shoulder-arm

The majority of those with RA report problems from their shoulders, (7, 8, 9) and movement-induced pain is a common problem (55, 56). In 70% of patients whose shoulder is affected, the acromioclavicular joint is also affected (8). Ennevaara (55) studied 200 RA patients with painful shoulder joints and found that approximately 56% had affections in the acromioclavicular joint, 39% had rotator cuff tendinitis and 36% biceps tendinitis. Around 60% of RA patients have elbow pain (57, 58) and almost all have pain and movement restriction in the wrists (e.g. 57). According to Eberhardt et al (2) loss of joint motion is present in about 25-35% in e.g. shoulder and elbow joints after five years since onset of the disease. Movement, and especially pain, seem

important to treat and influence in patients with shoulder-arm problems.

Patients with RA have lower isometric (3, 59, 60, 61, 62, 63, 64), and isokinetic muscular strength (3, 61, 62, 65) than healthy subjects. Further, muscular endurance (static) is reportedly lower than that of healthy people (60) and also isokinetic endurance (3). Weakness in shoulder-arm muscles has been reported (59, 63, 64, 65) but is less investigated. Shoulder rotation muscular strength is of particular interest as the muscles involved are the weakest (isokinetically) in the shoulder joint (e.g. 66). The majority of the muscles around the shoulder joint are involved in shoulder rotation and since these also stabilise the joint (e.g 67) it seems important to exercise them. Another reason for exercising shoulder rotation is that this movement is reportedly most important for personal hygiene activities (68, 69).

Activity limitation with focus on shoulder-arm

According to the four-class functional classification system (I-IV), established by Steinbrocker et al (70) most patients belong to classes I-II (e.g 71, 72), and can perform usual daily activities adequately despite discomfort or limited mobility in one or more joints. Patients in class III manage too little or none of the activities of normal occupation or self-care, while those in class IV are bedridden or confined to a wheelchair with little or no self-care ability. Differences in physical activity according to HAQ, between healthy persons and both early and longstanding RA patients have been reported (73). The most common problems according to HAQ are grip function and personal hygiene (4, 74). Compared with non-arthritic women, a group of RA women, mainly in functional class I-II (5) were more influenced according to physical, psychosocial and overall SIP.

In a population of 650 people with RA attending a rheumatology clinic during one year in Sweden, 72% had shoulder complaints. Among these, several activity limitation problems were reported. Thus 74% could not do their hair, 70% could not pull a sweater over their head and 79% could not take down a 1-kg packet of sugar from an eye-level shelf (9). Rehabilitation to reduce activity limitation in the shoulder-arm seems indicated.

Physiotherapeutic rehabilitation and exercises in RA

Together with inflammation-, pain- and disease-moderating drugs and surgery, rehabilitation forms an important part of what health and medical care can offer the RA patient. The physiotherapist may work in a multidisciplinary team or alone. Physiotherapeutic rehabilitation includes therapeutic physical exercises and training with fitness exercises, pain management, functional movement and physical activity training, the teaching of joint protection (including assistive devices and orthosis), energy conservation (balance between relaxation and training/physical activity), ergonomics, coping strategies such as alternative ways of performing physical activities, sports, training and leisure-time exercises and pain-coping strategies (e.g 40, 75).

Therapeutic physical exercises for RA patients have been developed during the past twenty years. Before 1970's it was recommended that physiotherapeutic exercises be performed carefully and be partly assistive, while if muscle strength was trained it should be done isometrically in the belief that exercises could exacerbate disease activity and pain and provoke joint damage. The more active disease and the higher the functional class (70) the more careful the exercise should be (57). However, Ekblom et al (e.g. 76) and Nordemar et al (77, 78) showed that active dynamic training, muscle strength exercises and physical activity are well

tolerated by RA patients without increased disease activity or worsened radiological joint status; and that there were several advantages. In Sweden, physiotherapists Ekdahl (e.g. 79) and Stenström (e.g. 80) have further evaluated and developed exercises and training for RA patients.

Impairment has been positively influenced by physiotherapeutic exercises, training and/or physical activity (e.g. 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88). Recently, intensive, dynamic exercise in patients with active disease has also shown increased muscle strength compared to exercise within a conservative ROM and isometric exercise program - this without deleterious effects on disease activity (18). Training also reportedly gives alterations in cellular immunological parameters (89) and increased haemoglobin levels (79, 81), and influences radiological progress (77) and neuropeptide levels (e.g. 90). No study reports any negative effects on disease activity, pain or radiological joint status. Several of the above mentioned exercise studies also show effects on psychological and social factors but few have found effects of physiotherapeutic exercises on the activity limitation and HRQL questionnaires used in this thesis; HAQ, FSQ and SIP.

Van den Ende (18) concluded that dynamic muscular exercises in RA patients bring increased muscular strength although the review concerns mainly evaluation of lower-extremity strength. Studies comprising specific exercises and strength evaluation of the upper extremity are less common than those of the lower extremity or a mixture of both. Stenström (17) concluded that aerobic training and dynamic exercises may have several advantages over non-aerobic and static exercises in short-term training. However, at the start of the work reported in this thesis we found no study that compared a specific muscle exercise e.g. static strength

and/or endurance exercise, with dynamic strength and/or endurance exercise.

Therapeutic exercises in shoulder and upper extremity

While studies of therapeutic exercise in the shoulder and upper extremity are rare, few studies evaluate upper-extremity rehabilitation in RA (Boström, review 2000, unpublished data). One reason for this might be that physiotherapists usually focus on whole-body exercises and those that focus on the most problematic joint. Still, exercises and/or physical training/activity of whole-body exercises seem to influence the upper extremity, for example in shoulder flexion (86), in grip strength, joint mobility in upper extremity and lifting and pain while lifting a weight from 0.5m to nose level and from floor to 0.5m (80) and elbow biceps muscular strength (77). Which exercise was the reason for improvements in the upper extremity in these studies is impossible to conclude, for which reason interventions studying exercises in one joint at a time are of importance.

Dellhag et al (91) have shown that a combination of active hand ROM and slight resistive exercises and hand wax therapy seems to be more effective than exercise only or wax only for grip-and-pinch muscular strength. They also found exercises better than wax for reducing hand pain. In another study, different active hand exercise (ROM, or ROM and resistive exercise) groups were compared with a group that did not do exercises (92). Here, grip strength improved only in the exercise groups. In a further study a group that did hand ROM and, functional movements and resistive exercises at home for four years improved in grip and pinch strength in comparison with a control group that decreased in the same variables (93).

ROM and resistive muscle exercises in the shoulder-arm region in combination with

information on a joint-protective way of living may influence shoulder-arm movement and shoulder pain (94, 95), shoulder muscular strength (94) and arm muscular endurance (95). In these studies however, the evaluators knew which group the patients belonged to. Boström et al (94) did not evaluate influences on activity limitation and HRQL and Mannerkorpi et al (95) found no change in activities. These authors pointed out the lack of instruments for measuring functional movement impairment and activity limitation in RA patients with shoulder-arm problems.

Measuring shoulder-arm movement impairment and activity limitation in RA

Joint mobility is important to measure in RA as the decrease here has been reported greater than the decline in activity (measured with HAQ), at least during the first five years of the disease (2). Assessments of functional movement give fast information on the joint and muscle function in one or several joints. For RA there are several instruments that measure mainly functional movement in upper and lower extremities (e.g. the Keitel Functional Index (96), the Signals of Functional Impairment (SOFI) (97), the Escola Paulista de Medicina (EPM)-ROM (98) (for a review see Stenström (99)). However, these instruments include few functional shoulder-arm movements and some, for example the EPM-ROM test (98), do not include a shoulder test at all. Further, the instruments do not include assessments of pain. Also, in the present work a capacity to measure pain was one of the initial criteria for an instrument assessing shoulder-arm functional movement. As the ability to reach different parts of the body and to reach up were other criteria, the above-mentioned instruments were not appropriate. In addition, the scale steps are also few and as another criterion was to find an instrument giving detailed information for further examination and treatment planning, and

for postintervention evaluation, these tests were not appropriate here either. One requirement for the fast and simple instrument needed was the avoidance of assistive devices; but the Keitel (96) and the SOFI (97) require a tape-measure and a goniometer, respectively. The shoulder-arm functional movement instrument for primarily orthopaedic patients described by Solem-Bertoft (100) requires a tape-measure and a jug of water. It involves hand-to-neck, hand-to-back and pouring water from the jug. For the present investigation, a further scale step for hand-to-neck movement to make the test more difficult and hopefully more discriminating for RA patients than the other hand-to-neck tests, was also desired. In an earlier study by the author (94) a functional shoulder-arm movement test with three movements, three scale points and a tape-measure was used for evaluating shoulder-arm exercises. This was not tested for reliability but the experience led to the idea of a suitable instrument for evaluating shoulder-arm movement in physiotherapeutic rehabilitation in RA.

Thus, at the start of the studies presented in this thesis there were no instruments that met our criteria or had the reliability and validity for assessing shoulder-arm functional movement in RA. However, some instruments have been developed since then. The test by Mannerkorpi et al (95) includes the hand-to-neck and hand-to-scapula movements, has five scale steps (0-4), but in the measurement of hand-to-scapula the assessor needs a tape-measure.

Several instruments measure physical activity limitation in RA as summarised by Stenström et al (99), but none was initially found that specifically measured activity limitation in shoulder-arm or met measurement properties such as reliability and validity. Moreover, the instruments (101, 102) developed since then often combine measurements of impairment and activity limitation, which was not our aim.

However, for orthopaedic patients there are several more instruments measuring impairment and/or activity limitation in the shoulder than for patients with RA (103). We were inspired by the instruments presented in the literature but failure to find an instrument that measured only activity limitation in RA led to the construction of a shoulder-arm activity limitation questionnaire based on the present author's own clinical experience and Study I.

Measurement properties

In physiotherapeutic rehabilitation the most frequently used instruments must have satisfactory reliability and validity. The work includes reliability tests of a) a specially-designed functional shoulder-arm movement impairment assessment model, b) measurement of active shoulder ROM and c) a specially-designed dynamic muscle function test of the shoulder (Study I). The models of the functional shoulder-arm movement impairment instrument and a specially-constructed questionnaire for measuring shoulder-arm activity limitation were also tested for validity (see below).

Reliability
Reliability is the proportion of variance in a measurement that is not error variance. Intra-rater reliability is whether the same rater makes a second assessment with the same result. This is also termed test-retest reliability. Inter-rater reliability is whether different raters assessing a respondent obtain the same result (34). Both intra- and inter rater reliability were tested in the thesis.

Validity
Validity is defined as the extent to which a measurement method measures what it is intended to. There are different kinds of validity (34) and the concepts most important for this thesis are presented as follows:
-Content validity is the extent to which a measurement covers all aspects of the topic

it was intended to measure. Face validity is a form of content validity and could be comments from experts reviewing the instrument's clarity and completeness. Factorial validity is also a form of content validity and concerns how far the items accord in measuring one or more common themes. Factorial validity was calculated and face validity was investigated through experience from colleagues of the present functional shoulder-arm movement impairment assessment model. Factorial validity was also tested on the model of a shoulder-arm activity limitation questionnaire.
-Construct validity is used when there is no criterion against which to evaluate the validity of a measurement. The validity of an instrument is then assessed by comparing the results of several contrasting tests of validity. In concurrent validity, scores on one measurement are compared with those obtained from alternative, equivalent, simultaneous measurements. Divergent validity is when the measurement is compared with those from several other instruments. The instrument will not correlate with others which measure different themes. The construct validity (concurrent and divergent) of the present functional shoulder-arm movement impairment assessment model and the model of a shoulder-arm activity limitation questionnaire was tested.
-Sensitivity to change is the ability of an instrument to detect clinically important changes (34). In this thesis the sensitivity to change after exercises was tested on instruments at both impairment level, activity limitation level and as regards HRQL.

Relationships between impairment and activity limitation

Physiotherapy practice embraces at least two perspectives on impairment and activity limitation. One is the focus on impairment level with the assumption that an activity limitation will be influenced by

treatment and intervention. The other perspective is the focus on activity level with the ensuing analysis of reasons for activity limitations. If the relationships between impairment levels and activity limitation levels are strong, then one can examine, set goals, treat and evaluate at either level. If the relationships are weak, focus on impairment level may be questioned, unless it is goal-related, as one of the main aims of physiotherapy is to prevent activity limitation, and to preserve and/or increase activity (e.g. 25, 40, 75)

Relationships between impairment and activity limitation with focus on shoulder and upper extremity in RA

Therapeutic exercises of only the shoulder and upper extremity entail reductions of impairment (e.g. greater muscular strength and movement and less pain) (91, 92, 93, 94, 95). One reason why reduction in activity limitation was not reported is the scarcity of evaluations of activity limitation. Another reason might be that improvements at impairment level do not necessarily lead to lessened activity limitation. In patients with severe RA, the relationships between impairment and activity limitation are probably more obvious but in mild or moderate R.A maybe not so evident. The present patients, in whom the relationships between pain, movement and muscular strength impairment on one hand and self-reported activity limitation and HRQL on the other were studied, had mild-to-moderate RA.

Pain impairment and activity limitation
Pain has been associated with physical activity limitation measured with the HAQ (e.g. 4, 15, 18, 104, 105, 106, 107*)*. Pain has also been related to SIP (16, 107, 108), although there are fewer studies on these relationships than on those between pain and HAQ. At the start of our work no studies were found on the relationships between shoulder-arm pain and SIP in RA.

Movement impairment and activity limitation
Several authors (e.g. 4, 15, 18, 97, 104, 105, 109) have found that movement impairment is related to HAQ. HAQ has a rather large number of questions dealing with upper-extremity function. Still the part of SOFI covering *lower*-extremity functional movement impairment correlated better to HAQ than the *upper*-extremity part (including hand-to-neck, elbow supination and extension) (97). This might be because the lower-extremity part of SOFI includes weight-bearing movements and assessments of pain. Further studies seem needed on the relationships between functional shoulder-arm movement and HAQ.

Some studies (5, 16, 108) report on the relationship between movement impairment and SIP in RA. As there are still few studies on the relationships between functional shoulder-arm movement and SIP further exploration was needed.

Muscular strength impairment and activity limitation
Grip strength has been associated to HAQ (e.g. 4, 105, 107) and lower extremity muscular strength (3, 18). Recently, elbow isometric muscular strength in combination with knee strength has also been presented as an indicator of HAQ outcome (106). To our knowledge there is no study on the relationship between shoulder muscular strength and HAQ.

Grip strength is above all related to the physical dimension and overall SIP (16, 107, 110). However, there are few studies on the relationships between muscular strength impairment on one hand and SIP on the other, and no study with the shoulder-arm in focus.

The present approach

This thesis has a biopsychosocial approach (11, 20, 111) studying principally the relationships between pain, movement and muscular strength on one hand and activity limitation and HRQL on the other. The approach considers the human being as three distinct but inter-related entities - a biological, a psychological and a social being - examining all three and then combining them together to make the whole.

Aims of the studies

The overall aim of this thesis was to construct and evaluate instruments for measuring and assessing impairment and activity limitation outcomes in RA patients with shoulder-arm problems. The main foci were the relationships between impairment and activity limitation and HRQL, and the effects of physiotherapeutic shoulder exercise at these levels.

The specific aims were:

- to design a model of assessment of functional movement impairment in the shoulder-arm with a scale that was sufficiently detailed for use in defining further evaluation and treatment needs and in post-intervention assessment. The aim was also to test the day-to-day variation and intra- and inter-rater reliability of this model and those of active motion range in shoulder flexion, abduction and external rotation and of a specially-designed dynamic muscle function test of shoulder (Study I).

- in descriptive and explorative studies of female patients with mild or moderate RA, to analyse the relationships among:

- disease activity (ESR, the number of swollen joints and Ritchie index),
- functional shoulder-arm movement, passive shoulder motion range,

passive/active elbow motion range and active wrist motion range,
- shoulder-upper arm pain-at-rest and during functional shoulder-arm movements and shoulder tendalgia,
- isometric and isokinetic shoulder rotational muscular strength,
- age, disease duration, and
- activity limitation (as shown by HAQ, parts of FSQ and physical, and psychosocial dimensions of SIP) and HRQL (overall SIP)

- to construct a model for an instrument measuring activity limitation in shoulder arm (the Shoulder-arm disability questionnaire, SDQ). Thus the relationships between movement, pain and muscular strength on one hand and SDQ, HAQ, FSQ and SIP on the other were of main interest (Studies II-IV).

- in an experimental and randomised study, to compare static and dynamic shoulder rotational muscular endurance exercises in a group of women with mild or moderate RA and to see whether such exercise could influence aspects of disease activity, impairment, activity limitation and HRQL. We also wanted to know whether the results influenced perceived disease activity and satisfaction with health (Study V).

MATERIAL AND METHODS

Subjects

The subjects included in the various studies are presented in Table 1. Altogether, there were 90 patients, 86 women and 4 men with RA according to the ARA criteria (48). The men were included only in Study I, dealing with day-to-day variation and reliability. In Study I, 15 patients belonged to functional classes I-II and eight to class III-IV (70). In Studies II-V, 63 patients belonged to functional class I-II and four to functional classes III-IV. The majority of the patients were in a non-acute phase of their disease.

The criteria for participating were: R.A (48), female, aged 20 or older, pain and/or problems from limited movement in the shoulder-arm region, and willingness to participate later in a training study concerning shoulder joint exercises.

In Study I the 23 subjects were chosen consecutively from among those attending a physiotherapy out-patient clinic at a rheumatology department in Stockholm, Sweden. The remaining patients (Studies II-V), were from two urban rheumatological clinics (secondary centres) in Stockholm, during 1989-1992. In Study II 67 subjects wished to participate and in study III 63 remained in the study. Due to a long period of data collection, technical problems with the isokinetic muscular strength measuring devices and the Study IV requirement that the patients should be able to perform a motion range arc of 60° in shoulder rotation, complete data sets were obtained only for 32 of the 63 subjects in Study III. These 32 were clinically somewhat better in activity and HRQL and somewhat older than the patients in Study III. In Study V, 63 patients constituted the "intention-to-treat" group. Of these 63 (from Study III), 45 finally agreed to participate in a training study. Analysis of reasons for not participating showed that the participants were on average significantly younger and had shorter disease duration. The participants also had better scores in the specially-constructed functional shoulder-arm movement test, and on the HAQ and the FSQ. They also had clinically somewhat less shoulder-upper arm pain and better scores in the SIP than the non-participants. During the training period, eight subjects altogether dropped out from both training groups, leaving 37 for the comparison of training modalities.

Table 1. Number of subjects (n) in each Study, age (years) and disease duration (years) (mean, SD and range).

Study		n	Age			Disease duration		
			mean	SD	range	mean	SD	range
I.	first test-retest	8	51.6	14.3	30-69	7.5	6.5	0.5-18
	second test-retest	15 (4 male)	62.9	14.8	34-82	12.6	10.0	0.5-37
I.	Total	23						
II.	67 subjects	67	59.3	13.0	24-82	13.0	11.7	0.3-52
III.	63/67 subjects	63	59.2	13.4	24-82	12.5	11.3	0.3-52
IV.	32/63 subjects	32	62.5	10.0	35-79	13.8	13.3	0.3-52
V.	37/63 subjects	37	57.4	12.1	24-74	10.1	9.0	0.3-43
II-V.	Total	67						
I-V.	Total	90						

Procedures

Study I

First test-retest study

The purpose of the first test-retest study was to test the day-to-day variation and intra- and inter-rater reliability of two tests constructed by C.B and of recordings of active ROM in the shoulder-arm and shoulder joint. One of the specially-constructed tests included four functional shoulder-arm movements: hand-raising, hand-to-opposite-shoulder, hand-to-neck and hand-behind-back. Each of these movements was tested for day-to-day variation and reliability. The other specially-constructed test was a functional dynamic test of muscle function. These tests are described in detail under Evaluation Method. The assessments and recordings was done by each of three physiotherapists in random order on each of three days in one week. Each subject was tested at approximately the same time of day. The subjects sat during the tests. The tests were included in a routine examination of the shoulder joint (functional diagnosis) also covering tests of swollen joints, joint stability, bursitis, passive ROM, isometric muscular strength (flexion, abduction and external rotation), pain and tendalgia. In other words, clinical reliability was tested.

Before starting, the three physiotherapists received verbal and written information about the constructed instruments and body segment reference levels to be recorded for active motion range. They were also informed about the whole routine examination of the shoulder joint. On each occasion, two trials were performed for each functional shoulder-arm movement. The first trial was used for learning and the values from the second were used in the analysis. For the dynamic muscle function test for shoulder and for the different active motion range directions the patients also tested their performance before the physiotherapists' recordings.

The subjects also assessed their pain-at-rest in the shoulder-upper arm, pain in connection with the functional shoulder-arm movements, with the dynamic shoulder muscle function test and with recordings of active shoulder motion range. After the shoulder joint examinations on the first and last days the patients also completed the HAQ.

Pain was recorded to ensure that the pain levels were stable despite the testing, and as a check that the patients' exertion when carrying out the functional shoulder-arm movements, dynamic shoulder muscle function test and active motion ranges was about the same each time.

The functional shoulder-arm movements were compared with active motion range, assessed pain-at-rest and during shoulder-arm movements, and with HAQ, to find the day-to-day variation.

Second test-retest study

In the second test-retest study of the functional shoulder-arm movements, the range of the scale points was modified in one of the movements. This was because of problems in assessing that movement and so that all movements would be reflected by six scale steps. To establish the intra- and inter-rater reliability of each functional shoulder-arm movement, the modified version was assessed on each patient by each of two physiotherapists in random order on each of two non-consecutive days in one week. The subjects sat during the tests. The functional shoulder-arm movement assessments were not included in a routine shoulder joint examination.

Studies II-IV

The validity of the functional shoulder-arm movements and a specially-constructed shoulder-arm activity limitation questionnaire (Shoulder-arm disability questionnaire, SDQ) were tested in Studies II-IV. Also, the relationships between impairment on one hand and activity

limitation and HRQL on the other were studied.

The following aspects were handled by physiotherapists not otherwise involved in the studies:
number of swollen joints in the upper extremity (Studies II, III), Ritchie index for upper-body half (Studies III, IV), shoulder tendalgia test (Studies III, IV), assessments of functional shoulder-arm movements (Studies II-IV), measurements of passive ROM in the shoulder and elbow flexion and extension (Study III), active ROM in elbow supination (Study III), active wrist motion (Studies III, IV) and isometric shoulder rotational muscular strength (Study IV).

Due to the long period of data collection, three physiotherapists did the recordings. To increase reliability the physiotherapists received both verbal and written information before starting and they also observed another physiotherapist, who was familiar with the different measurements and assessments, before assessing on their own. Isokinetic shoulder internal rotation muscular strength was recorded by one physiotherapist (C.B.) (Study IV). The patients assessed their pain-at-rest and during functional shoulder-arm movement themselves and completed activity limitation (SDQ, HAQ, parts of FSQ and physical and psychosocial dimensions of SIP) and HRQL (overall SIP) questionnaires.

Study V
In Study V, the effects of shoulder rotational muscular endurance exercises on impairment, activity limitation and HRQL were investigated. The patients were randomly assigned to a static training group or a dynamic training group and assessments and measurements were taken and questionnaires were filled in before and after a training period (average 10 weeks) and before and after a non-training period (average 10 weeks). The following

aspects were handled by three physiotherapists not otherwise involved in the study: number of swollen joints in the upper extremity, Ritchie index for upper-body half, assessment of functional shoulder-arm movement, dynamic and static muscle function tests for shoulder and isometric shoulder rotational muscular strength. The patients assessed their pain-at-rest and during functional shoulder-arm movement and in connection with dynamic and static muscle function tests themselves and completed activity limitation (SDQ, HAQ, parts of FSQ and physical and psychosocial dimension of SIP) and HRQL (overall SIP). The patients also filled in a questionnaire about their problems from the upper extremity and the neck, sleep disturbances, and opinions about their disease activity and satisfaction with health.

The patients were requested not to begin new exercises, not to change their medication intake and not to have cortisone injections during the whole observation period.

They were instructed to exercise three times a week for 10 weeks using a pulley apparatus (LIC, Solna, Sweden) to train internal and external shoulder rotational muscular endurance with a load of 30% of their individually tested maximum voluntary isometric muscular strength. Generally accepted training therapy principles (38) were followed, one of the goals of training therapy at the chosen load levels being to reduce pain. The patients exercised each rotation direction 30 times, then rested for 30s, and then repeated this procedure twice according to training therapy practice. At baseline, the pulley weight (mean) was for internal rotation 1.5 kg (0.6-2.6) in the static group and 1.4 kg (0.3-3.0) in the dynamic group. For external rotation the pulley weight (mean) in the static group was 0.9 kg (0.4-1.8) and in the dynamic group 0.8 kg (0.3-1.5). The patients' individual maximum joint

rotation range gave the range for the dynamic training. The contraction time for the dynamic group was 4s; 2s concentric and 2s eccentric, and for the static group 3s. The reason for these contraction times was that little resistance occurs at each end of the ROM due to changes in torque (112, 113). We estimated, through calculations of circumference of dose-and-time curves during dynamic contractions, that the time when the muscles received little resistance was around one second. This procedure made it possible to get comparable exercise dose values in both groups. A special apparatus was constructed for this training to govern the contraction time and to count the number of contractions (Figure 1). In each 40-60 min. training session, both shoulders were exercised. The resisting pulley cord cuff was applied around the patient's wrist so that the training should not include the wrist and hand.

The patients were seated and positioned in relation to the pulley apparatus as described by Harms-Ringdahl (112, 113), according to training therapy (38) and following experience from an earlier study (94). The positions adopted were those which give good adaptation of resistance in the middle of the motion range, where rotator muscles are strongest (112, 113). In the static group, patients had resistance at the corresponding position in the motion range.

After two or three introductory sessions with physiotherapists, the patients continued the training on their own. The physiotherapists here were not involved in the assessments and measurements. The patients were instructed what to do if pain should increase, namely; 1) to allow several rest periods; 2) to reduce the number of repetitions or the weight; and 3) not to exercise that particular day or days.

Every third week, isometric shoulder rotator muscular strength was re-tested by a physiotherapist otherwise not involved in
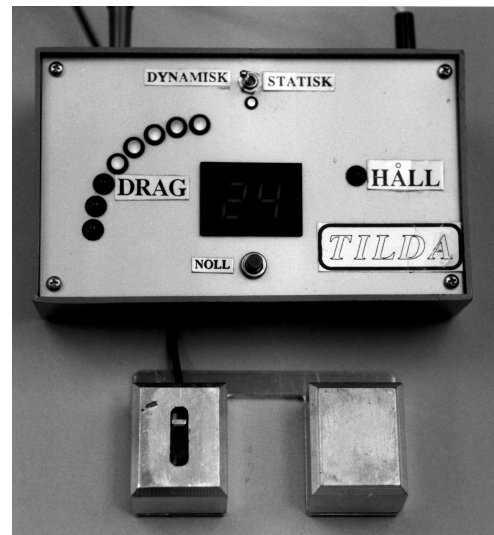

Figure 1. *The apparatus used to govern the contraction time and count the number of contractions during exercise.*

the outcome measurements. A mechanical dynamometer (Salter, PIAB, Täby, Sweden) adapted to the pulley apparatus was used. The training load for the exercises was adjusted according to the new values, if there were new values. When re-testing strength, the method of training was also checked.

The patients kept diaries in a special book at the physiotherapy department where they trained. They noted their frequency of training, reasons for changes in training or for not training, and their opinions about the training.

Evaluation methods

Signs of disease activity
Disease activity was measured and assessed according to recommended variables (114). For two of the variables, however, the methods were modified for the shoulder-arm focus. The variables were measured separately, not as a score.

Erythrocyte sedimentation rate
Erythrocyte sedimentation rate (ESR) *(*mm/hr) was laboratory-tested for each patient in Studies II-III.

Number of swollen upper-extremity joints
The number of swollen joints in the upper extremity was established with palpation of the seated patient (Studies II, III, V). The following joints were palpated: sternoclavicular, acromioclavicular, glenohumeral, elbow, wrist, metacarpophalangeal (MCP), and proximal interphalangeal (PIP). Swollen joints were defined as exhibiting detectable, palpable synovial thickening. Each swollen joint scored one point, with a maximum score of 30 points per patient. Assessing the number of swollen joints has satisfactory reliability (115).

Ritchie articular index for upper-body half
The Ritchie articular index (116), which scores joint tenderness, was used in Studies III-V. The patient lay down and firm manual pressure was applied to the following joints: jaw, sterno- and acromioclavicular, glenohumeral, elbow, wrist, MCP and PIP. For the neck, passive rotation in both directions replaced pressure. Tenderness was graded on a 0-3 scale where 0=no tenderness, 1=tenderness, 2=tenderness and wincing, 3=wincing and withdrawal. The maximum possible score was 42. All joints were assessed separately but the jaw, acromioclavicular and sternoclavicular joints, and the MCP and PIP of each hand, were calculated as single units, the highest score for a single joint giving the score for the joint group. The Ritchie index has satisfactory reliability (e.g. 4).

Impairments
Development of a functional shoulder-arm movement instrument
As we wanted the functional shoulder-arm movement instrument to include the ability to reach different parts of the body and reach up, the test included four common functional movements; hand-raising, hand-to-opposite-shoulder, hand-to-neck and hand-behind back. The test was designed with a score range between 1-6 for all movements except for hand-to-neck, which had 1-7. The scale steps approximated anatomical reference points and anatomical planes were used. The higher the scale point the better the ability. The choices of functional shoulder-arm movements and scale points were influenced by clinical experience, an earlier study by the author (94) and literature review. Each functional shoulder-arm movement was tested for day-to-day variation and clinical reliability in the first test-retest study (Study I). In the second test-retest study (Study I), point 2 was excluded from the hand-to-neck movement a) because the movement was difficult to assess and b) to give all four functional shoulder-arm movements the same scale, range, 1-6.

In Study II a fifth common functional shoulder-arm movement was added, namely hand-to-seat with 1-6 scale points. This movement was included in an earlier study by the author (94). Experience of using the functional shoulder-arm movements also led to a slightly modified version. Scale points 4-6 in hand-to-neck and 1-3 in hand-behind back were changed from the first version presented in Study I, as we thought this would make the assessments easier to assess. The maximal ability according to the test in each functional shoulder-arm movement are shown in Figure 2a-e with a subject standing. The assessments can be done with the patient standing or sitting. In the sitting position the lumbar region of the spine is somewhat stabilised and in our studies the subjects were sitting.

The inter-rater reliability for hand-to-seat was tested on 15 RA women mainly in functional class I-II (none of the 90 subjects presented in Table 1) and the agreement between two physiotherapists with 18-20 years of experience of patients' joint function problems was calculated. If agreement within the same scale score was required, 73% agreement was attained and if difference of one scale point was accepted 100% was attained. The modified

functional shoulder-arm movement test including the hand-to-seat movement presented in Table 2 was further used and tested for validity in Studies II-V.

The functional shoulder-arm movement instrument also included assessments of pain intensity in the shoulder and upper-arm during the movements. The assessments used to Borgs' Category Ratio scale, CR-10 scale (117), described below.

Motion range in upper extremity
Measurements of active and passive ROM were recorded according to the procedure of the American Academy of Orthopaedic Surgeons (118) and with a goniometer ad modum Brodin (LIC, Stockholm, Sweden). The patients were seated for active motion range measurements and supine for passive. The reliability of passive shoulder flexion, abduction, and external rotation (119), passive elbow flexion and extension (120), and active wrist dorsi- and volarflexion measurements (121) has been reported as satisfactory. Some have shown satisfactory reliability for measuring active motion range in the shoulder and wrist in patients with RA (122).

The active motion ranges of shoulder flexion, abduction and external rotation were recorded in Study I. External rotation was recorded with the arm hanging at the side of the body and the elbow flexed 90°. Active motion range of elbow supination and active wrist dorsi- and volar flexion, respectively, were recorded in Study III. Measurements of active wrist volar flexion were also used in Study IV.

Passive flexion, extension, abduction, adduction, internal- and external rotation in the shoulder joint, and passive elbow flexion and extension, were also recorded (Study III). During internal and external rotation the upper arm was abducted to 90°.

2a. Hand-raising

2b. Hand-to-opposite-shoulder

2c. Hand-to-neck Side view

2d. Hand-to-neck Back view

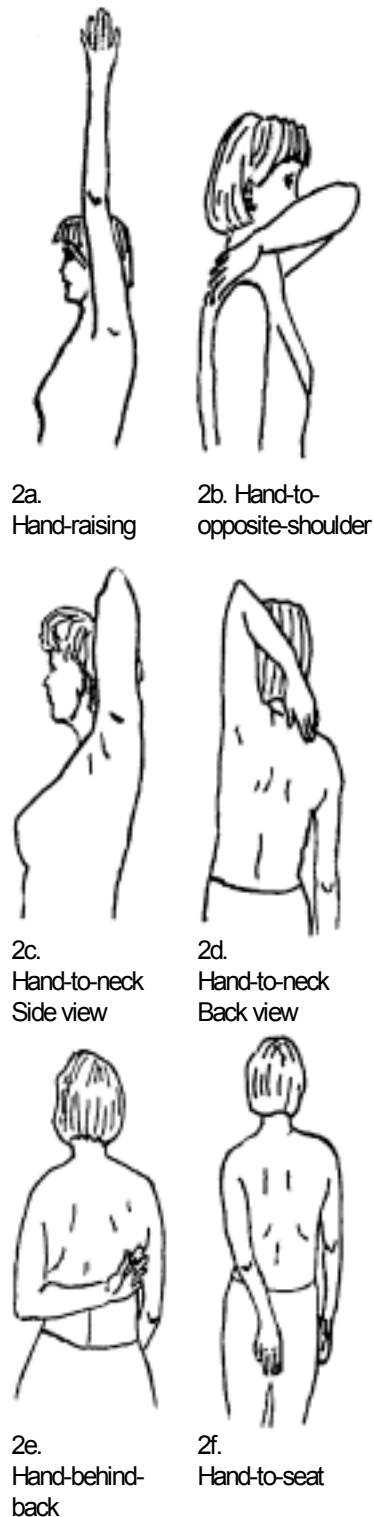2e. Hand-behind-back

2f. Hand-to-seat

Figure 2a-f. The five functional shoulder-arm movements. The pictures show maximal ability (scale score 6) in each movement with a subject in a standing position.

Table 2. Shoulder-arm movement impairment instrument, version used in Studies II-V (Swedish version in appendix). Modified Table from Boström et. al.: Scand J Rheumatol 1995;24:352-359; with permission.

Hand-raising
Scale score. The patient...
1. does not reach level of xiphoid process with elbow
2. reaches xiphoid process level with elbow but with compensatory shoulder elevation
3. reaches xiphoid process level with elbow
4. raises elbow to shoulder level
5. raises elbow to eye level
6. raises elbow above head without flexing neck

Hand-to-opposite-shoulder
Scale score. The patient…
1. does not reach contralateral coracoid process of scapula with metacarpophalangeal (MCP) joint on third finger
2. reaches coracoid process of scapula with MCP, third finger
3. reaches around contralateral spine of scapula with distal interphalangeal (DIP) joint, third finger
4. reaches around contralateral spine of scapula with DIP, third finger and lift elbow above xiphoid process level
5. reaches around spine of scapula with DIP, third finger, and can lift elbow to shoulder level
6. reaches around spine of scapula with DIP, third finger and can lift elbow to eye level

Hand-to-neck
Scale scores. The patient...
1. does not reach fourth cervical spinous process of vertebra (C4) with DIP on third finger
2. reaches cervical spinous process of vertebra (C4) with DIP, third finger, but with compensation by flexion and rotation of neck, adduction of upper arm or elevation of shoulder
3. reaches cervical spinous process of vertebra (C4) with DIP, third finger
4. reaches cervical spinous process of vertebra (C4) with DIP, third finger, and can move elbow laterally towards frontal plane, but does not reach it
5. reaches cervical spinous process of vertebra (C4) with DIP, third finger and reaches frontal plane with elbow
6. passes cervical spinous process of vertebra (C4) with MCP, third finger, and moves hand towards contralateral superior angle of scapula with elbow in frontal plane

Hand-behind-back
Scale score. The patient…
1. cannot reach behind frontal plane through posterior superior iliac spine (PSIS) with styloid process of radius
2. reaches lateral crista at PSIS level with dorsum and styloid process of radius
3. reaches ipsilateral PSIS with dorsum and styloid process of radius
4. reaches contralateral PSIS level with dorsum and styloid process of radius
5. gets styloid process of radius to spinous process of vertebra at contralateral elbow level
6. gets styloid process of radius past spinous process of vertebra towards contralateral inferior angle of scapula

Hand-to-seat
Scale score. The patient…
1. cannot reach behind frontal plane through PSIS with styloid process of radius
2. reaches lateral crista at PSIS level with dorsum and styloid process of radius
3. reaches ipsilateral PSIS with dorsum and styloid process of radius
4. reaches sacrum at PSIS level with styloid process of radius and dorsum
5. reaches sacrum at posterior inferior iliac spine (PIIS) level with styloid process of radius and thumb and hand in sagittal plane
6. reaches sacrum at PIIS level with styloid process of radius and vola

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Dynamic muscle function test for shoulder
A dynamic muscle function test for shoulder was designed and tested for day-to-day variation and clinical reliability in Study I. The test included the number of times the hand could be raised, as far as possible according to the individual ROM, during one minute. After the test the patients were asked to assess their shoulder-upper arm pain during the hand-raisings on Borg's CR-10 scale (117) (see below). The test was performed with the subject standing. In Study V this test was modified to comprise the number of hand-raisings from 0-90° of shoulder flexion during one minute. This was to standardise shoulder flexion angle, so that it was similar for all subjects.

Static muscle function test for shoulder
A test for static shoulder muscle function i.e. the patient's ability to hold both arms simultaneously at 45° of shoulder abduction with extended elbows for three minutes was designed and tested. Exertion was assessed, at termination, according to Borg's Rating of Perceived Exertion scale (RPE) (117). This ranges from 6 to 20, where 6 means no exertion at all and 20 maximal exertion. This scale is reliable (117). After the test the subjects were also asked to assess their shoulder-upper arm pain on Borg's CR-10 scale (117) (see below) (Study V). The test was performed with the subject standing. A similar test, but with 2 kg weights on each wrist has been used in patients with rotator tendinosis (123). In patients with RA, 90° of abduction and weights on each wrist has been found to be sensitive to change after shoulder-arm exercises (95). In our study we used 45° of abduction because not all patients had 90° abduction in their shoulders.

Pain in shoulder-upper-arm and in shoulder
Pain intensity was assessed in the shoulder-upper-arm at rest (Studies I-V), during functional shoulder-arm movements (Studies I-V), measurements of active shoulder ROM (study I), and during dynamic (Studies I, V) and static (Study V) shoulder-muscle function tests. The Borg CR-10 scale (117) from 0 to 10, where 0 equals "no pain" and 10 "very, very severe pain", was used. This scale is reliable (117), as is the assessment of pain intensity with numeric rating scales in RA patients (124).

The presence of shoulder tendalgia was tested (Studies III and IV). Isometric muscle contraction and stretching were performed, and the tendon and its insertion were palpated (125). If pain was provoked by all three actions, the patient was considered to have tendalgia. The muscles tested above all were the biceps brachii (resistance against elbow flexion), supraspinatus (resistance against abduction), infraspinatus (resistance against external rotation) and subscapularis (resistance against internal rotation). The reliability of assessing shoulder tendinitis has been reported satisfactory (126).

Isometric muscular strength of shoulder rotators
The maximum isometric voluntary muscular moment of shoulder rotators was tested (Studies IV and V) using a special apparatus (Rodby, Enhörna, Sweden) and an electromechanical force transducer (Bofors, Sweden). The subject sat in an adjustable test chair with backrest and with the feet supported at a height that allowed 90° of knee flexion. The trunk was fixed to the backrest with seat belts. The electromechanical force transducer was connected to a mechanical arm, which could be adjusted to the subjects' anthropometric measurements and to the direction of resistance desired. Shoulder rotation strength was tested with the upper arm kept vertical close to the trunk; the shoulder joint in neutral position (i.e. 0°), 90° flexion in the elbow and the forearm horizontally forwards between pronation and supination. A resistance pad was

applied at the distal, dorsal and volar sides, respectively, of the forearm.

A submaximal test followed by at least 30s of rest was performed before each measurement of maximum. The contraction was gradually increased and verbal feedback given until the value stabilised at a peak level. The highest value of three reproducible recordings was used in the analysis. For each subject, the moment arm was measured from the joint axis to the point of application of the force transducer. The movement centre of the shoulder joint axis was projected to the longitudinal axis of the humerus at the centre of the lateral epicondyle of the humerus. The reliability of measurements of isometric shoulder muscular external rotation in the Rodby apparatus is satisfactory (127).

Isokinetic muscular strength of shoulder rotators
Maximum isokinetic muscular strength of shoulder rotators was tested (Study IV) using a Kinetic-Communicator (KIN-COM) dynamometer with a special software program. Two different devices (due to technical problems with the devices) with the same testing system were used; version 3.0 and version 3.21 (Chattex Corporation, Chattanooga, Tennessee). The reliability of the KIN-COM operating systems (lever arm position, lever arm velocity and force measuring systems) i.e. the ability to reproduce measurements of weight, has been reported acceptable (128). In our study the angles and gravity corrections were recorded before measurements. The reliability of measurements of shoulder rotator muscular strength with the KIN-COM has been reported satisfactory (129).

The subjects sat (Figure 3) with the trunk stabilised and the feet on a foot rest. The part of KIN-COM where the mechanical joint is situated was tilted maximally backwards to align with the anatomical joint axis for shoulder rotation. The elbow was placed in a V-shaped support aligned with the KIN-COM mechanical joint axis, keeping the shoulder joint at approximately 30° of abduction, slightly flexed (5-10°), and approximately 90° of elbow flexion, and the forearm in between supination and pronation. To minimise the efforts of the wrist dorsi- and volar flexors the forearm was fixed distally to a pad including a force transducer. The subjects were asked not to move the forearm in elbow flexion and extension during the measurements. The moment arm was measured in the same way as in the isometric muscular testing.

Concentric and eccentric shoulder internal rotation muscular strength was measured at 60°/s. The minimal force required to start the contractions was set at 5N. Concentric contraction was measured first, then eccentric and then concentric again, etc. The subjects rested for about 30s between each contraction. Three contractions per type were performed and the average was used in the analysis. Measurements at 30°/s and external rotation at both 30°/s and 60°/s were also taken, but these movements were more difficult to perform and pain and/or weakness resulted in some breaking off the trial and thus not being included in the analysis.

Figure 3. *Positioning during isokinetic measurement of shoulder rotator muscle strength. (From Boström in Scand J Rehab Med, in print 2000, with permission).*

In the analysis, torque average at 60° ROM was used because this might better represent a functional movement than the commonly used peak torque. Several authors (e.g. 130) have also shown that the range of angles at which peak torque in shoulder rotation strength is attained varies widely. The majority of the measurements were taken at between approximately 30° internal rotation and approximately 30° external rotation, being 0° when the forearm was in the sagittal plane. Measurements that exceeded 60° ROM were cut off at the end of the ROM arc.
.

Activity limitation and HRQL

A model for a shoulder-arm activity limitation questionnaire

A self-administered questionnaire on 17 activities involving the shoulder joints and upper extremities was constructed in Study II, based on our clinical experience, a literature review and the results from Study I. The activities covered personal hygiene, dressing and lifting, carrying, pouring and tying knots. Each activity was scored from 4 to 0 according to the patient's own assessment of how hard it had been to perform an activity on her own during the previous week, that is; without difficulty (4), with some difficulty (3), with great difficulty (2), impossible to do (1), and did not do the activity for other reasons (0). The choice of scale steps was inspired by Jette et al (13).

A factor analysis showed that the questionnaire contained four factors. One was excluded because few of the patients did these activities in their daily life or had no problems in doing them. The remaining three factors were considered as different variables (SDQ factors 1, 2 and 3, respectively) and a score was calculated for each. This was done to achieve factorial validity of the model of SDQ. Factor I covers mainly personal hygiene (washing one's; face, armpits, back and buttocks, combing one's hair, doing one's hair, putting on/taking off a coat). Factor 2

covers dressing (putting on/taking off socks, trousers, shoes, a sweater) and factor 3 lifting, carrying, pouring and tying (knots).The total score for each factor was calculated in the same way as in the FSQ (see below). Possible scores for each factor are 0-100, the higher the score the better the ability. The SDQ factors were used as SDQ 1, 2 and 3 and further tested for validity in Studies II-V.

HAQ

The self-administered HAQ records the ability to perform activities during the most recent week. It was used in Studies I-V. The part of the questionnaire intended to measure physical activity limitation and pain has been translated into Swedish and has good reliability (4). We used the Swedish version but only the part that measures physical activity limitation. The HAQ contains 20 questions divided into eight categories: Dressing/grooming, Arising, Eating, Walking, Hygiene, Reach, Grip and Other activities. Each category consists of 2-3 activities and is scored from 0-3 (0=without any difficulty, 1=with some difficulty, 2=with much difficulty and 3=unable to do). Using assistive devices and or help from another person gives score 2. The highest score obtained for any activity in a category determines the score for that category. The HAQ may range from 0.0 to 3.0 - the higher the score, the more disabled the patient - and is calculated as the sum of scores for the different categories divided by the number of categories responded to.

FSQ

The FSQ is a self-administered questionnaire designed for primary care patients and intended to measure physical and psychological ability, work performance, social activity, and quality of social interaction (13). It is classified as a questionnaire measuring HRQL (34) but in this thesis only the parts of the questionnaire measuring physical and social activity were used. The parts of a

Swedish version/translation (14 questions) (131) which measure physical and social activity were used in Studies II-V. The FSQ has satisfactory reliability (13) and in Sweden it has been tested for usefulness and reliability on patients with polio, and on those with dystrophia myotonica (131), and for usefulness on those with chronic back pain (132). Each activity is scored on its difficulty during the most recent month, from 4-0: did without difficulty 4, did with some difficulty 3, did with great difficulty 2, usually did not do because of health 1, and usually did not do for other reasons 0. Each scale score is derived as follows:

$$SS = \frac{\left(\sum_{i=1}^{n} y_i\right) - n}{n} \times \frac{100}{k}$$

where

SS = transformed FSQ scale score

y_i = individual questionnaire response score

n = number of questions in the scale for which valid information is available

k = maximum minus minimum valid response score (the numerical values given in the 2 summary scales being 1 to 4 leaving k-values in the FSQ 4-1=3)

(Adapted from Jette et al, 1986 and modified from Einarsson & Grimby, 1990)

Transformed scale values range from 0 to 100, with a score of 100 indicating maximum ability.

SIP

The SIP (14) comprising 136 items was completed by the patients and the results were used in Studies II-V. Each item describes a sickness-related behavioural change. In completing the SIP, the test person was asked to endorse only those statements that described her on that day and in relation to her health. The SIP items are weighted following a pre-determined weighting system in relation to the estimates of relative severity of dysfunction of the statement. Scores are calculated for each category (12), the two

dimensions (physical and psychosocial) and the overall instrument. Scores are expressed as percentages of maximum dysfunction for each category, two dimensions and an overall index, a high score corresponding to more severe dysfunction. The SIP includes a physical dimension (Ambulation, Mobility, Body care and movement), a psychosocial dimension (Social interaction, Communication, Alertness behaviour and Emotional behaviour), independent categories (Work, Sleep and rest, Eating, Home management, Recreation and pastimes) and an overall SIP. Each dimension and overall SIP give 0-100 points. The Swedish version of the instrument, presented and tested for reliability by Sullivan et al (133), was used.

Patients' perceived problems, sleep disturbance, disease activity and satisfaction with health

The patients also completed a questionnaire about the magnitude (no, small or large) of their problems from the upper extremity (fingers/wrist and elbow) and the neck; whether their sleep was perceivedly disturbed due to shoulder-upper arm pain, and their opinions about their disease activity and satisfaction of health. The question about disease activity was "How active is your disease ?" with the possible answers not active, slightly active or active. The question about health; How do you feel about your health ? is included in the FSQ (13), but was here used separately. The answers are; very dissatisfied, dissatisfied, not sure, satisfied and very satisfied. The reliability of questions similar to the present ones about disease activity and health is satisfactory (134). The results of this questionnaire are presented in Study V.

Statistical methods and analysis

Study 1

First test-retest study

Friedman's two-way analysis of variance by ranks was used to find whether there were any significant changes in assessments of functional shoulder-arm movements, active ROM and pain in shoulder-upper arm (during functional movements and recordings of ROM) with respect to: the mean values between occasions per day (i.e. systematic changes between the order of assessments per day); the mean values between days (i.e. systematic changes between days) and the mean values between physiotherapists (i.e. systematic differences between the three physiotherapists).The Wilcoxon matched pairs signed-ranks test was applied to identify changes in functional shoulder-arm movements, shoulder-upper arm pain-at rest and in HAQ between the first test day and the last.

First and second test-retest studies

Reliability was expressed as percentage agreement between ratings (intra-rater reliability) and raters (inter-rater reliability).

Study II

Factor analysis (extracting factors using principal components analysis) was used to form a concise description of the five functional shoulder-arm movements and the model of SDQ. These analyses seek a few underlying dimensions (factors) that account for patterns of variation among observed items. The factors with Eigen values (variance explained by the factor VP) ≥1.00 were considered as important. Sorted, orthogonally-rotated factor loadings (correlations of the items with the factors) and communality (how much of each item's total variance is accounted for by the factor) as well as VP are presented in Study II. Factor loadings less than 0.25 are set to zero. Items with high loadings on a given factor are considered to define that factor.

Factor scores are derived from factor score coefficients, based on factor loadings (the factor score coefficients were multiplied by the values from the items in the two instrument models analysed). These factor scores for the functional shoulder-arm movement impairment instrument and SDQ (factors 1, 2 and 3) were used in the calculations of correlation coefficients.

Study III

In Study III forward stepwise, multiple linear regression analysis was used when evaluating how far the variation in different activity limitations and HRQL instruments could be explained by age, disease duration, disease activity, functional shoulder-arm movement, shoulder-upper arm pain-at-rest, shoulder tendalgia, passive shoulder motion ranges, passive/active elbow motion ranges and active wrist motion ranges.

Factor scores from factor analysis (Study II) for the five single functional shoulder-arm movements together, i.e. functional shoulder-arm movement impairment instrument and factors 1, 2 and 3 of the SDQ were used in the analysis.

Before regression analysis, two variables were dichotomised and nine variables were log-transformed to reduce positive skew.

Study IV

From study III, the significant predicting variables (except passive shoulder adduction and active elbow supination, whose predicting values were rather low) that described activity limitations and HRQL were included as possible predicting variables in a new model of regression analysis. Together with isometric and isokinetic shoulder rotational muscular strength, there were ten predicting variables. Due to the small sample size, only three dependent variables could be analysed at the same time in the regression model.

Two variables were dichotomised and three were log-transformed to reduce positive skew. Four variables were also squared due to negative skew. Factor-based scores for the factors SDQ 1, SDQ 2 and SDQ 3 were used.

In the result and discussion section the word indicate instead of predict will be used as our measurements were done at the same time.

Study V

Outcome variables were analysed according to a repeated measures analysis of variance (ANOVA). Two variables were positively skewed and were therefore log-transformed.

The Within factor (repeating) in the ANOVA was time, with time points 0, 10 and 20 weeks. Group x Time interaction referred to the statistical test of whether one of the groups was affected differently than the other across the investigation frame. The Between factor was treatment group. Differences between levels of the Within-factor time were evaluated using *post hoc* contrast. In cases of significant interaction, simple effects were examined.

Changes in one variable were analysed using the Mann Whitney U test and Friedman ANOVA by ranks for intra-group and inter-group comparisons, respectively. For variables measured on a nominal scale the Sign test and the Chi-square test were used for intra-group and inter-group comparisons, respectively. Six variables were dichotomised. For inter-group differences of these variables the values were coded into: (1) unchanged, or changed from perceiving no problems in the specific variable to perceiving problems; (2) changed from perceiving problems in the specific variable to perceiving no problems.

Due to intentional cross-over design, seven patients (4 in the dynamic group and 3 in

the static) had their non-training period before the training period. These are included together with those who had their non-training period after the training period.

Studies I-IV

Correlations were calculated with Spearman's rank-order correlation coefficient and or Pearson's product moment correlation coefficient.

Studies II-V

In view of the large number of significance tests, the p-values were corrected according to the Bonferroni procedure. Thus, $p < 0.01$ was considered significant in order to maintain an approximately overall level of 5%.

Studies III and IV

We used the following classification to interpret the correlation values. Correlations from 0 to 0.25 indicate little or no relationship, those from 0.25 to 0.50 a fair degree of relationship, those from 0.50-0.75 a moderate-to-good relationship and those above 0.75 a very-good-to-excellent relationship.

The references for the different statistical methods are included in the different Studies.

Ethical scrutiny

The design of all the studies was approved by the Ethical Research Committee at Karolinska Hospital, Stockholm.

SUMMARY OF RESULTS

Study I
Functional shoulder-arm movement model
In the two test-retest studies reported in Study I, the scores included all scale points in all shoulder-arm movements during the test days but levels 3-6 were most frequent.

Clinical reliability tested with Friedman's two-way analysis of variance by ranks
There were no significant changes between the order of assessments on each day or between days. However, there was a significant difference between physiotherapists in the assessments of hand-behind-back (left shoulder) (p<0.05) and in hand-to-opposite-shoulder (right shoulder) (p<0.05) (first test-retest study).

Reliability tested as percentage agreement in first and second test-retest study
Agreement was considered to obtain when the physiotherapists' assessments were identical and when the assessments varied no more than one point on the scale. Intra- and inter-rater reliability for each functional shoulder-arm movement in the second test-retest study is presented in Table 3.

In the first test-retest study when all three assessments had to be identical for the four functional shoulder-arm movements, *intra-rater agreement* varied from 29 to 64%, while if one point of difference was allowed, agreement varied from 75 to 87%. In the second test-retest study when it was required that both assessments be identical, agreement varied from 53 to 75%. When a difference of one point was allowed, agreement varied from 73 to 98%.

In the first test-retest study, when it was required that all three assessments be identical for the four functional shoulder-arm movements, *inter-rater agreement* varied from 13 to 51%. With one scale point of difference, agreement for the four functional shoulder movements varied from 54 to 81%. In the second test-retest study when it was required that both assessments be identical, agreement varied from 55 to 63%. When one scale point of difference was allowed, agreement varied from 80 to 95%.

Comments: The reliability of the hand-to-seat movement was tested separately (see Development of a functional shoulder-arm movement instrument) as it was not included in the first version of the functional shoulder-arm movement model in Study I. The levels 4-6 were most frequent in that movement.

Table 3. Intra- and inter-rater reliability for each shoulder-arm movement (percentage agreement) (n=15). Second test-retest, Study I. From Boström et. al.: Scand J Rheumatol 1991;20:36-48: with permission.

Shoulder-arm movement	Agreement within same scale score (%)		Difference of one scale point (%)	
	Intra	**Inter**	**Intra**	**Inter**
Hand-raising	62	55	90	82
Hand-behind-back	75	57	98	95
Hand-to-neck	53	63	73	80
Hand-to-opposite-shoulder	65	63	92	88

Active motion range of the shoulder
Active motion range was tested for day-to-day variation and clinical reliability in the first test-retest study.

Clinical reliability tested with Friedman's two-way analysis of variance by ranks
There were significant changes between the order of assessments per day for abduction (right, left shoulder) ($p<0.05$) and external rotation (right shoulder) ($p<0.05$) and there were significant changes between days for flexion (right shoulder) ($p<0.05$). There were also significant differences in the measurements between physiotherapists for flexion (left shoulder) ($p<0.05$), abduction (right shoulder) ($p<0.001$), and external rotation (right shoulder) ($p<0.05$).

Clinical reliability tested as percentage agreement
Clinical intra- and inter-rater reliability were calculated when assessments within 5° or 10°, respectively, were considered to agree. When a 5° difference was accepted, agreement varied from 15 to 23% for intra-rater reliability and from 2 to 21% for inter-rater reliability. With a 10° difference, agreement varied from 33 to 56% for intra-rater reliability and from 19 to 52% for inter-rater reliability.

Comments: We calculated reliability when 5° and 10° were considered to agree. Five degrees has been suggested by Boone et al (135) in order to be able to state that improvement has occurred and 10° was our own suggestion. As the day-to-day variation was probably rather large and the reliability was not satisfactory, active motion range was not used in the further studies (Studies II-V).

Dynamic muscle function test of the shoulder
The dynamic muscle function test was tested for day-to-day variation and clinical reliability in the first test-retest study.

Clinical reliability tested with Friedman's two-way analysis of variance by ranks
The number of hand-raising movements increased significantly between the order of assessments per day (right shoulder) ($p<0.05$) and between days (left shoulder) ($p<0.05$) but there were no significant differences between the physiotherapists' assessments.

Clinical reliability tested as percentage agreement
Intra-and inter rater reliability, as the percentage agreement of all assessments for the test, was considered to obtain when all three physiotherapists' assessments were within five numbers for the hand-raising movement. Agreement was 46% for intra-rater reliability and 79% for inter-rater reliability.

Comments: All subjects managed to perform the test. The test was modified for Study V (see Evaluation Methods).

Pain in shoulder-upper arm
There was no significant change in perceived shoulder-upper arm pain-at-rest during the test days; nor were there significant changes between perceived pain for different occasions/day, different days, or different physiotherapists during the assessments of the functional shoulder-arm movements and measurements of active motion range (first test-retest study, Study I).

HAQ
There was no significant change between the first and the third test days (first test-retest study, Study I).

Study II
Content and construct validity of the model of a functional shoulder-arm movement instrument
After a revision of the functional shoulder-arm movement model including the addition of another common functional movement, factor analysis showed that the

five shoulder-arm movements investigated were strongly inter-related, indicating factorial validity. The total shoulder-arm movement impairment score (denoted shoulder-arm movement impairment instrument), based on the sum of the mean values of each functional shoulder-arm movement, was considered as a possible scoring system and used in further analysis (Studies II-V). The total score of the means of the right and left shoulder-arm movement instrument varied from 5-30 points.

Correlations between the shoulder-arm movement impairment instrument and HAQ, FSQ and SIP are presented in Table 4. The associations between shoulder-arm movement and HAQ, FSQ and the physical dimension and SIP overall were fair-to-moderate. There was no significant relationship between shoulder-arm movement and the psychosocial dimension of SIP. The relationships between shoulder-arm movement and SDQ 1 were moderate-to-good (r=0.55) and not significant for SDQ 2 and 3, respectively.

The association between shoulder-arm movement and shoulder-upper-arm pain-during-shoulder-arm-movement was fair (r=-0.44) and there was no significant correlation between the former and shoulder upper-arm pain-at-rest. There were no significant correlations between shoulder-arm movement and ESR or the number of swollen joints in the upper extremity.

Construct validity of SDQ factors
The associations between the three different factors of the SDQ and HAQ, FSQ and SIP were fair-to-moderate to good (r=0.32-0.53) or not significant. The relationships between SDQ 1 and SIP and that between SDQ 2 and the psychosocial dimension and SIP overall, were not significant. The relationships between SDQ and shoulder-arm movement is described above. There were no

relationships between SDQ 1, 2 and 3 on one hand and ESR, the number of swollen joints in the upper extremity, shoulder upper-arm pain at rest and during shoulder-arm movement on the other.

Results and comments:
The correlations between the different activity limitation and HRQL questionnaires are also presented in Table 4. The relationships between HAQ, FSQ and the physical dimension of SIP were very good to excellent indicating that they all measure physical activity. The relationship between FSQ and SIP overall was also very good to excellent, indicating that FSQ also measures other dimensions than physical activity e.g. social activity as intended. The associations between HAQ and FSQ and the psychosocial dimension of SIP were moderate-to-good, indicating that HAQ and FSQ measure different aspects of activity limitation than the psychosocial dimension of SIP.

Study III
Construct validity of shoulder-arm movement instrument
Between shoulder-arm movement and the Ritchie index for upper-body half there was no significant relationship. The same was true for the relation to shoulder tendalgia.

Shoulder-arm movement correlated moderately-to-well with passive shoulder flexion (r=0.68) and external rotation (r=0.59). The relationships between shoulder-arm movement and passive shoulder extension, abduction and internal rotation were fair (r=0.42-0.43). Between shoulder-arm movement and passive shoulder adduction, and elbow flexion there were no significant relationships. Shoulder-arm movement correlated moderately-to-well with passive elbow extension, active supination and wrist motion range (r=0.58-0.66).

Table 4. Correlations (Spearman´s rank correlation coefficient) between shoulder-arm movement impairment, HAQ (Health Assessment Questionnaire), FSQ (Functional Status Questionnaire) and SIP (Sickness Impact Profile) (*** = p<0.001) (n=in brackets). Modified Table from Boström et. al.: Scand J Rheumatol 1995;24:352-359; with permission.

Variables	Shoulder-arm movement	HAQ	FSQ physical-social	SIP, physical	SIP, psycho-social	SIP overall
Shoulder-arm movement	–	-0.48*** (66)	0.48*** (61)	-0.53*** (64)	-0.20 (64)	-0.45*** (64)
HAQ	–	–	-0.81*** (61)	0.76*** (64)	0.53*** (64)	0.72*** (64)
FSQ	–	–	–	-0.79*** (59)	-0.57*** (59)	-0.81*** (59)

The relationships between motion range measurements

The associations between passive shoulder ROM indicated moderate-to-good (0.54-0.74) relationships between passive shoulder flexion on the one hand and extension, abduction, internal rotation and external rotation on the other. There was a moderate-to-good (r= 0.56) relationship between abduction and external rotation and between internal and external rotation (r=0.67), respectively. All the other relationships were fair (figures not presented) with the exception of that between adduction and abduction, which was non-significant.

The correlation between passive elbow extension and flexion was fair (r=0.46), and that between elbow extension and active supination was moderate-to-good (r=0.67). Between active elbow supination and active wrist dorsiflexion, there was also a moderate-to-good (r=0.60) correlation as with the correlation with active wrist volar flexion (r=0.64). The correlation between active wrist dorsiflexion and volar flexion was very good to excellent (r=0.81).

Regression analysis of different activity limitation and HRQL questionnaires

Multiple linear regression analysis indicated that limitations in shoulder-arm movements and in active wrist motion range explained approximately 30-35% of the variation among the patient's results within HAQ and the physical dimension of SIP. Shoulder-arm (about 11-24%) also indicated SDQ 1, 2 and FSQ while wrist volar flexion (about 19%) indicated the overall SIP. The Ritchie index for the upper-body half might be an indicator of activity limitation and HRQL especially for overall SIP, explaining approximately 6-28% of the variation within different questionnaires, while shoulder tendalgia explained approximately 24% of the variation in SDQ 3. Our model explained between approximately 11 and 30% of the variation among the patients' results within shoulder-arm activity limitation and 25-50% of the variation in the other more general activity-limitation and HRQL questionnaires studied (Table 5). Age, disease duration, ESR, number of swollen joints in the upper extremity, passive shoulder flexion, extension, abduction, internal and external rotation, elbow flexion and extension and active wrist

Table 5. Indicator variables for SDQ 1, 2, 3 (Shoulder-arm Disability questionnaire 1, 2, 3), HAQ (Health Assessment Questionnaire), FSQ (Functional Status Questionnaire), SIP (Sickness Impact Profile). (Ritchie index: Ritchie index upper-body half). Values presented are regression coefficient (b), standard error of b (SE(b)), adjusted R^2 (R^2), constant and total R^2 (n=60-63, missing values excluded listwise). Modified Table from Boström et. al.: Scand J Rehabmed 1997;29:223-232; with permission. [a]

Variables	SDQ 1	SDQ 2	SDQ 3	HAQ	FSQ-physical-social	SIP-physical	SIP-psycho-social	SIP-overall
	b (SE(b)) R^2	b (SE(b)) R^2	b (SE(b)) R^2	b (SE(b)) R^2	b (SE(b)) R^2	b (SE(b)) R^2	b (SE(b)) R^2	b (SE(b)) R^2
Tender joints:								
-Ritchie index			-1.09 (0.45) **6.2**	0.73 (0.24) **7.9**		0.40 (0.19) **6.8**	0.65 (0.21) **14.8**	0.57 (0.12) **28.1**
Shoulder:								
-tendalgia			-0.80 (0.25) **23.8**					
-pain-at-rest								0.15 (0.07) **3.4**
-pain-during movement					-24.80 (9.62) **6.9**			
-adduction				0.01 (0.005) **3.8**	-0.55 (0.19) **8.1**			
Elbow:								
-supination							0.01 (0.005) **5.1**	
Wrist:								
-volar flexion				-0.008 (0.004) **5.0**		-0.01 (0.003) **31.3**	-0.01 (0.004) **4.6**	-0.009 (0.002) **18.7**
Shoulder-arm movement	0.52 (0.12) **23.8**	0.36 (0.13) **11.3**		-0.22 (0.08) **24.5**	10.68 (2.72) **18.1**	-0.13 (0.06) **3.8**		
Constant*:*	-0.01	-0.03	1.35	-0.60	114.12	1.07	-0.30	0.88
Total R^2:	**23.8**	**11.3**	**30.0**	**41.2**	**33.1**	**41.9**	**24.5**	**50.2**

[a] The following variables were also included in the regression model: age, disease duration, ESR, number of swollen joints in the upper extremity, passive shoulder flexion, extension, abduction, internal rotation and external rotation, elbow flexion and extension and active wrist dorsiflexion but did not indicate activity limitation/health-related quality of life questionnaires.

dorsiflexion did not indicate the activity limitation and HRQL instruments.

Comment: The Ritchie index for upper-body half and shoulder tendalgia indicated SDQ 3 to 30% which adds more knowledge about the construct validity of the SDQ-model.

Study IV
Construct validity of shoulder-arm movement instrument
The relationship between shoulder-arm movement and isometric shoulder internal rotator muscular strength was moderate to good (r=0.53) and the correlation between shoulder-arm movement and isometric shoulder external rotation strength was fair (r=0.48). There were no significant correlations between shoulder-arm movement and isokinetic shoulder internal rotation muscular strength.

Construct validity of the SDQ model
The relationships between isometric and isokinetic shoulder rotational muscular strength and SDQ 1, 2 and 3 were not significant except for that between SDQ 1 and isokinetic eccentric shoulder internal rotation muscular strength, where it was moderate-to-good (r=0.65).

Correlations between shoulder rotational muscular strength variables
Correlations between isometric internal and isometric external shoulder rotational muscular strength were very good to excellent (r=0.78) and that between concentric and eccentric isokinetic shoulder internal rotation muscular strength was moderate to good (r=0.59). The other relationships between muscular strength variables were fair (r=0.36-0.42).

Correlations between shoulder rotational muscular strength and HAQ, FSQ and SIP
The relationships between muscular strength and HAQ, FSQ and SIP were not significant except for that between

isometric shoulder internal rotation and the physical dimension of SIP, where it was fair (r=-0.46).

Regression analysis of SDQ
In a follow-up (from Study III) regression analysis the shoulder rotational muscular strength variables were indicators only for SDQ and not for the general activity-limitation and HRQL questionnaires i.e. HAQ, FSQ or SIP. Therefore only SDQ was included in the regression analysis. About 61% of the variation among the results within SDQ 1 was explained by isokinetic eccentric shoulder internal rotation muscular strength, shoulder-arm movement and pain during shoulder-arm movement. About 25% of the variation within SDQ 2 was explained by isokinetic eccentric shoulder internal rotation muscular strength, shoulder-arm movement and shoulder-upper-arm pain-at-rest. For SDQ 3, the indicator variables were isokinetic eccentric shoulder internal rotation muscular strength, Ritchie index for upper-body half and shoulder tendalgia, together explaining about 42% (Table 6). Wrist volar flexion, isometric internal and external shoulder rotation muscular strength and isokinetic concentric shoulder internal rotation muscular strength did not indicate SDQ activity in this regression analysis model.

Comments: The regression model adds more knowledge about the construct validity of the SDQ-model.

Summary of the validity tests of the shoulder-arm movement instrument
The relationships between shoulder-arm movement impairment and the different variables in Studies II-IV are presented in Figure 4. In Study II indications of content (factorial) and construct validity and in Studies III-IV indications of construct validity for the shoulder-arm movement instrument are reported. Shoulder-arm movement did not correlate significantly to disease activity, SDQ 2 and 3 or the

psychosocial dimension of SIP. However, it did correlate to pain during shoulder-arm movement, passive shoulder motion range (except adduction), passive elbow extension, active elbow supination, active wrist motion and isometric shoulder rotational muscular strength. It also correlated to SDQ 1, HAQ, FSQ and the physical dimension of SIP and overall SIP.

Comments: The shoulder-arm movement impairment instrument has since been used by many physiotherapists among patients with RA (136). The physiotherapists' responses to the instruments' usefulness indicate face validity (see Discussion). It is also one of several instruments recommended for use in rheumatological physiotherapeutic rehabilitation of RA patients in Sweden (137).

The shoulder-arm movement impairment instrument has also been correlated to the part of SOFI (97) that measure upper extremity function. The relationship was moderate-to-good (Spearman's correlation coefficient r=-0.65, p<0.01, n=17 RA women mainly in functional class I-II (70), none of the 90 subjects presented in Table 1). In that same group of subjects, the relationship between the hand-to-neck movement in the shoulder-arm movement impairment instrument and the hand-to-neck movement in SOFI was very good to excellent (Spearman's correlation coefficient r=-0.88, p<0.01). Hand-to-seat movement did not correlate significantly to elbow supination in the SOFI instrument. The shoulder-arm movement impairment instrument correlated significantly to the total score of SOFI (r= -0.60, p<0.05).

Study V
Effects of shoulder rotational muscular endurance exercises on impairment level
The ANOVA results showed that the Group-x-Time interactions for the number of swollen joints in the upper extremity, pain during shoulder-arm movement, and pain during dynamic and static muscle function test of the shoulder, were not significant. However, the analysis revealed a significant improvement in both groups. *Post-hoc* contrasts showed that the patients had improved significantly in these variables after ten weeks of training. No statistically significant changes from ten to twenty weeks (non-training period) in these variables were demonstrated. No other significant changes were demonstrated through the ANOVA test (Table 7). There were no significant intra-group changes or inter-group differences in shoulder-arm pain-at-rest.

Figure 4.
Correlations (Pearson´s product moment or Spearman´s rank-order correlation coefficients) (indicating construct validity) between shoulder-arm movement impairment instrument and the variables in Studies II-IV (*=p<0.05, **=p<0.01, *** p<=0.001).
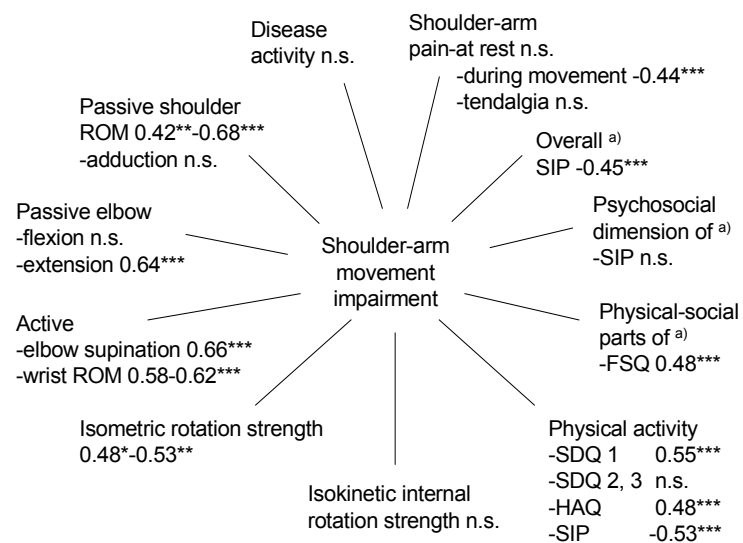[a) health-related quality of life]
n.s.= non significant

Table 6. Indicator variables for SDQ (Shoulder-arm Disability Questionnaire) 1, 2, 3. Values presented are regression coefficient (b), standard error of b (SE (b)), adjusted R^2 ($\mathbf{R^2}$), constant and total adjusted R^2 ($\mathbf{R^2}$) ($n = 32$).

Variables	SDQ 1[a] b (SE (b)) $\mathbf{R^2}$	SDQ 2[a] b (SE (b)) $\mathbf{R^2}$	SDQ 3 b (SE (b)) $\mathbf{R^2}$
Ritchie index for upper-body half			-2.5 (0.96) **0.217**
Shoulder:			
Occurrence of pain-at-rest		-2123.2 (1031.6) **0.063**	
Pain during movement	-151 (62) **0.168**		
Occurrence of tendalgia			-18.4 (8.4) **0.076**
Isokinetic internal rotation eccentric muscular strength	320 (65) **0.408**	223 (98.9) **0.125**	2.1 (0.76) **0.122**
Shoulder-arm movement [a]	3.2 (1.6) **0.038**	4.5 (2.3) **0.063**	
Constant	1225 (1336.8)	1498 (1673.4)	54 (13.2)
Total adjusted $\mathbf{R^2}$	**0.614**	**0.251**	**0.415**

[a] The variables are squared-transformed.

Effects of shoulder rotational muscular endurance exercises on activity limitation and HRQL

The Group-x-Time interactions for the physical dimension and overall SIP were significant. Tests for simple effects in the static training group showed that the physical dimension and overall SIP displayed no significant differences over time, but the dynamic training group did. *Post-hoc* contrasts showed that the dynamic training group had improved significantly in the same variables after ten weeks of training. No statistically significant changes from ten to twenty weeks (non-training period) were demonstrated. No other significant changes were demonstrated through the ANOVA test (Table 8). There were no significant intra-group changes or inter-group differences in the psychosocial dimension of SIP.

Patients' perceived problems, sleep disturbance, disease activity and satisfaction with health

There were no significant intra-group changes in either group or inter-group differences concerning perceived problems from the upper extremity and the neck, sleep disturbances due to shoulder-upper arm pain, or patients' opinions about disease activity and satisfaction with health (Table 9).

Table 7. Measurements at 0, 10 and 20 weeks. Medians and percentiles (25:e and 75:e) for the static and dynamic groups (no.=numbers; extr.=extremities; dynamic and static test=dynamic and static muscle function test). The mean of right and left shoulder were calculated in the variables shoulder-arm: pain at rest; static and dynamic test and muscle strength. . From Boström et. al.: Scand J Rheumatol 1998;27:281-90: with permission.

Variables	Static group			Dynamic group		
	0 weeks n=17	10 weeks n=17	20 weeks n=16	0 weeks n=20	10 weeks n=20	20 weeks n=18
Disease activity						
No. swollen upper extr. joints (0-30)	9.0 (5;14.5)	8.0 (4;10) *	5.0 (4.3;10.8)	10.0 (7.3;17.8)	6.5 (4.5;10.0) *	5.5 n=20 (3.8;12.5)
Ritchie index [2] upper-body half (0-42)	6.0 (3;9.5)	6.0 (4;10.5)	9.5 (3.5;12)	9.0 (5.3;12.5)	8.5 (6.3;11.0)	8.5 (5.3;13.0)
Shoulder-arm:						
-pain-at rest [1][2] (0-10)	1.5 (0;2.3)	0 (0;1.5)	0.4 (0;0.9)	0.6 n=18 (0;2)	0.5 (0;2)	0.3 n=17 (0;1.9)
-pain during movement [2] (0-50)	12.0 (5.9;14.8)	7.0 (4;12.3) *	8.5 (2.1;13.4)	15.5 n=19 (12.5;18)	10.3 (4.2;15.6) *	8.9 (2.4;16.8)
-movement [3] (5-30)	26.5 (22.3;28)	27.0 (24.5;28.8)	26.3 (22.8;28.6)	26.0 (23.1;28)	24.5 (20.6;28.4)	26.3 (21.5;28)
Shoulder:						
-dynamic test [2] (pain) (0-10)	3.0 (1.6;4)	1.5 (0.5;2.6) *	1.3 (0.3;3.2)	3.4 (1.8;3.9)	2.0 (1;3.7) *	2.5 (1.2;3.9)
-dynamic test (no. of flexions)	24.0 (18.3;29.5)	24.0 (19.8;29.8)	23.0 (18.3;35.1)	26.8 (13.3;35)	27.8 (16.6;36.1)	24.8 (16.4;33.6)
-static test [2] (pain) (0-10)	4.5 (3;7.8)	3.0 (2.3;4.9) *	3.3 (2;5.5)	3.3 (1.8;4.9)	3.0 (0.8;5.5) *	3.0 (0.8;5.5)
-static test [4] (exertion) (6-20)	15.0 (13.3;16)	15.0 (13.3;16)	14.5 (13;16)	14.8 (12.3;16.5)	14.8 (12.3;16.5)	13.0 (12;17)
-internal rotation strength (Nm)	10.8 n=16 (5.4;15.9)	9.0 (6.4;12.9)	10.0 (5.3;12.4)	9.7 n=18 (6.5;13.6)	12.1 n=19 (7.6;21.5)	7.9 n=17 (5.8;13.9)
-external rotation strength (Nm)	5.7 n=16 (3.1;8.9)	6.0 (5;7.8)	6.1 (4.3;7.7)	5.9 n=18 (3.1;7.7)	6.4 n=19 (3.3;10.5)	6.2 n=16 (3.6;8.6)

* Significant intra-group changes between 0 and 10 weeks in static and dynamic groups according to the analyses of variance.
[1] Variable shoulder-arm pain-at rest not included in the Analyses of Variance.
[2] The higher the value the worse the pain or tenderness.
[3] The higher the score the higher the ability.
[4] The higher the value the greater the exertion

Table 8. Measurements at 0, 10 and 20 weeks. Medians and percentiles (25:e and 75:e) for the static and dynamic groups. (SDQ 1, 2, 3=Shoulder-arm disability questionnaire factors 1, 2, 3; HAQ=Health Assessment Questionnaire; FSQ=Functional Status Questionnaire; SIP=Sickness Impact Profile). From Boström et. al.: Scand J Rheumatol 1998;27:281-90: with permission.

Variables	Static group			Dynamic group		
	0 weeks n=17	10 weeks n=17	20 weeks n=16	0 weeks n=20	10 weeks n=20	20 weeks n=18
SDQ 1 [2] (0-100)	76.1 (61.4;88.0)	85.6 (61.8;92.8)	85.6 (64.2;90.4)	73.7 (61.8;93.9)	80.9 (63.1;93.9)	83.3 (60.7;95.1)
SDQ 2 [2] (0-100)	74.9 (62.4;91.6)	83.3 (66.6;99.9)	83.3 (66.3;95.7)	74.9 (66.6;91.6)	74.9 (66.6;97.8)	91.6 (66.6;99.9)
SDQ 3 [2] (0-100)	66.6 (50.0;76.3)	74.9 (56.9;79.1)	66.6 (58.3;74.9)	58.3 (45.1;72.9)	66.6 (50.0;77.0)	66.6 (31.2;79.1)
HAQ [3] (0-3)	1.30 (0.94;1.38)	1.00 (0.88;1.44)	1.13 (0.91;1.47)	1.20 (0.88;1.50)	1.10 (0.50;1.30)	0.90 (0.60;1.90)
FSQ physical social [2] (0-100)	72.2 (62.7;80.1)	74.3 (67.8;79.4)	69.7 (67.2;76.2)	74.3 (58.4;82:3)	74.0 (52.5;88.1)	82.4 (45.9;92.4)
SIP physical [3] (0-100)	6.9 (3.3;19.7)	5.7 (2.8;11.7)	10.6 (3.7;17.2)	11.2 n=19 (2.2;20.2)	4.0 (1.7;13) **	2.9 (0;15.6)
SIP psycho-social [1] [3] (0-100)	4.7 (0;15.5)	2.1 (0;11.4)	5.8 (0.4;17.3)	4.1 n=19 (0;10.5)	0.96 (0;70)	1.9 (0;9.6)
SIP overall [3] (0-100)	8.4 (5.1;16.1)	7.6 (3.1;18.5)	11.0 (4.6;23.3)	8.7 (n=19) (5.5;15.9)	5.9 (2.5;14.7) **	5.7 (2.4;75.0)

** Significant intra-group changes between 0 and 10 weeks in dynamic group according to the analyses of variance

[1] Variable psycho-social dimension of SIP not included in the Analyses of Variance.

[2] The higher the score the higher the ability.

[3] The higher the score the lower the ability.

Diary notes about training

During the training period patients expressed opinions about the exercise load being too high or too low. Some also wanted to exercise without rests in between the 90 repetitions, and others had to rest more in order to reach 90 repetitions. Written diaries on the training occasions indicated that the average training frequency was twice a week in both groups. Reasons for not training three times a week included a feeling of increased disease activity and pain; illness not related to the disease or exercise programme; other daily routines, and vacations abroad.

Table 9. Numbers of patients (percentage) perceiving problems from upper extremity and neck, disturbances to sleep at night due to shoulder-upper arm pain, and perceived disease activity and dissatisfied with health at 0 weeks, and after 10 and 20 weeks in the static and dynamic groups. From Boström et. al.: Scand J Rheumatol 1998;27:281-90: with permission.

Variables	Static group			Dynamic group		
	0 weeks	10 weeks	20 weeks	0 weeks	10 weeks	20 weeks
Problems fingers/wrists	12 (80%) n=15	15 (94%) n=16	16 (100%) n=16	19 (95%) n=20	18 (95%) n=19	15 (83%) n=18
Problems elbows	9 (56%) n=16	10 (63%) n=16	7 (44%) n=16	15 (75%) n=20	10 (53%) n=19	10 (59%) n=17
Problems neck	10 (67%) n=15	11 (73%) n=15	10 (63%) n=16	12 (63%) n=19	10 (53%) n=19	9 (53%) n=17
Night sleep shoulder-upper arm pain	8 (53%) n=15	5 (36 %) n=14	4 (27%) n=15	15 (75%) n=20	7 (41%) n=17	8 (50%) n=16
Perceived disease activity	7 (41%) n=17	7 (41%) n=17	6 (38%) n=16	7 (35%) n=20	5 (26%) n=19	6 (33%) n=18
Dissatisfied health	9 (53%) n=17	8 (47%) n=17	9 (57%) n=16	12 (60%) n=20	8 (40%) n=20	11 (65%) n=17

GENERAL DISCUSSION

Physiotherapeutic exercises in RA have been evaluated in many studies and found beneficial. However, exercises for the shoulder and upper extremity *alone* have rarely been dealt with. To evaluate the exercises properly there is a great need for measurement tests of proven reliability and validity. Physiotherapists concerned with the rehabilitation of patients with rheumatic diseases in Sweden report a particular need for suitable outcome instruments (136). For trials of, mainly, relevant drugs there is international consensus on what tests to use – minimum core sets – which the European League Against Rheumatism (EULAR) presents as measures of: tender joints, swollen joints, joint pain, acute phase response, patient-assessed disease activity, function, assessor-assessed disease activity and radiography (114). Physiotherapeutic rehabilitation lacks such a consensus but it is hoped that one may develop through the intensive research of the past few years.

The studies in this thesis deal with evaluation of both specially-constructed and commonly used instruments measuring impairment, activity limitation and HRQL in RA with focus on shoulder and upper extremity. The relationships studied are those between instruments applying to impairment levels and activity limitation levels according to the ICIDH. The results show that movement, pain and muscle strength *are* related to activity-limitation but to a rather small extent; although the questionnaires used in the present analysis covered shoulder-arm activity limitation, disease-specific issues, more general activity limitation and HRQL. One concludes that all levels in the ICIDH model have to be measured if all consequences of the disease are to be understood. Evaluation of shoulder joint exercises also showed effects on

impairment and activity limitation levels and on HRQL.

The population in the studies

Our patients had rather low pain values. Shoulder-arm movement impairment was generally not extensive and the patients were not so influenced according to the activity limitation and HRQL questionnaires. The majority were in functional class I-II (70), having mild-to-moderate disease in a non-acute phase. Also, not all had their shoulders as their main problem. The results in our studies may have been influenced by more variation in disease activity and pain. However, as the majority of RA patients are classified in functional class I-II (71, 72), our results refer to the majority of patients. The patients were rather old but the disease is common among the elderly in Sweden (138). Our sample was also rather small and Studies II-V concerned women only: as there are indications that activity limitation has gender aspects in RA (139). Muscular strength also has gender aspects (e.g. 140) and maybe also other impairments do. The present results therefore concern *women* with RA.

Reliability

The reliability of instruments and/or measurement methods may be tested in many ways. Different coefficients can be calculated, e.g. intra-class correlation, variation coefficient and kappa coefficient. However, methods such as ROC curves and associated values are being used increasingly. At the start of our studies, percentage agreement was a rather common way to calculate reliability. Friedman's two-way analysis of variance by ranks was however not so common.

Stiffness and transient decreases in joint mobility vary diurnally in RA (141). To counter this the reliability tests could have been conducted differently. The assessors could have measured and assessed at the same time without seeing each other's protocols. For the test of the reliability of the shoulder-arm movement impairment instrument and of the dynamic shoulder muscle function test, the assessors could have used a video of patients doing the tests. However, we wished to find the day-to-day variation and the reliability in a clinical situation, hence our choice of method.

Shoulder-arm movement impairment instrument

The shoulder-arm movement impairment instrument constructed for this thesis showed satisfactory intra and inter-rater percentage agreement when one scale point of difference was allowed; i.e., to establish a clinical change after an intervention, the change must be greater than one scale point. In the first test-retest study the reliability of the shoulder-arm movement model was tested in a clinical situation where the physiotherapists had never used the instrument before. This is probably one reason why there were significant differences between the physiotherapists in assessing two of the movements. The other reason might be the day-to-day variation in joint mobility (e.g. 141). Although pain and HAQ did not change during the test week, active ROM did, which confirms the variation in joint mobility. In the second test-retest study when only the reliability of the shoulder-arm movement impairment model was tested and with only one day in between, reliability increased. However, base-line recordings seem indicated in treatment evaluation.

Reliability also depends on how many scale steps an instrument has: the fewer there are, the higher the reliability. However an instrument with detailed information and discriminative ability was wanted. The reliability of the SOFI upper-extremity part with three scale steps was considered satisfactory, with Spearman correlation coefficients between 0.77-0.91 (97). That the most frequently used scale

steps in the shoulder-arm movement impairment instrument were 3-6 indicates that the number of scale steps in the instrument may be decreased when used among patients with mild or moderate disease.

Active motion range

The clinical reliability of shoulder active motion range measurements was not satisfactory, probably due to day-to-day variation in joint mobility but also, although the physiotherapists were informed about body segment reference levels, to different ways of measuring, not analysed. Five degrees and 10° as used in our agreement calculations seem too little for reliable results. In measuring active motion range it is probably more reliable to measure threshold values important for ADL (142) than to measure according to the common method tested in this thesis. Some instruments in RA also include threshold values (98, 143) although their importance for ADL is unclear.

Dynamic muscle function test

The day-to-day variation and reliability of a specially designed dynamic shoulder muscle function test were also studied. Day-to-day variation is probably the reason for the low intra-rater reliability shown. This test probably also includes exercise effects of the number of hand-raisings. The patients may also have remembered their scores and tried to improve. The test was modified for evaluating shoulder joint exercises to make it more standardised.

Other instruments used in the studies

In the Ritchie index, the measurement of passive motion range and the test of tendalgia there is no indication of the external force applied by the assessor. Passive motion range is difficult to measure and in this thesis the motion ended when the patient said "stop", which might have increased reliability. In the test of swollen glenohumeral joint, it is probably impossible to palpate for synovial

thickening (55). However both sterno- and acromioclavicular joints are included in the number of swollen joints in the upper extremity, so the shoulder joint is represented. However, palpation of swollen joints is difficult and practice is necessary. The number of swollen joints and the Ritchie index were also modified in this thesis and the reliability of these modifications is unknown. The static shoulder muscle function test was not tested for reliability and for further use its reliability has to be tested. Measuring isokinetic muscular strength is reliable for the lower extremity in RA (e.g. 61). The SDQ has not been tested for reliability, and studies are needed here; but its scale technique and formula are almost the same as that of the FSQ, which does have satisfactory reliability (13). It is a common belief that the results of most tests and questionnaires depend on the patient's motivation and emotional status.

Validity

Validity is a wide concept, one of its dimensions being reliability. Most studies start with the analysis of *content* validity. *Criterion* validity is often the next validity test, which considers whether the instrument correlates highly with a "golden standard" measure of the same theme (34).

Shoulder-arm movement impairment instrument

For the present shoulder-arm movement impairment instrument, *factorial* validation showed that five shoulder-arm movements belonged to the same factor. *Face* validity was based on the experience of collaborating physiotherapists, the instrument having been used mainly among RA patients (e.g. 144, 145, 146) but also in other rheumatic diseases (e.g. 147). Some have used the instrument with patients in orthopaedic settings (e.g. 148). It has been used both for description and for evaluating interventions.

At the start of the present studies there was no "golden standard" for a functional shoulder-arm movement impairment instrument to compare with. *Construct* validity was therefore tested through correlation with other instruments, whereupon it was found to have concurrent and discriminative validity. In other words, it did *not* correlate to variables where it could be expected not to be related e.g. disease activity and psychosocial dimension of SIP. On the other hand it *did* correlate to other impairments and to all activity limitation (except the psychosocial dimension of SIP) and HRQL instruments used except for SDQ 2 and 3. Why it did not correlate significantly to SDQ 2 and 3, might be because these instruments probably reflect hand function and lower-extremity impairment variables besides pain and isokinetic shoulder internal rotation eccentric muscular strength. We also correlated the present shoulder-arm movement impairment instrument with the hand-to-neck, elbow supination and upper-extremity parts, and with the whole score of SOFI (97), another functional movement impairment instrument. As the correlation between the present shoulder-arm movement instrument and the upper-extremity part of SOFI is moderate-to-good and not very-good-to excellent, it seems that they measure different aspects of functional movement in the upper extremity. The SOFI test had one functional movement of the shoulder-arm and two of the elbow, while the shoulder-arm movement impairment instrument concentrates on shoulder-arm movements. However, since 1990 (6), wrist extension has been included in the upper-extremity part of SOFI, so that the differences between the instruments have maybe grown. Yet the hand-to-neck movement in both tests correlates very well to excellently and one can probably use either movement depending on one's purpose. Hand-to-seat in the shoulder-arm movement impairment instrument did not correlate significantly with elbow

supination in SOFI. However our results showed a moderate-to-good correlation between hand-to-seat and elbow supination. The reason for this is probably the different way of measuring elbow supination.

The SDQ
Factorial validity calculated on questions dealing with shoulder-arm activity showed that the questionnaire covered three major factors. These were divided into three instruments; SDQ1, 2 and 3. When further tested, each indicated construct validity. However, as the instruments seem to measure different aspects of activity limitation further studies are needed.

Other instruments used in the studies
Validity could of course be discussed more deeply for each instrument included in our studies. However, that was not one of our aims and information on validity is presented indirectly in the relationship analysis between impairment on one hand and activity limitation and HRQL on the other. Only some comments will be made here.

The Ritchie index for upper-body half did not correlate to ESR or the number of swollen joints in the upper extremity, indicating that these variables measure different aspects of disease activity. The Ritchie index for upper-body half and shoulder tendalgia, however, had a fair correlation. This indicates that both, to some extent, measure similar pain structures. Pain is difficult to measure and although the present studies focused on joint and muscle pain, motivational and emotional aspects may also play a role (54).

Since the relationships were not-very-good to excellent, our results suggest that, to get information from a joint structure, the physiotherapist must measure or assess all directions of the passive shoulder motion range and elbow flexion and extension.

As all patients managed the dynamic shoulder muscle function test it is probably possible to use it as an endurance test without time limits. Alternatively, one may measure the time the patient can perform a certain number of hand-raisings and then assess the pain. However, its measurement properties have to be further evaluated.

All the patients also managed the static shoulder-muscle function test, and we therefore suggest that this could be used as an endurance test without time limit, and maybe with weights at the wrists. The test needs further developing as its measurement properties have not been studied.

As the relationship between isometric shoulder internal rotational and external rotational muscular strength was very good to excellent it is possible to measure one of the directions and still get information on rotational strength. However, isokinetic concentric and eccentric shoulder internal rotational muscular strength both have to be measured, since they did not relate very-well-to-excellently to each other.

Sensitivity to change

Sensitivity to change may also be calculated in different ways. Some think that the change in raw score between two measurement times is enough. However, a common test is effect size, of which the basic measure is the raw score change for the measurement divided by the standard deviation of the measurement at the first measurement. Effect size depends on sample size: the larger the sample, the better the effect size (34). Another approach is to decide the percentage by which a given variable should change in order to be considered clinically important. Such levels have been suggested in evaluation of drugs in RA (149), where e.g. swollen and tender joints, pain and global assessments and patient-self-assessed activity limitation should have changed by 20% or more in order to be considered

clinically important. However, the patient's own view and/or satisfaction with the changes after an intervention must be of most interest in physiotherapeutic rehabilitation.

In the present case, sensitivity to change was evaluated only from raw scores as one of the aims was to elicit effects of exercises at different ICIDH levels. Sensitivity to change depends of course on what reasonable change the exercise method could attain, and on the severity of the disease in the population studied, i.e. patients with a problem sufficiently great to allow measurable improvement. It is also difficult to know whether failure to observe a change after interventions reflects an insensitive instrument or the absence of any change to observe. Sensitivity to change in physiotherapeutic exercises often concerns short-term evaluations as it is hard to keep the patients from changing medication during longer periods.

Shoulder-arm movement impairment instrument
One aim was to test the shoulder-arm movement impairment instrument for sensitivity to change after shoulder joint exercises. In the event, the movement impairment did not improve after the exercises but the assessment of pain in connection with the movements did. The reason for the lack of change in movement was probably that the patients had only small problems from their shoulder-arm region and that the exercise form chosen was thought to influence pain in the first place. In an earlier study by Boström et al (94) where shoulder-arm ROM exercises were included, the patients perceived that movement had improved and in an evaluation of shoulder-arm exercises by Mannerkorpi et al (95) this was in fact shown objectively in the hand-to-neck movement (right shoulder) and active abduction (left shoulder). Moreover the present shoulder-arm movement

impairment instrument has been used in two multidisciplinary rehabilitation programme studies in patients with RA (144, 145) and in one physiotherapeutic intervention study on patients with orthopaedic diagnosis in the shoulder (148). Here it showed sensitivity to change.

Dynamic and static muscle function tests

While there was no change after the exercise period in the number of hand-raising movements achieved, pain in connection with hand-raising decreased. In other words the pain part of the dynamic shoulder muscle function test might be sensitive to change.

We also evaluated the static shoulder muscle function test for sensitivity to change. Pain changed after shoulder joint exercises, indicating sensitivity to change. The time for which the arm could be held at 90° of abduction with a weight on the wrist has been used and found sensitive to change after shoulder-arm exercises in RA (95). However, 45° is probably more suitable as the majority of patients can abduct to that level.

Other functional muscle tests of the shoulder and upper extremity in RA have for example used the ability to lift weights between different levels (e.g. 80, 86) and some have proved sensitive to change after exercises (80).

Pain

Pain assessment is sensitive to change, which is in line with other studies evaluating physiotherapeutic exercises (e.g. 17). The results from the present studies, showed that pain during movement is sensitive to change, but not pain at rest as found in another study by the present author (94). Pain at rest and during movement probably measure different structures and aspects of pain, and it is therefore important to measure both.

Tender joints are considered sensitive to change in drug evaluations (114). However, the Ritchie index for the upper-body half was not sensitive to change in the present study. Others have used the Ritchie index as an outcome also and found no change after physiotherapeutic exercises (e.g. 83, 85).

Swollen joints

Swollen joints are sensitive to change, as shown in drug evaluations (114). Although only the number of swollen joints in the upper extremity was counted, the number was sensitive to change in the present exercise evaluation. Others have found similiar results after exercise interventions (81, 83).

Isometric muscular strength

Isometric shoulder rotational muscular strength did not change after exercise, indicating no sensitivity to change. The probable reason for this is that muscle endurance and not muscle strength was exercised.

SDQ

The SDQ instruments were not sensitive to change after shoulder-arm exercises, probably because SDQ comprises too few activities. Further SDQ 2 and 3 are probably not sensitive enough for shoulder-arm impairments as they include activities where probably also hand function and lower-extremity function is important. Mannerkorpi et al (95) also evaluated activities after shoulder-arm exercises and asked about patients' ability to comb their hair, put on a sweater and take down a cup from a shelf. Though an index of these activities was made for each arm, no changes after exercise were shown. Further studies are needed concerning the sensitivity to change of questionnaires for shoulder-arm in RA.

HAQ and FSQ

HAQ did not change after shoulder-joint exercises, indicating no sensitivity to

change. This is in line with other evaluations of physiotherapeutic interventions (e.g. 18, 85). FSQ was not sensitive to change after shoulder joint exercises either. The sensitivity to change of parts of FSQ that we used in our studies is questioned by Söderback et al (132) evaluating patients with low-back pain. Further studies are needed on the sensitivity of this instrument.

SIP

The physical dimension and overall SIP seem sensitive to change after shoulder joint exercises. As SIP covers many items, changes are probably easier to detect than in the other activity limitation instruments. However, others have suggested that SIP is not suitable for evaluating shoulder problems (150).

The psychosocial dimension of SIP was not influenced by shoulder exercise, one reason being that the patients were not so affected in this dimension covered by SIP. Another reason is that the patients exercised individually and therefore had no direct influence from others.

Problems in upper extremity, sleep disturbance, perceived disease activity and health

No significant change was found in these single questions, indicating that they were not sensitive to change. The results are in line with an earlier exercise study concerning problems from upper extremity and sleep disturbance (95). As the majority of our patients were in a non-acute phase of their disease, it maybe was not reasonable to expect changes following shoulder exercise, nor to believe that shoulder exercise during a rather short intervention period improve patient's satisfaction with health, either.

The ICIDH-model and the relationships between impairment and activity limitation/HRQL

We used the ICIDH model when classifying tests and instruments and analysing relationships. However the instruments used in this thesis were not always easy to classify according to ICIDH. For example, pain is categorised as impairment but includes many dimensions. Functional limitation can be classified under both impairment and activity limitation depending on the purpose of the instrument and how it describes the item. Activity limitation questionnaires include not only activities but also impairments and handicaps. The instruments used were classified as measuring *mainly* at a certain level. SIP overall also measures HRQL according to the definition chosen in this thesis (27).

The relationships between impairment on one hand and activity limitation and HRQL on the other depend partly on the severity of the disease, partly on threshold values important for activity limitation (142, 151), and probably also on motivational, emotional (54, 134) and coping factors (15, 16, 52).

Movement

The relationships between shoulder-arm movement impairment and activity limitation/HRQL were for the majority of the comparisons fair-to-moderate to good and this impairment indicated SDQ 1 and 2, HAQ, FSQ and the physical dimension of SIP. Triffitt (152) also found fair-to-moderate to good relationships between active shoulder motion range and shoulder-arm activities such as combing hair, putting on a coat, washing back and contralateral armpit and using toilet in patients visiting a shoulder clinic.

As the passive shoulder motion ranges, except adduction, and passive elbow flexion and extension, indicated none of the activity limitation questionnaires or

HRQL, it seems unnecessary to measure passive motion range, unless this is goal-related or, in joint examination, for diagnosis. Passive adduction might be a measure of pain from joint compression and that is probably why it indicated HAQ and parts of FSQ although to a very low level. Triffitt (152) also found little-to-fair relationships between passive shoulder external rotation in adduction and the shoulder-arm activities mentioned above in patients visiting a shoulder clinic.

Active elbow supination and wrist volar flexion were the only motion ranges that indicated the psychosocial dimension of SIP. However the indication was low, probably because our patients were not so affected in this dimension. Hakala et al (105) found no relationships between functional movements for upper extremity (Keitel index) and anxiety and depression, and he suggests that movement impairment in RA does not usually entail anxiety or depression unless the restriction is severe.

Wrist volar flexion indicated both HAQ and SIP but probably also dorsiflexion did, as a common problem with stepwise regression models is that if two variables correlate strongly with each other, then when one of them is chosen at an early stage in the regression, the other will drop in predictive (indicating) power and may not be included in the model.

In osteoarthritis patients the relationships between motion range in the upper extremity and the categories in HAQ measuring upper-extremity activities are none to little-to-moderate to good. The highest correlation (0.57) found was in the hygiene activities (153). In conclusion, it seems that the relationship between active movement impairment in shoulder and upper extremity and activity limitation questionnaires/HRQL is in average rather low.

Aspects of disease activity and pain
The number of swollen joints in the upper extremity may not be the first outcome if the goal of treatment and training is lessened activity limitation and improved HRQL, as there was no relationship between swollen joints and these aspects. However, others (e.g. 15, 16) have shown relationships between swollen joints and activity limitation/HRQL and our results may be affected by the fact that the patients had mild or moderate RA.

Although only the upper-body half of the Ritchie index was used it indicated, however weakly, several activity limitation/HRQL questionnaires, which is in line with other studies (e.g. 15, 16). Among our indicating variables it was also the strongest indicator of the psychosocial dimension of SIP.

Shoulder tendalgia indicated SDQ 3 but no other activity limitation/HRQL questionnaires. The probable reason for the relationship with SDQ 3 is that the activities involved lifting, carrying, pouring and tying.

Muscular strength
Isometric shoulder rotational strength is probably not a suitable outcome variable if the goal of physiotherapeutic exercises is to decrease activity limitation and improve HRQL. On the other hand isometric shoulder internal rotation muscular strength correlated to the physical part of SIP and other researchers have also found relationships between grip strength (4, 105, 107) and elbow muscular strength, the latter in combination with knee strength on one hand and HAQ on the other (106). The relationships between shoulder rotational isometric muscular strength and activity limitation/HRQL may depend on threshold levels of muscular strength, as suggested by some authors (e.g. 151). Another reason why isometric strength did not contribute to the explanation of activity is that daily activities are most commonly performed at

several joint angles, not at one single angle. To plan and evaluate optimal exercises, isometric strength should be measured at different angles as suggested by some authors (e.g. 25).

Isokinetic eccentric shoulder internal rotation muscular strength indicated SDQ 1, SDQ 2 and SDQ 3 (weakly in the case of the latter two) but had no or little-to-fair, non-significant correlations to the other activity limitation/HRQL questionnaire except for the relationships to physical SIP, which were fair and significant. Isokinetic eccentric shoulder internal rotation strength explains a rather large part of SDQ 1, indicating that exercise of these muscles might be fruitful for improving personal hygiene activities. A reservation might be that eccentric contractions involve a risk of rotator cuff injury or shoulder subluxation (129). As measurement is possible it is probably also possible to exercise shoulder muscles but this needs to be performed with skill, for example in the way we measured the patients in this thesis.

Threshold levels might also explain the low correlation between isokinetic concentric muscular strength and the activity limitation/HRQL, except that eccentric contractions probably also stress the tendons and their insertions more than concentric contractions do, which might be the reason why eccentric contractions indicated SDQ.

Combinations of impairments in the shoulder and upper extremity indicating activity limitation and HRQL
Shoulder-arm movement and volar flexion together explained approximately 30-35% of the HAQ and the physical dimension of SIP. The shoulder-arm movements and pain during shoulder-arm movements indicated FSQ to approximately 25%. The Ritchie index for upper body half, shoulder-arm movement and/or wrist motion range indicated HAQ and SIP to

between 20-47%. Isokinetic eccentric shoulder internal rotation muscular strength, shoulder-arm movement and pain indicated SDQ 1 to 61% and SDQ 2 to 25%. Isokinetic eccentric shoulder internal rotation muscular strength and pain indicated SDQ 3 to approximately 42%. The variation in the different activity limitation/HRQL questionnaires could be better explained if several variables were combined. Still, there is much left to explain and, in addition, lower-extremity function and hand function, motivational, emotional, and coping factors may influence these relationships (15, 16, 52, 54, 134).

Activity limitation and HRQL-questionnaires and their sensitivity to reflect impairments
As the activity limitation and HRQL instruments used not only include upper-but also lower-extremity function in ADL and hand function, this reduces the sensitivity of the instruments with regard to the impact of shoulder, elbow and wrist movement impairment.

SDQ
The SDQ seems to measure different aspects of activity limitation. SDQ 1 reflected shoulder and upper-extremity variables to a rather large extent. SDQ 2 also reflected shoulder and upper-extremity variables but much less. SDQ 3 reflected shoulder and upper-extremity variables to a higher extent than SD2. Of the three SDQ instruments it seems that SDQ1 is the most sensitive for reflecting shoulder and upper-extremity impairment and this is recommended for further use and development.

HAQ and FSQ
HAQ reflected to some extent shoulder and upper-extremity variables and also FSQ but somewhat less so.

SIP
The physical part of SIP and overall SIP reflected shoulder and upper extremity variables to a rather large extent. However, the psychosocial dimension of SIP reflected shoulder and upper extremity variables only to a small extent.

Over the years, RA-specific instruments measuring HRQL, for example the SIP-RA (154) which is a shorter version of the SIP have been more and more used. The Arthritis Impact Measurement Scale, AIMS has been translated into Swedish (155) and one of its part scales of interest for the shoulder-arm region. Hakala et al (105) showed that the shoulder component in the Keitel index is related to AIMS.

Regression analysis
The results of regression analyses searching for indicating variables depend on the sample size but also on what dependent variables there are. With the impairment variables pain, movement and muscular strength in focus; the variables hand function, grip strength, elbow function, lower-extremity function, pain in other joints than shoulder-upper arm probably also correlate to the instruments of activity limitation and HRQL treated in this thesis. In further analysis, shoulder-arm impairments and the above-mentioned impairments should be studied in the same regression analysis.

Shoulder joint exercises and the effects on impairment and activity limitation/HRQL

Exercise method
The patients only exercised twice a week while according to training therapy (38) 4-5 times a week is necessary if joint pain is to be influenced. The results may have been somewhat better if the patients had exercised more frequently. On the other hand they did not have much pain, which might have influenced their compliance and hence the possibility of improving. Stenström et al (80) has shown that

exercising despite pain is effective and it might be that, up to a certain threshold, the more pain the patient have the more motivated to exercises she may be. In the present study both shoulders were exercised even if the problems in one were only mild. Had the patients exercised only the painful shoulder, the results may have differed somewhat as our earlier study (94) where only the painful shoulder was exercised: pain at rest was less and muscular strength improved.

Thirty percent of maximum isometric muscular strength as a load was probably too low to influence isometric muscular strength. On the other hand endurance exercises influence muscular endurance in the first place (156, 157). As our exercise load was low the exercises should have influenced endurance although exactly at which level of maximal isometric muscular strength, endurance and not isometric strength is influenced is uncertain.

Four seconds of dynamic contraction was chosen because we considered this would give an acceptable velocity (around 30-35°/s) for a movement sequence. No recommendations for duration of contractions in isotonic muscular endurance training have been found in the literature although for isometric contraction 6s often is mentioned. However, exercises with higher velocity are maybe more strongly indicated to minimise the muscle atrophy which takes place primarily in fast-twitch fibres in RA (49).

For this experimental form of exercise it was necessary to exercise at a physiotherapy department even though the frequency of the exercise sessions might have been greater had the patients been able to train at home. However, compliance as regards the contraction time and the number of contractions was probably greater with the specially-designed apparatus.

Evaluation methods

When evaluating shoulder rotational muscular endurance, evaluating static and dynamic muscular endurance might have been obvious, for the training is most efficient for the same type of training as the exercises (156, 157). However, no such test had been tested and evaluated on patients with RA and shoulder-arm problems when the present work started. For this reason the established method of isometric muscular strength measurements was used, although it was not likely that changes would occur. The patients also did submaximal tests (dynamic and static muscle function test of shoulder) and were stopped after one minute and three minutes, respectively, in order not to provoke pain.

Non-training period

The reason why our patients kept their improved values in several variables after the training period (non-training period) was over might be that they continued to exercise in one way or another outside our control. They might also during exercise have found that training was a way to cope with the disease, as reported in other studies (158). This might have a positive effect as much as ten weeks after the training finished. Although there were no statistical differences in cortisone injections between the two groups, this might still have influenced the results.

Effects of shoulder exercises on impairment and activity limitation level/HRQL

Despite the rather small study population mildly or moderately affected, with exercise on average only twice a week, our results indicate that shoulder rotator muscular endurance training influenced aspects of disease activity and impairment. The dynamic group also showed the influence of aspects of activity limitation and health-related quality of life. In other words, exercise at impairment level improved variables at impairment level and

aspects of disease activity. However, effects at activity level/HRQL were also shown. Physical and overall SIP improved only with dynamic training, probably as everyday activities consist mostly of dynamic movements, and therefore the absence of changes in the static group was not surprising. As the dynamic endurance contraction was at a rather low velocity, the major difference to isometric contraction was that it was performed during movement.

The reason why training could reduce pain in both groups might be the relationships between pain, training, and the levels of various neuropeptides (90). In rats, pain control systems become more active in long-lasting muscle exercises (159) and during submaximal exercises (160). Regular exercises also decreases sensitivity to pain (160). The training in our study was rather long-lasting, at submaximal loads, and rather regular. Another reason for reduced pain might be that RA patients experienced that they could control their pain after training (80) and/or perhaps the fewer swollen joints increases the ability to perform movements without pain. The reason why the number of swollen joints decreased might be that exercise lowers synovial volume by increasing lymph flow, as suggested by some (161).

The reasons why patients' opinions of their disease activity and satisfaction with health did not change might be that the decrease in the number of swollen joints and in shoulder-arm pain was small. The relationship between "objective" assessment of swollen and tender joints and "subjective" assessed general health is reportedly weak (162). One reason for this discrepancy might be uncertainty as to what the patient means by disease activity and health.

What does the improvement in physical and overall SIP mean in terms of satisfaction with health for the individual

patient? Some observers have suggested that patients' perceptions of their actual ability are related to their mental and general health perceptions (163), others ascribe them to their attitude to illness (164). The relationships between perception of activity limitation and HRQL and perception of satisfaction with health seem complex. Thus both have to be measured. Examination of these relationships is needed, and in a current interview study patients' perceptions of their disease, its treatment, rehabilitation and exercise are being examined.

GENERAL SUMMARY AND CONCLUSIONS

-Measurement of active shoulder motion range showed low clinical reliability, while day-to-day variation was probably large.

- A specially constructed model for assessment of shoulder-arm movement impairment showed satisfactory reliability although, here also, day-to-day motion range variation seemed large and base-line recordings seem indicated. For a clinical change after an intervention to be established, the change must be greater than one scale point. The model instrument was considered to have content and construct validity. Although not sensitive to change in the exercise study on movement, it was sensitive concerning the associated pain assessment.

- Day-to-day variation was also probably large in a test specially constructed and tested to assess the reliability of dynamic shoulder-muscle function. However, a modified version of this test, and a static muscle function test of the shoulder, were sensitive to change concerning pain in connection with the tests.

- Factor analysis showed that a special questionnaire for measuring shoulder-arm activity limitation showed three themes

and three different instruments were therefore constructed: shoulder-arm disability questionnaire (SDQ) 1, 2 and 3. Our results indicate construct validity for the SDQ: SDQ 1 reflected shoulder and upper extremity variables to a rather large extent. SDQ 2 and 3 probably reflect hand and lower-extremity function as well, which reduces the sensitivity of the instruments with regard to shoulder, elbow and wrist impairment. The SDQ 1, 2 and 3 was not sensitive to change after shoulder exercises.

- The variables number of swollen joints in upper extremity, passive shoulder (except adduction) and elbow motion range and isometric and isokinetic (concentric internal rotation) shoulder rotational muscular strength did not indicate activity limitation or health-related quality of life (HRQL). However, the variables pain (including Ritchie index for upper-body half and shoulder tendalgia), passive shoulder adduction, shoulder-arm movement, active elbow supination and wrist motion, and shoulder isokinetic eccentric internal rotation muscular strength did indicate activity limitation and HRQL.

- Combining the variables shoulder-arm movement, pain and isokinetic eccentric shoulder internal rotation muscular strength explained a rather large proportion (61%) of SDQ 1 and 25% of SDQ 2. Isokinetic eccentric shoulder internal rotation muscular strength and pain variables indicated SDQ 3 to approximately 42%. Limitations in shoulder-arm movement and active wrist motion range explained 30-35% of the variation among the patient's results within each of the physical activity limitation questionnaires (HAQ and the physical dimension of SIP) used. Shoulder-arm movement and pain indicated the physical and social activity parts of FSQ to approximately 25%. Pain variables, shoulder-arm movement and/or wrist

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motion range indicated HAQ, FSQ and physical and overall SIP to between 33-50%.

- Static and dynamic shoulder rotator endurance training reduced both the number of swollen joints in the upper extremity and pain during movement, and it seems that either exercise form can improve aspects of disease activity and impairment. However, to lessen activity limitation and improve HRQL, dynamic exercise seems to be importance.

- The results presented in this thesis show that movement, pain and muscular strength are related to activity limitation and HRQL but to a rather small extent, even though the questionnaires covered shoulder-arm limitation, disease-specific and more general activity limitation and HRQL. Still there is much left to explain and, moreover, hand function, lower-extremity function, threshold values, disease severity, motivational, emotional, and coping factors may influence these relationships.

- Lastly it is concluded that all levels in the ICIDH model have to be measured if all consequences of RA are to be understood. Evaluation of shoulder joint exercises at impairment level showed effects on aspects of disease activity, impairment and activity limitation levels and on HRQL. However perceived satisfaction with health did not improve, for which reason the relationships between the different levels in the ICIDH-model and health have to be studied further.

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REFERENCES

1 Nisell R, Lundeberg T. Smärta och inflammation. Fysiologi och terapi vid smärttillstånd i rörelseorganen. Studentlitteratur Lund 1999

2 Eberhardt KB, Fex E. Functional impairment and disability in early rheumatoid arthritis – development over 5 years. J Rheumatol 1995, 22; 1037-42

3 Ekdahl C, Broman G. Muscle strength, endurance and aerobic capacity in rheumatoid arthritis : a comparative study with healthy subjects. Annals of the Rheumatic Diseases. 1992, 51(1); 35-40

4 Ekdahl C, Eberhardt R, Andersson SI, Svensson B. Assessing disability in patients with rheumatoid arthritis . Use of a swedish version of the Stanford Health Assessment questionnaire. Scand J Rheumatol 1988, 17(4); 263-71

5 Ahlmén EM, Bengtsson CB, Sullivan BM, Bjelle A. A comparison of overall health between patients with rheumatoid arthritis and a population with and without rheumatoid arthritis . Scand J Rheumatol 1990, 19; 413-21

6 Eberhardt KB, Rydgren LC, Pettersson H, Wollheim FA. Early rheumatoid arthritis – onset, course and outcome over 2 years. Rheumatol Int 1990, 10; 135-42

7 Laine VAI, Vainio KJ, Pekanmaki K. Shoulder affections in rheumatoid arthritis. Ann Rheum Dis 1954; 157-60

8 Petersson CJ. Painful shoulders in patients with rheumatoid arthritis. Scand J Rheumatol 1986, 15; 275-9

9 Bjelle A. Epidemiology of shoulder problems. Baillière's Clinical Rheumatology. 1989, 3 (3); 437-51

10 International classification of impairments, disabilities and handicaps. A manual of classification relating to the consequences of disease. World Health Organization, Geneva 1980

11 ICIDH-2: International classification of impairments, activities and participation. A manual of dimensions of disablement and functioning. Beta-1 draft for field trials. World Health Organization, Geneva 1997

12 Fries JF. The assessment of disability: from first to future disability. British J Rheum 1983, 22(suppl); 48-58

13 Jette AM, Davies AR, Cleary PD, Calkins DR, Rubenstein LV, Fink A, Kosecoff J, Young RT, Brook RH, Delbanco TL.The Functional Status Questionnaire. Reliability and validity when used in primary care. Journal of General International Medicine. 1986, 1; 143-49

14 Bergner M, Bobbitt RA, Carter WB, Gilson BS. The Sickness Impact Profile: Development and final version of a health status measure. Med Care 1981, 19; 787-805

15 Ramey DR, Raynauld JP, Fries JF. The Health Assessment Questionnaire 1992. Status and review. Arthritis Care and Research 1992, 5 (3); 119-29

16 De Bruin AF, De Witte LP, Stevens F, Diederiks JPM. Sickness Impact Profile: The state of the art of a generic functional status measure. Soc Sci Med 1992, 35 (8); 1003-14

17 Stenström CH. Therapeutic exercise in rheumatoid arthritis. Arthritis Care and Research 1994, 7 (4); 190-7

18 van den Ende CHM. Exercise Therapy in rheumatoid arthritis. Dissertation. Leiden 1997

19 Minor MA, Sanford MK. The role of physical therapy and physical modalities in pain management. Rheumatic disease clinics in North America 1999, 25 (1); 233-48

20 ICIDH-2: International classification of functioning and disability. Beta-2 Draft Full Version. Geneva, World Health Organization, 1999

21 Nagi SZ. Disability concepts revisited: Implications for prevention. In Disability in America: Toward a National Agenda for prevention. (Edited by Pope AM and Tarlov AR), 309-27. Division of Health Promotion and Disease prevention, Institute of Medicine. National Academy Press, Washington DC 1991

22 Jette AM. Disentangling the process of disablement. Soc Sci Med 1999, 48; 471-2

23 Verbrugge LM, Jette AM. The disablement process. Soc Sci Med 1994, 38 (1); 1-14

24 Pörn I. An Equilibrium model of health in Nordenfelt and Lindahl, BIB (eds). Health, disease and causal explanations in medicine. D. Reidel Publishing Company 1984; 3-9

25 Tyni-Lenné R. Fysioterapins kunskapsområde 82 – 98 i Vetenskaplig utveckling av sjukgymnastik. Internordiskt symposium Göteborg 12 – 14 okt 1987, Vårdhögskolan i Göteborg FoU rapport 1 1998

26 Lundström L. Conditions for acting. A theoretical discussion. Nordisk Fysioterapi 1998, 2; 37-40

27 Anderson RT, Aaronson NK, Wilkin D. Critical review of the international assessment of health-related quality of life. Quality of Life Research 1993, 2; 369-95

28 Description of Physical Therapy adopted by the 14 th General meeting of World Confederation for Physical Therapy, WCPT 1999; 1-9

29 Hislop HJ. The not-so impossible dream. Physical Therapy 1975, 55 (10); 1069-80

30 Carr J, Shepherd R, Gordon J, Gentile AM, Held JM, editors. Movement science. Foundations for physical therapy in rehabilitation. London: Heinemann Physiotherapy, 1987

31 Cott CA, Finch E, Gasner D, Yoshida K, Thomas SG, Verrier MC. The movement continuum theory of physical therapy. Physiotherapy Canada 1995, 47 (2); 87-95

32 Hoppenfeld S. Physical examination of the spine and extremities. Appleton – Century – Crofts, New York 1976

33 Brodin H. Fysioterapi I. Studentlitteratur

34 McDowell I, Newell C. Measuring health. A guide to rating scales and questionnaires. Oxford University Press, New York Oxford 1996

35 IASP. Classification of chronic pain. Descriptions of chronic pain syndromes and definitions of pain terms. Editors: Merskey H, Bogduk N. IASP Press, Seattle 1994

36 Brodin H, Moritz O. Fysioterapi II. Studentlitteratur. Lund 1976

37 DeLateur BJ. Therapeutic exercise to develop strength and endurance, 427- 64 in Krusen´s handbook of physical medicine and rehabilitation. (Edited by Kottke, Stillwell, Lehmann).

38 Gustavsen R, Streeck R. Training therapy. Prophylaxis and rehabilitation. 2. rev. ed. Stuttgart: Georg Thieme Verlag 1993

39 Arvidsson I, Eriksson E, Knutsson E, Arnér S. Reduction of pain inhibition on voluntary muscle activation by epidural analgesia. Orthopedics 1986, 9 (10); 1415-19

40 Broberg C. Sjukgymnastik och klassifikation. Rapport från ett projekt och förslag till terminologi för sjukgymnastik. Legitimerade sjukgymnasters riksförbund. Nordisk Bokindustri 1997

41 Engström-Laurent A, Leden J, Nived O, Slurfelt G. Reumatologi. Almqvist & Wiksell Medicin, Stockholm 1994

42 Rasker JJ, Cosh JA. The natural history of rheumatoid arthritis over 20 years. Clinical symptoms, radiological signs, treatment, mortality and prognostic significance of early features. Clin Rheumatol 1987, 6 (2 Suppl); 5-11

56

43 Pincus T, Callahan LF, Vaughn WK. Questionnaire, walking time and button test measures of functional capacity as predictive markers for mortality on rheumatoid arthritis. J Rheumatol 1987, 14; 240-51

44 Hochberg MC. Epidemiology of rheumatoid arthritis in developed countries. J Rheumatol 1983, 10 (suppl 10); 7-9

45 Kirwan JR, Silman AJ. Epidemiological, sociological and environmental aspects of rheumatoid arthritis and ostearthrosis. Baillière's Clin Rheumatol 1987, 1; 7-9

46 Isomäki H. Epidemiologisk och socialmedicinsk betydelse av reumatoid artrit. Nordisk medicin 1989, 104;173-5

47 Pincus T, Callahan LF. Reassessment of twelve traditional paradigms concerning the diagnosis, prevalence, morbidity and mortality of rheumatoid arthritis. Scand J Rheumatol 1989, suppl 79; 67-95

48 Arnett FC, Edworthy SM, Bloch DA, McShane DJ, Fries JF, Cooper NS, Healey LA, Kaplan SR, Liang MH, Luthra HS, Medsger Jr TA, Mitchell DM, Neustadt DH, Pinals RS, Schaller JG, Sharp JT, Wilder RL, Hunder GG. The American Rheumatism Association 1987 revised criteria for classification of rheumatoid arthritis. Arthritis Rheum 1988, 31; 315-24

49 Edström L, Nordemar R. Differential changes in type I and II muscle fibres in rheumatoid arthritis. A biopsy study. Scand J Rheumatol 1974, 3; 155-60

50 Stokes M, Young A. The contribution of reflex inhibition to arthrogenous muscle weakness. Clin Sci 1984, 67; 7-14

51 Danneskiold-Samsøe B. Muscle function in women with rheumatoid arthritis: the influence of glucocorticosteroids. A clinical and morphological investigation. Dissertation. University of Copenhagen, Copenhagen, Denmark 1987

52 van Lankveld W, Näring G, van der Staak C, van´t Pad Bosch P, van de Putte L. Stress caused by rheumatoid arthritis : relation among subjective stressors of the disease, disease status and wellbeing. J Behav Med 1993,16;309-21

53 Stenström CH, Lindell B, Swanberg E, Harms-Ringdahl K, Nordemar R. Functional and psychosocial consequences of disease and experience of pain and exertion in a group of rheumatic patients considered for active training. Scand J Rheumatol 1990, 19; 374-82

54 Leibing E, Pfingsten M, Bartmann U, Rueger U, Schuessler G. Cognitive behavioral treatment in unselected rheumatoid arthritis out-patients. Clin J Pain 1999, 15 (1); 58-66

55 Ennevaara K. Painful shoulder joint in rheumatoid arthritis. Acta Rheumatologica Scandinavica 1967, 11 (Suppl)

56 Gibson KR. Rheumatoid arthritis of the shoulder. Physical Therapy 1986, 66; 1920-9

57 Brattström M. Ledskydd och rehabilitering vid inflammatorisk ledsjukdom. Studentlitteratur Lund 1980

58 Amis AA, Hughes SJ, Miller JH, Wright V. A functional study of the rheumatoid elbow. Rheumatology and rehabilitation 1982, 21; 151-7

59 Ekblom B, Lövgren O, Alderin M, Fridström M, Sätterström G. Physical performance in patients with rheumatoid arthritis. Scand J Rheumatol 1974, 3; 121-5

60 Nordesjö L-O, Nordgren B, Wigren A, Kolstad K. Isometric strength and endurance in patients with severe rheumatoid arthritis or osteoarthrosis in the knee joints. Scand J Rheumatol 1983, 12; 152-6

61 Danneskiold- Samsøe B, Grimby G. Isokinetic and isometric muscle strength in patients with rheumatoid arthritis: The relationship to clinical parameters and the influence of corticosteroid. Clin Rheumatol 1986, 5; 459-67

62 Hsieh LF, Didenko B, Schumacher Jr R. Isokinetic and isometric testing of knee musculature in patients with rheumatoid arthritis with mild knee involvement. Arch Phys Med Rehabil 1987, 68; 294-7

63 Tiselius P. Studies on joint temperature, joint stiffness and muscle weakness in rheumatoid arthritis: an experimental and clinical investigation. Acta Rheumatol Scand 1969, (Suppl 14); 70-98

64 Häkkinen A, Hannonen P, Häkkinen K. Muscle strength in healthy people and in patients suffering from recent onset inflammatory arthritis. Br J Rheumatol 1995, 34; 355-60

65 Beals CA, Lampman RM, Banwell BF, Braunstein EM, Albers JW, Castor CW. Measurement of exercise tolerance in patients with rheumatoid arthritis and osteoarthritis. J Rheumatol 1985, 12; 458-61

66 Shklar A, Dvir Z, Isokinetic strength relationships in shoulder muscles. Clin Biomech 1995, 10;369-73

67 Alderink GJ, Kuck DJ. Isokinetic shoulder strength of high school and college –aged pitchers. J Orthop Sport Phys Ther 1986, 7; 163-72

68 Neer CS. The rheumatoid shoulder in: Cruess M, ed. Surgery of rheumatoid arthritis. Philadephia: Lippincott 1971; 117-25

69 Jonsson E, Brattström M, Lidgren L. Evaluation of the rheumatoid shoulder function after hemiarthroplasty and arthrodesis. Scand J Rheumatol 1988, 17; 17-26

70 Steinbrocker O, Traeger CH, Batterman RC. Therapeutic criteria in rheumatoid arthritis. JAMA 1949, 140; 659-62

71 Allander E. A population survey of rheumatoid arthritis. Acta Rheumatol Scand 1970 (Suppl 15)

72 Hakala M, Nieminen P. Functional status assessment of physical impairment in a community based population with rheumatoid arthritis: Severely incapacitated patient are rare. J Rheumatol 1996, 23; 617-23

73 Guillemin F, Brian con S, Pourel J. Validity and discriminant ability of the HAQ functional index in early rheumatoid arthritis. Disability and Rehabilitation 1992, 14 (2); 71-7

74 Bendtsen P, Bjurulf P,Trell E, Lindström F, Larsson JE. Crossectional assessment and subgroup comparison of functional disability in patients with rheumatoid arthritis in a swedish health care district. Disability and Rehabilitation 1995, 17 (2); 94-9

75 Kompetensbeskrivningar för sjukgymnaster. Socialstyrelsen. SoS-rapport 1999:1. Stockholm

76 Ekblom B, Lövgren O, Alderin M, Fridström M, Sätterström G. Effect of short-term physical training on patients with rheumatoid arthritis. A six-month follow-up study. Scand J Rheumatol 1975, 4; 87-91

77 Nordemar R, Ekblom B, Zachrisson L, Lundqvist K. Physical training in rheumatoid arthritis. A controlled long-term study: I. Scand J Rheumatol 1981, 10; 17-23

78 Nordemar R. Physical training in rheumatoid arthritis: a controlled long-term study. II. Scand J Rheumatol 1981,10; 25-30

79 Ekdahl C. Muscle function in rheumatoid arthritis. Assessment and training. Dissertation. Lund & Dalby 1989

80 Stenström CH. Dynamic therapeutic exercise in rheumatoid arthritis. Qualitative and quantitative aspects. Dissertation. Stockholm 1993

81 Lyngberg K, Danneskiold- Samsøe B, Halskov O. The effects of physical training on patients with rheumatoid arthritis: changes in disease activity, muscle strenght and aerobic capacity. A clinically controlled minimised cross-over study. Clin Exp Rheumatol 1988, 6; 253-60

82 Häkkinen A, Häkkinen K, Hannonen P. Effects of strenght training on neuromuscular function and disease activity in patients with recent onset inflammatory arthritis. Scand J Rheumatol 1994, 23; 237-42

83 van den Ende CHM, Hazes JMW, le Cessie S, Mulder WJ, Belfor DG, Breedveld FC, et al. Comparison of high and low intensity training in well controlled rheumatoid arthritis. Results of a randomized clinical trial. Ann Rheum Dis 1996, 55; 798-805

84 Danneskiold- Samsøe B, Lyngberg K, Risum T, Telling M. The effect of water exercise therapy given to patients with rheumatoid arthritis. Scand J Rehab Med 1987,19; 31-5

58

85 Lyngberg KK, Harreby M, Bentzen H, Frost B, Danneskiold- Samsøe B. Elderly rheumatoid arthritis patients on steroid treatment tolerate physical training without an increase in disease activity. Arch Phys Med Rehabil 1994, 75; 1189-95

86 Minor M, Hewett JE. Physical fitness and work capacity in women with rheumatoid arthritis. Arthritis Care Res 1995, 8(3); 146-54

87 Stenström CH, Arge B. Sundbom A. Dynamic training versus relaxation training as home exercise for patients with inflammatory rheumatic diseases. A randomized controlled study. Scand J Rheumatol 1996, 25; 28-33

88 Komatireddy GR, Leitch RW, Cella K, Browning G, Minor M. Efficacy of low load resistive muscle training in patients with rheumatoid arthritis functional class II and III. J Rheumatol 1997, 24; 1531-9

89 Lyngberg K, Trede N, Halkjaer-Kristensen J, Andersen V, Peder BK. Physical exercise modulates the cellular immune system in patients with rheumatoid arthritis. Scand J Med Sci Sports 1991, 1; 167-73

90 Ekdahl C, Ekman R, Petersson I, Svensson B. Dynamic training and circulating neuropeptides in patients with rheumatoid arthritis: a comparative study with healthy subjects. International Journal of Clinical Pharmacology Research 1994, 14(2); 65-74

91 Dellhag B, Wollersjö I, Bjelle A. Effect of active hand exercise and wax bath treatment in rheumatoid arthritis patients. Arthritis Care and Research 1992, 5 (2); 87-92

92 Hoenig H, Groff G, Pratt K, Goldberg E, Franck W. A randomized controlled trial of home exercise on the rheumatoid hand. J Rheumatol 1993, 20; 785-9

93 Brighton SW, Lubbe JE, van der Merwe. The effect of a long term exercise programme on the rheumatoid hand. British Journal of Rheumatology 1993, 32; 392-5

94 Boström C, Ljungqvist T. Aktiv dynamisk träning - något för reumatiker med axelsmärta? Sjukgymnasten 1984, 14; 25-9

95 Mannerkorpi K, Bjelle A. Evaluation of a home training programme to improve shoulder function in rheumatoid arthritis patients. Physiotherapy Theory and Practice 1994,10; 69-76

96 Keitel W, Hoffman H, Weber G, Krieger U. Ermittlung der prozentualen Funktionsminderung der Gelenke durch einen Bewegungsfunktionstest in der Rheumatologie. Deutsch Gesundsheitsw 1971, 26; 1901-3

97 Eberhardt KB, Svensson B, Moritz U. Functional assessment of early rheumatoid arthritis. British Journal of Rheumatology 1988, 27; 364-71

98 Ferraz MB, de Oliviera LM, Aruvjo PMP, Atra E, Walter SD. EPM-ROM scale: an evaluative instrument to be used in rheumatoid arthritis trials. Clin Exp Rheumatol 1990, 8; 491-4

99 Stenström CH, Nisell R. Assessment of disease consequences in rheumatoid arthritis: A survey of methods classified according to the International classification of impairments, disabilities and handicaps. Arthritis Care and research 1997, 10 (2); 135-50

100 Solem-Bertoft E. Physiotherapeutic analysis of pain in the shoulder. Dissertation. Uppsala 1995

101 van den Ende CHM, Rozing PM, Dijkmans BAC, Verhoef JAC, Voogt-van der harst EM, Hazes JMW. Assessment of shoulder function in rheumatoid arthritis. J Rheumatol 1996, 23; 2043-8

102 Matsen FA, III, Smith KL, DeBartolo SE, von Oesen G. A comparison of patients with late-stage rheumatoid arthritis and osteoarthritis of the shoulder using self-assessed shoulder function and health status. Arthritis Care and Research 1997, 10 (1); 43-7

103 Solem Bertoft E. Painful shoulder disorders from a physiotherapeutic view: A review of literature. Critical reviews in Physical and Rehabilitation Medicine 1999, 11; 229-77

104 Fuchs HA, Brooks RH, Callahan LF, Pincus T. A simplified twenty-eight joint quantitative articular index in rheumatoid arthritis. Arthritis Rheum 1989, 32; 531-7

105 Hakala M, Nieminen P, Manelius J. Joint impairment is strongly correlated with disability measured by self-reported questionnaires. Functional status assessment of individuals with rheumatoid arthritis in a population based series. J Rheumatol 1993, 21; 64-9

106 Stucki G, Brühlmann P, Stucki S, Michel BA. Isometric muscle strength is an indicator of self-reported physical functional disability in patients with rheumatoid arthritis. Br J Rheumatol 1998, 37; 643-8

107 Fitzpatrick R, Newan S, Lamb R, Shipley M. A comparison of measures of health status in rheumatoid arthritis. Br J Rheumatol 1989, 28; 201-6

108 Sullivan M, Ahlmén M, Bjelle A. Health status assessment in rheumatoid arthritis. I. Further work on the validity of the Sickness Impact Profile. J Rheumatol 1990, 17; 439-47

109 Vlieland TPMV, van den Ende CHM, Breedveld FC, Hazes JMW. Evaluation of joint mobility in rheumatoid arthritis trials: the value of the EPM-range of motion scale. J Rheumatol 1993, 20; 2010-4

110 Deyo RA, Inui TS. Toward clinical applications of health status measures: sensitivity of scales to clinically important changes. Health Serv Res 1984, 19; 277-89

111 Nicassio PM, Smith TW. Managing chronic illness: A biopsychosocial perspective. American Psychological Association 1996

112 Harms-Ringdahl K, Ekholm J, Arborelius UP, Németh G, Schüldt K. Load moment, muscle strength and level of muscular activity during internal rotation training of the shoulder (In: Recent Advances in Rehabilitation Medicine). Scand J Rehab Med 1983, 9 (suppl); 125-35

113 Harms-Ringdahl K, Arborelius UP, Ekholm J, Németh G, Schüldt K. Shoulder externally rotating exercises with pulley apparatus. Joint load and EMG. Scand J Rehab Med 1985, 17; 129-40

114 Scott DL, Panayi GS, van Riel PLCM, Smolen LBA, van de Putte LBA, and the consensus study group of the European workshop for rheumatology: Disease activity in rheumatoid arthritis: preliminary report of the consensus study group of the European workshop for rheumatology research. Clin Exp Rheumatol 1992, 10; 521-5

115 Smolen JS, Breedveld FC, Eberl G, Jones I, Leeming M, Wylie GL. et al. Validity and reliability of the twenty-eight-joint count for the assessment of rheumatoid arthritis activity. Arthritis Rheum 1995, 38; 38-43

116 Ritchie DM, Boyle JA, McInnes JM, Jasani MK, Dalakos TG, Grieveson P, Buchanan WW. Clinical studies with an articular index for the assessment of joint tenderness in patients with rheumatoid arthritis. QJ Med 1968, 147; 393-406

117 Borg G. Borg's perceived exertion and pain scales. Champaign, IL: Human Kinetics 1998

118 American Academy of Orthopaedics surgeons: Joint Motion: Method of measuring and recording. American Academy of Orthopaedics Surgeons, Chicago, Denver, Boston, 1965. Reprinted E.&S. Livingstone, Edinburgh and London. Great Britain by Bishop and Sons, Ltd., Edinburgh, 1966

119 Riddle DL, Rothstein JM, Lamb RL. Goniometric reliability in a clinical setting. Shoulder measurements. Phys Ther 1987, 67; 668-73

120 Rothstein JM, Miller PJ, Roettger RF. Goniometric reliability in a clinical setting. Phys Ther 1983, 63; 1611-5

121 Horger MM. The reliability of goniometric measurements of active and passive wrist motions. Am J Occup Ther 1990, 44; 342-8

122 Archenholtz B, Ahlmén M, Bengtsson C, Bjelle A, Hansson G, Lurie M, Sullivan M, Svensson G. Reliability of articular indices and function tests in a population study of rheumatic disorders. Clin Rheumatol 1989, 8(2), 215-24

123 Brox JI, Brevik JI, Ljunggren AE, Staff PH. Influence of anthropometric and psychological variables, pain and disability on isometric endurance of shoulder abduction in patients with rotator tendinosis of the shoulder. Scand J Rehab Med 1996, 28; 193-200

60

124 Ferraz MB, Quaresma MR, Aquino LR, Atra E, Tugwell P, Goldsmith CH. Reliability of pain scales in the assessment of literate and illiterate patients with rheumatoid arthritis. J Rheumatol 1990, 17; 1022-4

125 Moritz U. Nack- och skuldersmärta. I. Rehabiliteringsmedicin ed. Höök O. Almqvist & Wiksell Medicin, Värnamo 1995; 253-71

126 Pellecchia GL, Paolino J, Connell J. Intertester reliability of the Cyriax evaluation in assessing patients with shoulder pain. J Orthop Sports Phys Ther 1996, 23; 34-8

127 Lannersten L. Reliabilitet vid mätningar av isometrisk styrka och uthållighet. Projektarbete. Arbetsmiljöinstitutet, Karolinska institutet 1992/3

128 Farell M, Richards JG. Analysis of the reliability and validity of the kinetic communicator exercise device. Med Sci Sports Exer 1986, 18; 44-9

129 Hageman PA, Mason DK, Rydlund KW, Humpal SA. Effects of position and speed on eccentric and concentric isokinetic testing of the shoulder rotators. J Orthop Sports Phys Ther 1989, 11; 64-9

130 Ng LR, Kramer JS. Shoulder rotator torques in female tennis and nontennis players. J Orthop Sports Phys Ther 1991, 13; 40-6

131 Einarsson G, Grimby G. Disability and handicap in late poliomyelitis. Scand J Rehabil Med 1990, 22; 113-21

132 Söderback I, Schult ML, Nordemar R. Assessment of patients with chronic backpain using the "Functional Status Questionnaire". Scand J Rehabil Med 1993, 25; 139-43

133 Sullivan M, Ahlmén M, Archenholtz B, Svensson B. Measuring health in rheumatic disorders by means of a Swedish version of the Sickness Impact Profile. Results from a population Study. Scand J Rheumatol 1986, 15; 193-200

134 Ward MM. Are patient self-report measures of arthritis confounded by mood ? A longitudinal study of patients with rheumatoid arthritis. J Rheumatol 1994, 21; 1046-50

135 Boone DC, Azen SP, Lin CM, Spence C, Baron C, Lee L. Reliability of goniometric measurements. Phys Ther 1978, 58(11); 1355-60

136 Stenström CH. Enkät om mätmetoder till medlemmar i LSR:s (Legitimerade Sjukgymnasters Riksförbund) för reumatologi. Unpublished paper 2000-03-26

137 REFORM. Reumatologisk Fysioterapi och Riktlinjer för mätmetoder. Sektionen för reumatologi inom Legitimerade Sjukgymnasters Riksförbund, LSR 1999

138 Statistiska centralbyrån. Reumatikers levnadsförhållanden. ULF 1978

139 Thompson PW, Pegley FS. A comparison of disability measured by the Stanford Health Assessment Questionnaire disability scales (HAQ) in male and female rheumatoid outpatients Br J Rheumatol 1991, 30; 298-300

140 Lannersten L, Harms-Ringdahl K, Schüldt K, Ekholm J. Isometric strength in flexors, abductors and external rotators of the shoulder. Clin Biomech 1993, 8; 235-42

141 Moskowitz RW. Clinical rheumatology (2nd ed.) Philadelphia: Lea & Febiger 1982.

142 Badley EM, Wagstaff S, Wood PH. Measures of functional ability (disability) in arthritis in relation to impairment of range of joint movement. Annals of the Rheumatic Diseases, 1984, 43; 563-9

143 Spiegel TM, Spiegel JS, Paulus HE. The joint alignment and motion scale: a simple measure of joint deformity in patients with rheumatoid arthritis. J Rheumatol 1987, 14; 887-92

144 Eurenius E. Intensiv rehabilitering i reumatikerprogram på Sätra Brunn. Examensarbete Vårdhögskolan Uppsala 1995

145 Eurenius E. The Disability Rating Index and the Global Self-rating Index – reliability and validity in rheumatoid arthritis. (Uppsats) Course within a master of science in Physiotherapy Umeå University 1998

146 Mayer M, Stenström CH, Lundeberg T, Sundbom A, Nisell R. Sensory stimulation with acupuncture in rheumatoid arthritis. A randomised controlled study. Abstract. World Confederation for physical therapy international congress, Japan 1999

147 Mayer M. Funktion och smärta vid systemisk sclerodermi. (Function and pain in systemic scleroderma). Forskningsprojekt. Kompletteringskurs i sjukgymnastik, Karolinska Institutet 1996

148 Révay S, Dahlström M, Dalén N. Water exercise versus instruction for self-training following a shoulder fracture. Int J Rehab Res 1992, 15; 327-33

149 Felson DT, Anderson JJ, Boers M, et al. American College of Rheumatology preliminary definition of improvement in rheumatoid arthritis. Arthritis and Rheumatism 1995, 38; 727-35

150 Winters JC, Sobel JS, Groenier KH, Arendzen JH, Meyboom De Jong B. A shoulder pain score: a comprehensive questionnaire for assessing pain in patients with shoulder complaints. Scand J Rehab Med 1996, 28; 163-7

151 Jette AM, Assmann SF, Rooks D, Harris BA, Crawford S. Interrelationships among disablement concepts. J Gerontol Med Sci 1998, 53; 395-404

152 Triffit PD. The relationship between motion of the shoulder and the stated ability to perform activities of daily living. J Bone Joint Surg 1998, 80 A(1); 41-6

153 Blalock SJ, van H Sauter S, DeVellis RF. The Modified Health Assessment Questionnaire Difficulty Scale. A health status measure revisited. Arthritis Care and Research 1990, 3(4); 182-8

154 Sullivan M, Ahlmén M, Bjelle A, Karlsson J. Health Status Assessment in rheumatoid arthritis II. Evaluation of a modified shorter Sickness Impact Profile. J Rheumatol 1993, 20; 1500-7

155 Archenholtz B, Bjelle A. Reliability, validity and sensitivity to change of a swedish version of the revised and expanded Arthritis Impact Measurement Scales (AIMS2). J Rheumatol 1997, 24; 1370-77

156 Hansen JW. The training effect of repeated isometric muscle contractions. Int Z Angew Physiol 1961, 18; 474-7

157 Bonde-Petersen F, Graudal H, Hansen JW, Hvid N. The effect of varying the number of muscle contractions on dynamic muscle training. Int Z Angew Physiol 1961, 18; 468-73

158 Minor MA, Brown JD. Exercise maintenance of persons with arthritis after participation in a class experience. Health Education Quarterly 1993, 20; 83-95

159 Andersson S. The functional background in acupuncture effects. Scand J Rehab Med 1993, Suppl 29; 31-60

160 Thorén P, Floras JS, Hoffmann P, Seals DR. Endorphins and exercise: physiological mechanisms and clinical implications. Med Sci Sports Exerc 1990, 22(4); 417-28

161 Byers PH. Effect of exercise on morning stiffness and mobility in patients with rheumatoid arthritis. Res Nurs Health 1985, 8; 275-81

162 Prevoo MLL, Van Riel PLCM, Van'T Hof MA, Van Rijswik MH, Van Leeuwen MA, Kuper HH, et al. Validity and reliability of joint indices. A longitudinal study in patients with recent onset rheumatoid arthritis. Br J Rheumatol 1993, 32; 589-94

163 Spiegel JS, Leake B, Spiegel TM, Paulus HE, Kane RL, Ward NB, et al. What are we measuring ? An examination of self-reported functional status measures. Arthritis Rheum 1988; 31(6); 721-8

164 McFarlane AC, Brooks PM. An analysis of the relationship between psychological morbidity and disease activity in rheumatoid arthritis. J Rheumatol 1988, 15; 926-31

FUNKTIONSSKATTNING SKULDRA - ARM

Patienten;

Hand-mot-tak *(armbågen som riktmärke i sagitalplan)*

1. får ej armbågen till processus xiphoideus nivå (i horisontalplan)
2. får armbågen till processus xiphoideus nivå men kompenserar med skulderelevation
3. får armbågen till processus xiphoideus nivå utan kompensation
4. får armbågen till axelnivå
5. får armbågen till ögonnivå
6. får armbågen ovan huvudet (humerus vertikalt)

Hand-motsatt-axel

1. får ej finger III MCP till motsatt processus coracoideus
2. får finger III MCP till motsatt processus coracoideus
3. får finger III DIP runt om motsatt spina scapulae i underarmens längsriktning
4. får finger III DIP runt om motsatt spina scapulae och kan lyfta armbågen ovan processus xiphoideus nivå
5. får finger III DIP runt om motsatt spina scapulae och kan lyfta armbågen till axelnivå
6. får finger III DIP runt om motsatt spina scapulae och kan lyfta armbågen till ögonnivå

Hand-i-nacke

1. får ej finger III DIP (distala interphalangealleden) till spinalutskotten mellersta cervicalryggen (kring C4)
2. får finger III DIP till mellersta cervicalryggen med kompensation (skulderelevation)
3. får finger III DIP till mellersta cervicalryggen utan kompensation
4. får finger III DIP till mellersta cervicalryggen och armbågen kan föras ut åt sidan i riktning mot frontalplan
5. får finger III DIP till mellersta cervicalryggen och armbågen kan föras helt ut åt sidan i frontalplan
6. kan föra överarmen i riktning mot huvudet i frontalplan med tredje fingret MCP (metacarpophalangealleden) i riktning mot motsatt angulus superior scapulae

Hand-i-rygg

1. får ej processus styloideus radii bakom ett frontalplan genom samma sidas SIPS (spina iliaca posterior superior)
2. får processus styloideus radii med handryggen mot samma sidas laterala cristakant i SIPS nivå
3. får processus styloideus radii med handryggen till samma sidas SIPS nivå
4. får processus styloideus radii med handryggen till motsatt SIPS nivå
5. får processus styloideus radii med handryggen mot columna i motsatt sidas armbågsnivå
6. får processus styloideus radii med handryggen förbi columna ovanför motsatt sidas armbågsnivå i riktning mot motsatt angulus inferior scapulae

Hand-till-säte

1-3. se ovan Hand-i-rygg
4. får processus styloideus radii med handryggen mot sacrum i SIPS nivå med tumme och hand i riktning mot sagitalplan till motsatt sidas SIPS
5. får processus styloideus radii med tummen mot sacrum i SIPS nivå och med handen i sagitalplan
6. får processus styloideus radii med handflatan mot sacrum i SIPS nivå