Karolinska Institutet

Thesis for licentiate degree 2008

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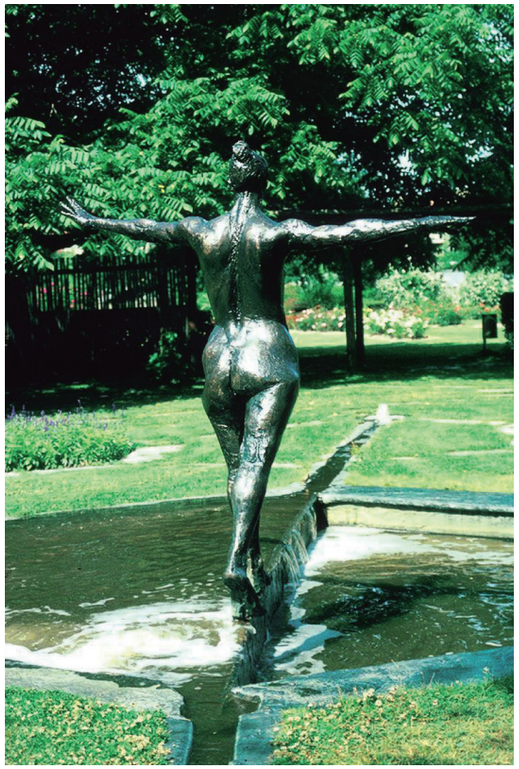
Description and Assessment



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ISBN 978-91-7409-095-6

Printed by

REPROPRINT AB
Stockholm 2008
www.reproprint.se
Gårdsvägen 4, 169 70 Solna

ABSTRACT

Background and aim: Patients with peripheral arthritis (PA) have several impairments that can influence balance and be risk factors for falls and fear of falling. Since disability varies among these patients, we need to know what tests are applicable for those with differing degrees of activity limitation. Only one balance capacity test, and no questionnaire on balance difficulties, has been developed for patients with PA. More differentiated balance capacity tests and self-reports validated for this group are needed in order to prescribe and evaluate balance exercise programmes tailored to individual needs. The overall aim of the work reported in the thesis was to develop the assessment of activities with balance limitations among patients with PA.

Material and Methods: For Study I, three samples of 65, 19 and 22 patients with PA and different degrees of activity limitation were recruited to investigate the applicability, the inter-rater-reliability and the intra-rater reliability, respectively, of the following assessments: walking on soft material, backwards and the figure-of-eight, the balance sub-scale of the Index of Muscle Function (IMF), the Timed Up-and-Go test (TUG) and the Berg Balance Scale (BBS). In Study II, three samples of 10, 22 and 20 female patients with PA participated. Activities with perceived balance limitations were identified from qualitative semi-structured interviews. A self-administered questionnaire (BAQ-PA) based on the interviews was constructed. The BAQ-PA was reviewed regarding content, and test-retest stability was examined twice with a one-week interval. Construct validity was investigated by correlation to previous falls, activity limitation, self-rated balance limitation, fear of falling and capacity tests.

Results: In Study I, the TUG and the BBS were found applicable and most sensitive for patients with severe activity limitation. The figure of eight and the IMF were applicable and most sensitive for patients with moderate and low activity limitation. Inter-rater reliability was high ($R \geq 0.79$) and intra-rater reliability was satisfactory for all assessments investigated. In Study II, perceived balance limitations were mainly related to outdoor activities. Test-retest-stability was good ($K_w=0.71$) for the suggested questionnaire (BAQ-PA) including 18 activities, which correlated higher to self-rated balance ($r_s=0.48$) and activity avoidance because of balance limitation ($r_s=0.55$) and previous falls ($r_s=0.49$) than to capacity tests ($r_s<0.44$), with the exception of the one-leg stance ($r_s=-0.75$). The BAQ-PA score was significantly higher among those reporting fear of falling ($p<0.05$) than among those not doing so.

Conclusions: Some applicable and reliable balance capacity tests were identified for patients with severe, moderate and low activity limitations. More sensitive tests should be developed for those with no assessable activity limitation. Further, the present work reports a first step towards development of a valid and reliable balance questionnaire where the patient's perspective on individual activities and wishes for improvement receive attention.

Key words: Peripheral arthritis, Activities, Balance, Assessments, Questionnaire

SAMMANFATTNING

Bakgrund och syfte: Patienter med perifer artrit (PA) har flera funktionsnedsättningar som kan påverka balans och vara riskfaktorer för fall och rädsla för att ramla. Funktionshindren varierar hos dessa patienter och därför behöver vi veta vilka tester som är lämpliga vid olika grad av aktivitetsbegränsning. För att utvärdera balans finns bara ett kapacitetstest och det finns ingen enkät utvecklad för patienter med PA. Det behövs mer differentierade kapacitetstester för balans och enkäter som är validerade för denna grupp för att kunna ordinera och utvärdera balansträningsprogram, som är utformade efter individuella behov. Det övergripande syftet med avhandlingsarbetet var att utveckla utvärderingsmetoder för aktiviteter med balansbegränsningar hos patienter med PA.

Material och metod: För Studie I rekryterades 65, 19 och 22 patienter med PA och olika grad av aktivitetsbegränsning för att undersöka lämplighet, interbedömarreliabilitet respektive intrabedömarreliabilitet av följande utvärderingsmetoder: gång på mjukt underlag, baklänges och i åtta-figur, balansskalan ur Index of Muscle Function (IMF), Timed up and Go test (TUG) och Bergs balansskala (BBS). I Studie II rekryterades 10, 22 och 20 kvinnliga patienter med PA. Aktiviteter med upplevda balansbegränsningar identifierades med hjälp av kvalitativa semi-strukturerade intervjuer. En själv-administrerad enkät (BAQ-PA) konstruerades på basis av intervjuerna. BAQ-PA granskades beträffande innehåll, och test-retest-stabilitet undersöktes två gånger med en veckas mellanrum. Begreppsvaliditet undersöktes genom korrelationer med tidigare fall, aktivitetsbegränsning, självskattad balansbegränsning, rädsla för att ramla och kapacitetstester.

Resultat: I Studie I visade sig TUG och BBS vara lämpliga och mest känsliga för patienter med hög aktivitetsbegränsning. Åtta-figuren och IMF visade sig vara lämpliga och mest känsliga för patienter med medelhög och låg aktivitetsbegränsning. Inter-bedömar-reliabilitet var hög och intra-bedömar-reliabilitet var tillfredsställande för alla undersökta utvärderingsmetoder. I Studie II rapporterades upplevda balansbegränsningar huvudsakligen i utomhusaktiviteter. Test-retest-reliabilitet var god (K_w=0.71) för den föreslagna enkäten (BAQ-PA) med 18 aktiviteter, som korrelerade högre till självskattad balans (r_s=0.48) och undvikande av aktiviteter på grund av balansbegränsningar (r_s=0.55) och tidigare fall (r_s=0.49) än till kapacitetstester (r_s<0.44), med undantag av ett-bens-stående (r_s=-0.75). BAQ-PA resultat var signifikant högre för dem som rapporterade rädsla för att ramla ($p<0.05$) än för dem som inte rapporterade detta.

Konklusion: Några lämpliga och tillförlitliga kapacitetstester för balans identifierades för patienter med höga, medelhöga och låga aktivitetsbegränsningar. Mer känsliga tester bör utvecklas för dem med inga mätbara aktivitetsbegränsningar. Vidare är detta arbete ett första steg mot att utveckla en valid och reliabel balansenkät där patientens perspektiv beträffande individuella aktiviteter med balansbegränsningar och önskemål om förbättringar uppmärksammas.

Nyckelord: perifer artrit, aktiviteter, balans, utvärderingsmetoder, enkät.

LIST OF PUBLICATIONS

I. Norén AM, Bogren U, Bolin J, Stenström C. Balance assessment in patients with peripheral arthritis: applicability and reliability of some clinical assessments. Physiother Res Int 2001;6:193-204.
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II. Norén AM, Olsson E, Opava CH. Activities with balance limitations among women with peripheral arthritis. Description and assessment. Submitted.

CONTENTS

LIST OF ABBREVIATIONS

PA	Peripheral Arthritis
RA	Rheumatoid Arthritis
PsA	Psoriatic Arthritis
ICF	International Classification of Functioning, Disability and Health
BBS	Berg Balance Scale
IMF	Index of Muscle Function
TUG	Timed Up and Go
TST	Timed Stands Test
A-task	Walking tandem on a two meter line on an Airex mat
B-task	Walking tandem backward two meter between lines
C-task	Walking in Figure-of-eight
HAQ	Disability Index of the Health Assessment Questionnaire
BAQ-PA	Balance Assessment Questionnaire for patients with peripheral arthritis

1 INTRODUCTION

1.1 PERIPHERAL ARTHRITIS

Peripheral arthritis (PA) is the common term for several long-term, inflammatory joint diseases such as rheumatoid arthritis (RA), psoriatic arthritis (PsA) or other unspecific polyarthritis. The annual incidences in the Swedish population are 24/100 000, 8/100 000 and 41/100 000 respectively (1). PA affects 0.5-1 % of the adult population, 0.51 % RA and 0.2 % PsA, predominantly females (2,3,4) and its etiology is not fully known. PsA is classified into five groups, of which the most common is polyarthritis (5). RA, the most frequent arthritis, is a systemic disease where the prevalence increases with age: the mean age at onset is 55 years. Genetic, environmental and life-style factors influence the risk of developing RA (6,7,8) and the American College of Rheumatology has set up criteria for its diagnosis (9). The prognosis depends on symptom severity at onset (10). Co-morbidities such as osteoporosis, cardiovascular problems, infections and depressions have been reported (11,12).

Early symptoms of RA are joint synovitis, fatigue, stiffness and pain often followed by impairment and activity limitation, and there is also a risk of joint destruction (3,13). Impairments such as decreased mobility (14), poor strength and endurance and reduced oxygen uptake (14,15,16), are well documented in patients with PA. Increased postural sway, suggested to indicate impaired balance, has also been reported (17). Activity limitations such as reduced physical activity (14), less leisure time activity, and difficulties in performing activities of daily living (18) have also been described.

The treatment of inflammatory arthritis has developed much in the past decades. The current drug treatment includes combinations of disease-modifying anti-rheumatic drugs and new biological drugs, with adjunctive treatments such as glucocorticoids or non steroid anti-inflammatory drugs. The recommendations are also to start medication as early as possible and to monitor disease activity and functioning systematically (19). The purpose of all treatment is to alleviate the consequences of the disease; to maintain functioning and health and to reduce disability; but also to improve knowledge of, and enhance coping with, the disease.

1.2 PHYSIOTHERAPY

Human movement is the central concept in physiotherapy, which has been described by the World Confederation for Physical Therapy as ‘providing services to individuals and populations to develop, maintain and restore maximum movement and functional ability throughout the lifespan including services in circumstances where movement and function are threatened by ageing, injury, disease or environmental factors. Functional movement is seen to be central to what it means to be healthy’ (20). Another way to describe physiotherapy is that it operates in a movement continuum from a micro to a macro level and with an interactive perspective in understanding physiological functioning of the body and the context in which the individual is living (21). The initial assessment of a patient can occur at one level, while further efforts can follow at several levels on the movement continuum. Thus, physiotherapy practice must be seen in its context, with the individual and in the team as well as in the social and political circumstances.

An international classification system with a biopsychosocial perspective on functioning, disability and health, the ICF (22), enables one to describe health conditions in a more differentiated way than with a medical diagnosis only. This is particularly important in rehabilitation. The ICF contains two parts, functioning with its negative aspect disabilities and contextual factors. Functioning has two components; body functions and structures and activities and participation. The negative aspects are impairments, activity limitations and participation restrictions, respectively. The contextual factors are labelled as environmental or personal. (22)

In physiotherapy PA is often evaluated and treated similarly to RA. The overall purpose of physiotherapeutic measures taken in relation to PA is to relieve pain and other symptoms, and to improve or maintain body functions, activities and participation in daily life. Physiotherapy in rheumatology has developed greatly in the past few decades, from rest and passive treatment towards active strategies including exercise and daily physical activity with the physiotherapist acting as a coach (23). The benefits of physiotherapeutic interventions among patients with PA have been described as improvements in joint mobility, muscle strength and endurance, and aerobic fitness (24,25). Balance issues are rarely described (17,26,27) and to our knowledge no exercise benefits have been demonstrated.

1.3 BALANCE

There is no generally accepted definition of human balance, but it can be defined as the ability to maintain the body's centre of mass within manageable limits of the base of support, as in standing or sitting, or in transit to a new base of support. Otherwise expressed, balance is the dynamics of body posture to prevent falling (28,29). Balance cannot be separated as one phenomenon but is more a foundation of human activities and integrated with the individual, the task to be performed and the environment (30,31).

In physiotherapy, balance is often called postural control. The postural control system consists of several subsystems related to the individual. These in turn include units that are categorized mainly as body functions according to the ICF: namely the neural and the sensory, and the musculoskeletal. These are centrally integrated and processed, but their mechanisms are not fully known. This system further judges body position for postural stability and orientation and generates forces to control body posture to maintain a position, in voluntary movements or in reactions to external disturbances (30). Neural functions are the neuromuscular synergies, the sensory functions including the visual, the somatosensory and the vestibular and also the higher levels of information processing such as attention (30). Centrally, an internal representation of the body position in space is believed to be constantly ready to change strategies effective for movement control as circumstances change. For voluntary movements anticipatory postural adjustments precede a possible destabilization (31). Reactive movement strategies are initiated and executed more rapidly and include the ankle strategy, the hip strategy and the change in support strategy such as stepping and grasping to compensate for external disturbances (32). Musculoskeletal functions generate forces necessary to keep a body position or react to disturbances. They include tension, response, strength and joint mobility and stability.

The nature of a task, or an activity, provokes the individual postural control system for maintaining body position and orientation to different extents. Nine domains of the ICF

describe activities and participation. Mobility, Self-care, Domestic life and some second-level domains included in Community, social and civic life are generally recognized as related to balance. For example no one would doubt that changing and maintaining body positions (33), dressing (34), performing household tasks (34), or recreation and leisure (35) challenge balance. However, Learning and applying knowledge, General tasks and demands, Communication, Interpersonal interactions and relations, and Major life areas may also interact with balance. Examples from these categories related to balance may include acquiring skills, undertaking multiple tasks (36), conversation (37), work and employment. Familiar activities with a sufficient base of support and possibility to react properly to perturbations, such as maintaining upright stance are less demanding than climbing ladders or carrying crystal glasses on a tray while wearing high heeled shoes, which are activities with a smaller base of support and limited possibilities for reactive movement strategies. Improved balance has been found in elderly people following exercise programs targeting balance (38,39,40) although the programs and the outcome methods need further development to obtain valid and consistent results.

Physical, social and attitudinal environmental factors may also provoke the postural control system in different ways (22,30). Products, such as medicine and technical aids; the natural and the human-made environment, such as climate conditions or light, sound and vibration; support and relationships; attitudes, and services, systems and policies, such as those related to architecture or transportation, may all influence balance. Thus outdoor environments, slippery surfaces, darkness or crowds place more demands on the postural system than indoor, familiar environments do.

Personal factors related to gender, age, body height and fear of falling also influence balance. The fact that balance decreases with age is well documented when assessed with capacity or laboratory tests (41, 42). A fear of falling is associated with decreased balance among elderly people (34).

Considering the multiple and multifaceted components of balance, each or several components together can cause balance difficulties in many different ways throughout life. Among persons with PA, balance difficulties may appear earlier in life and more severely than in healthy individuals because of musculoskeletal impairments such as muscle weakness, delayed muscle reaction, restricted joint mobility and stability; but also neural or sensory impairments of peripheral nerves or proprioceptors. Pain, fatigue, depression and medication side-effects are other possible influencing factors.

1.4 FALLS

A consequence of failure to maintain or restore balance is a fall, which depending on circumstances may lead to fractures or injuries, disability, fear of falling and a decrease in quality of life; and also to costs for society mainly because of the ageing population in the western countries. There is no commonly accepted definition of a fall and it is not always well described in the literature.

Research on falls and fall prevention is generally focused on elderly people. Female gender, arthritis, vertigo, use of psychotropic drugs and anti-depressants, previous falls and also disabilities including that of balance, hand muscle force and foot deformities are risk factors for falls in this population (43,44,45). Several of these factors are also present among patients with PA (13,14,15,46) and those with RA reportedly fall as

often as other people with disabilities caused by chronic disease and as elderly people (35,47,48,49).

Fear of falling and falls reportedly influence each other mutually as risk factors among elderly people (45). Reported percentages of fear in different populations vary depending on age, functioning and how questions are posed. People with RA are as afraid of falling as the elderly: fifty percent of those with RA above age 50 report fear of falling (35,47) and about 40 % report this as a limiting factor for physical activity (35). Further, patients with RA have lower bone density than the normal population (11) and are therefore at higher risk of fractures as serious consequences of falls.

1.5 ASSESSMENTS FOR PERIPHERAL ARTHRITIS

Already in the 1940s, assessment of the disease itself was separated from that of the functioning in patients with RA (50) by the introduction of the American Rheumatism Association (ARA) functional classification system. This described four functional classes. The system has later been developed into the well-validated (51) functional disability index included in the Stanford Health Assessment Questionnaire (HAQ) (52).

In physiotherapy, clinical measurements and assessments include manual examination, technical equipment, capacity tasks, and questionnaires. Assessments can focus on different components and domains of the ICF (53). Manual examination and technical equipment are used mainly to assess body structure and body function, while questionnaires are used mainly to assess activity, participation and contextual factors. Capacity tasks can be used to evaluate body functions as well as activities. Examples of common assessments for body functions in patients with PA are joint motion with goniometry, the Index of Muscle Function (46,54) and the Timed Stands Test (55); while activity limitation is often assessed with the disability index of the HAQ (52). As functioning varies over time in patients with PA and differs between them, assessments must be applicable to the actual patient. Further, assessing the patient's perspective, e.g. with attention to the patient's preference for improvement (56,57), has lately been emphasized (58,59).

1.6 BALANCE ASSESSMENTS

The complexity of balance requires one to define it in terms that make the choice of research methodology or outcome measures possible. In a recent Cochrane report, an overall classification of balance assessments in direct and indirect assessments was suggested (60). Direct assessments of body functions seek to describe and analyze the underlying mechanisms and strategies used to maintain a given position. The assessments are performed in laboratories registering kinetics and kinematics of the body including muscle activity when standing or walking over force platforms. Data from force plates, motion analysis and electromyography is processed using advanced software and gives information about not only the centre of pressure but also the centre of mass of the body and its vertical projection on the ground – the centre of gravity. The speed and location of these parameters can be assessed in quiet and perturbed stances and while walking (61,29,30). This research aims at detecting and interpreting what occurs in the human body before a movement becomes visible, and during a movement; and also how a task is performed. Interpretations of the above parameters have been much discussed. Thus reported correlations between direct and indirect balance assessments vary between studies (62,63,64).

Indirect assessments, used in the clinic, seek to judge whether and how far a certain activity meant to represent balance, can be performed by an individual. These balance capacity tests can be categorized in terms of the biomechanical requirements, described as: unperturbed, self-generated perturbations, external perturbations and perturbed/manipulated sensory mechanisms in standing and moving position respectively (61). The requirement for cognitive attention such as in dual tasks has received increasing attention. Most clinical balance tests contain parts intended to provoke self-generated perturbations when the subject is standing or moving. Few contain external perturbations, sensory manipulation/perturbation or cognitive attention. Examples of indirect balance assessments are presented in Table I.

Table I. Indirect balance capacity tests categorised mainly according to their biomechanical requirements (modified after Huxham, 2001)

	Stationary base of support	**Moving base of support**
- Unperturbed	Timed standing or sitting [1]	30m Gait test [2]
- Self-generated perturbations	Turning head standing [1] Tandem Stance [1] One Leg Stance [1, 3] Standing eyes closed [1, 3] Reaching forwards [1, 4]	Turning around [1] Walking on a line [3] Timed up and go to/from chair [5] Walking in figure of eight [6]
- External perturbations	Reaction of a shoulder tap [7]	
- Sensory manipulation or perturbation	Timed standing with manipulated surface and vision [8]	Rising, walking, reaching with manipulated vision [9]
- Cognitive attention		Stop walking when talking [10]

[1]Item of Berg Balance Scale (33), [2] Gait test (65), [3] Item of Index of Muscle Function (46,54), [4] Functional Reach (63), [5] Timed Up and Go (66), [6] Figure of Eight (67), [7] Shoulder Tap Test (68), [8]Clinical Test of Sensory Integration and Balance (69), [9] Sensory-Oriented Mobility Assessment Instrument (70), [10] Stop Walking when Talking (37).

These indirect capacity tests are meant to provoke different aspects of the postural control system. However, they still do not give sufficient information about the underlying mechanisms causing eventual limitations of the activity. Further when the test is performed in a rather predictable clinical context, the real situation in which when a person's balance difficulties occur is not assessed. A few self-reporting balance assessments referring to several aspects of balance in activities exist (71,34), but none was developed specifically for patients with PA.

1.7 MEASUREMENT PROPERTIES

Reliability, validity and ability to detect changes in a person or in a group are requirements for assessments if they are to be useful and meaningful for the given purpose. Reliability of an assessment refers to intra- and inter-reliability, the agreement between one tester on several occasions and between several testers respectively. It also refers to test-rest-reliability, i.e. the stability of self-reported data on different occasions. Standard error of measurement expresses absolute reliability in units of the actual measurement. Reliability of an instrument is a prerequisite for validity.

Validity can be of different types. Face validity concerns whether the assessment appears to measure what it intends to measure. Content validity means how far an instrument seems to cover all aspects of the actual domain. Convergent construct validity is the extent to which an instrument correlates to other instruments in the same domain when no 'gold standard' exists, while divergent construct validity is the extent to which an instrument disagrees with those from other domains. (72)

1.8 RATIONALE FOR THE PRESENT THESIS

Patients with PA have several impairments that can influence balance and that are risk factors for falls and fear of falling. Activities with balance limitations may appear earlier and more severely, and lead to more serious consequences, among patients with PA than among healthy individuals. Disability varies, therefore we need to know what tests are applicable for patients with different degrees of activity limitation. Only one capacity test – and no questionnaire developed and validated for evaluating balance among patients with PA – exist (46,54). More differentiated balance capacity tests and self-reports to assess balance validated for this group are needed to facilitate the prescription and evaluation of individually-tailored balance exercise programs.

2 AIM

The overall aim of the work presented in this thesis was to develop assessment of activities with balance limitations among patients with peripheral arthritis. Specific aims were:

- To investigate the applicability and the reliability of some balance capacity tests for use in patients with PA and various degrees of activity limitation (Study I).

- To describe activities in daily life in which patients with PA perceive balance limitations related to specific activities and to construct and assess some measurement properties of a self-reported questionnaire focusing on these activities (Study II).

3 MATERIAL AND METHODS

3.1 PARTICIPANTS

The 117 participants were mainly out-patients, recruited from the rheumatology departments at one university hospital, one county hospital and one physiotherapy clinic in primary health care. All participants had a diagnosis of RA, PsA or other polyarthritis with peripheral joint involvement. They had no additional major impairments or co-morbidities influencing balance (Table II).

In the sub-study of inter-rater reliability included in Study I, three physiotherapists, aged 23 to 40 years, from different specialities, participated. None had previous acquaintance with the clinical balance assessments used in the study. In the sub-study of validity included in Study II, twelve physiotherapists, aged 39 to 63 years participated in the review of the first draft of the Balance Assessment Questionnaire (BAQ-PA).

3.2 DATA COLLECTION

The assessments used in the present work are categorised and presented in Table III.

Table II. Participants in the two studies and their six samples included in the present work.

Study	**I**			**II**		
Sample	**I Applicability**	**II Inter-rater-reliability**	**III Intra-rater-reliability**	**I Interview**	**II Validity**	**III Test-retest-stability**
Participants, n	65	19	22	10	22	20
Participants, n, accumulated	65	70	82	92	112	117
Gender, female/male, n (%)	56/9 (86/14)	17/2 (89/11)	20/2 (91/9)	10/0 (100/0)	22/0 (100/0)	20/0 (100/0)
Age, yrs, md (range)	60 (18-80)	55 (18-75)	55 (19-80)	60.5 (31-73)	61.5 (30-77)	57.5 (30-68)
Symptom duration, yrs, md (range)	12 (0.5-67)	10 (0.5-65)	11 (1-45)	19.5 (5-31)	7 (0-43)	14 (0-49)
Diagnosis, n (%)						
RA	58 (89)	17 (89)	17 (77)	7 (70)	19 (86)	17 (85)
Polyarthritis, other	2 (3)	2 (11)	5 (23)	3 (30)	0 (0)	0 (0)
JRA	0 (0)	0 (0)	0 (0)	0 (0)	2 (9)	2 (10)
Psoriatic arthritis	5 (8)	0 (0)	0 (0)	0 (0)	1 (5)	1 (5)
Vision, n (%)						
Good	13 (20)	8 (42)	13 (59)	5 (50)	4 (18)	4 (20)
Good with glasses	38 (58)	8 (42)	6 (27)	4 (40)	13 (59)	13 (65)
Slightly impaired	14 (22)	3 (16)	3 (14)	1 (10)	5 (23)	3 (15)
Hearing, n (%)						
Good	52 (80)	18 (95)	20 (91)	6 (60)	19 (86)	16 (80)
Slightly impaired	13 (20)	1 (5)	2 (9)	4 (40)	3 (14)	4 (20)
Daily activity level, n (%)		Not assessed	Not assessed			
Sedentary	13 (20)			1 (10)	4 (18)	4 (20)
Light	46 (71)			5 (50)	16 (72)	14 (70)
Intermediate	6 (9)			4 (40)	1 (5)	1 (5)
Heavy	0 (0)			0 (0)	1 (5)	1 (5)
Lower-limb orthopedic surgery, n (%)	38 (58)	Not assessed	Not assessed	6 (60)	13 (59)	12 (60)
Fractures past year, n (%)	3 (5)	Not assessed	Not assessed	1 (10)	0 (0)	0 (0)
HAQ, 0 – 3, md (range)	1.0 (0-2.75)	0.75 (0-2.50)	0.75 (0-2.50)	1.25 (0.13-2.75)	1.0 (0.13-1.33)	1.0 (0.13-1.33)

Table III. Assessments used in the present work.

	Validated for patients with PA	Developed or validated for elderly people	Developed in Studies I and II	Used in Study I	Used in Study II
Self reporting					
- Questionnaire on demographics			x	x	x
- HAQ on activity limitation	x			x	x
- Two questions on self rated balance			x		x
- Three questions on the content of BAQ-PA, first draft			x		x
Semi structured interview			x		x
Capacity tests/tasks					
- A-task; Walking on soft material			x	x	
- B-task; Walking backwards			x	x	
- C-task; Walking in a figure-of-eight		x		x	x
- IMF, balance sub-scale	x			x	
- Timed Up & Go		x		x	
- Berg Balance Scale		x		x	
- Maximal gait speed		x		x	x
- One leg stance	x	x			x
- Timed stands test	x				x
- Active range of motion					x

3.3 PROCEDURE

In Study I, the sub-study of applicability, participants with no or low activity limitation (HAQ ≤ 1) performed all tasks. Those with moderate activity limitation (HAQ 1.125-2) performed the A, B and C tasks after managing the most difficult tasks of the IMF, and performed the IMF after managing the most difficult tasks of the BBS. The participants with severe activity limitation performed the TUG and the BBS only. In the sub-study of inter-rater reliability the participants were video-filmed in a standardized manner. Those with no or low activity limitation performed the A, B and C tasks and those with moderate or severe activity limitation performed the TUG and the BBS. In the sub-study of intra-rater reliability participants with no, low or moderate activity limitation performed the A, B and C tasks and all participants except four with no activity limitation (HAQ = 0) performed the TUG and the BBS

within two to seven days.

In Study II, the first draft of the BAQ-PA was constructed based on data from the interviews with Sample I and reviewed as to content by physiotherapists and participants from Sample I. The participants from Sample II answered the second draft of the BAQ-PA and carried out the capacity tests. The second draft was passed to Sample III, who answered it twice with a one week interval.

3.4 DATA ANALYSIS

As all quantitative data in the present work was nominally or ordinally scaled or appeared in small samples, nonparametric statistics were mainly used. Significance levels were set to p-value of 0.05. The statistics used are presented in Table IV (73).

Table IV. Statistical methods used in the present work.

	Study I			**Study II**		
	Sample I	**Sample II**	**Sample III**	**Sample I**	**Sample II**	**Sample III**
Descriptive statistics						
- Median and Range	x	x	x	x	x	x
Method of analysis						
- Spearman's Correlation coefficient	x				x	
- Reliability Coefficient		x	x			
- Standard Error of Measurement (SEM)			x			
- Wilcoxon's Rank Sum Test					x	
- Weighted Kappa Coefficient						x
- Wilcoxon's Sign Rank Test						x

The qualitative data in Study II was analyzed as to manifest content. Meaning units of daily activities with balance limitations were identified and condensed by deleting units considered not relevant and collapsing units related to similar activities (74). The first draft of the BAQ-PA was based on the remaining units formulated as activities.

3.5 ETHICAL APPROVAL

The design of the studies was approved by the Research Ethics Committee, Huddinge Hospital, Stockholm (D nr 77/97 and D nr 277/02).

4 RESULTS

4.1 STUDY I

In the sub-study of applicability all 65 participants were able to perform tasks for the BBS, 64 the TUG, 56 the IMF; balance/coordination sub-scale, and 47 the A, B and C tasks. Seven participants performed all three A, B and C tasks without oversteps. Twenty-five of 47 participants performed task A without oversteps, 21 made no oversteps in task B, and 11 performed task C without oversteps. Every participant with no activity limitation performed the IMF without difficulty, and four with low activity limitation and seven with moderate activity limitation did so. The scores seemed to increase with activity limitation in single tests, but more pronouncedly so in the total score of the IMF. All participants with severe activity limitation except one, who was not able to rise independently, performed the TUG. In the BBS the most sensitive tasks were ’reaching forward’ and ’360° turn’, with median scores three, and ’standing tandem’ with nine participants scoring zero. ’standing unsupported’, ’sitting unsupported’ and ’standing unsupported with eyes closed’ were performed without difficulties by every participant.

In the sub-study of inter-rater reliability, the reliability coefficients for A, B and C tasks were 0.79, 0.93, and 0.98 respectively. The reliability coefficient for the TUG was 0.97 and for the BBS 0.97.

In the sub-study of intra-rater-reliability, eight of 12 participants showed full agreement between two assessments in total score for the A, B and C tasks. SEMs were one overstep for tasks A and B, and two for task C. Total agreement or a difference of one second between the two tests was found for every participant in the scoring of the TUG and the SEM was 1 second. Total agreement or a difference of one scale step between the two test occasions was found for seven of ten participants for the BBS and the SEM was one scale step.

4.2 STUDY II

In the interview study, activities with balance limitations spontaneously mentioned in the interviews of almost every participant were outdoor activities such as walking on slippery or uneven surfaces but also descending stairs or climbing a kitchen ladder. Seven of ten participants spontaneously indicated fear of falling; all of them had fallen in the past. Winter weather conditions were mentioned by each participant as being another factor affecting balance.

Twenty-seven meaning units were transformed to statements on activities in the first draft of the BAQ-PA, each given a 7-grade scale (72) and one alternative for ‘not relevant’. Three individualized activities could be added and of the total activities three could be brought up as preferred for improvement. Fear of falling and previous falls was also elicited.

Regarding content validity no suggestions were obtained from the interview sample, but suggestions from the physiotherapists prompted changes of the draft. Floor effects caused reduction of six of the remaining 26 statements. No ceiling effects were found. No internal redundancy was found for the remaining 20 statements.

In the sub-study of test-retest-stability, weighted Kappa coefficients were low (< 0.40) for two statements, which were thus excluded. The Wilcoxon sign rank test indicated two systematic differences with p-values < 0.05.

As to construct validity the correlations of the total median value of the BAQ-PA-score to self-rated balance, to avoiding activities because of balance limitations and to number of previous falls (r_s = 0.48 – 0.55) were somewhat higher than the correlations to the capacity tests (r_s = -0.41 – 0.44). The exception was the one-leg stance (r_s = - 0.75). BAQ-PA was also significantly higher among those reporting fear of falling than among those not reporting such fear (md 2, range 0 – 5.5 versus md 1, range 0 – 2, p<0.05). The correlations to HAQ and joint mobility were lower (r_s = -0.35 – 0.28).

Five of 22 participants in Sample II added individual activity statements related to perceived balance limitations and all 22 participants mentioned at least one activity for preferred improvement.

The suggested BAQ-PA contains 18 closed and three open activity statements and also three open questions on activities preferred for improvement, one open question on how the balance limitations manifest themselves and finally two questions with ‘yes’ and ‘no’ answers, one on fear of falling and another one on previous falls (Appendix in Swedish).

5 DISCUSSION

5.1 MAIN FINDINGS

The ageing population of the Western world, including people with disability, and the increasing costs of fall-related injuries have increased attention to and research on balance. The American College of Sports Medicine recently included balance exercise in its recommendations on healthy physical activity for people aged over 65 years and for those aged 50-64 years with chronic conditions such as arthritis and at risk of falling (75). Such exercise calls for relevant and individually-tailored assessment and it has frequently and recently been suggested that no one single test but rather sets of balance tests are necessary to evaluate the many aspects of balance (60). Both persons with PA and physiotherapists have recently suggested that issues related to balance should be included in a core set of measurements based on the ICF (76,77). The present work thus represents an effort to contribute to such a development. The BAQ-PA is the first questionnaire to assess activities with balance limitations identified by patients with PA, and a number of applicable and reliable tests are suggested for patients with varying degrees of activity limitation.

Considering the need for differentiated tests, the present work indicates that for patients with severe activity limitations the TUG and the BBS seem to be most applicable. For patients with moderate and low activity limitation the Figure of eight seems most appropriate, while none of the tests investigated were applicable for patients with no activity limitation as indicated by the HAQ. However, none of the tests that assess stance on both feet, unperturbed or with eyes closed could be used to distinguish those with balance problems, regardless of activity limitation degree, in the present population (Study I). This has been found previously (17) and also tallies with the present finding that questions in the first BAQ-PA draft relating to balance difficulties in six activities mainly when standing still displayed ceiling effects (Study II).

The present results indicate that the TUG and the BBS represent a similar degree of difficulty and that both are less difficult to perform than the IMF and the Figure of eight, which thus represent another degree of difficulty. This was indicated by good or moderate correlations between the two former and the two latter, but the correlations between either of the former and either of the latter were generally weaker (Study I). The correlations between the TUG and the BBS were similar to those found by Podsiadlo (66), which seems logical as both tests were developed for elderly persons with more severe balance difficulties.

The patients with PA and a mean age of 60 years or below included in any of three samples of the present work (Study I) appeared to have lower BBS and TUG scores than healthy individuals aged 60 or above (78). While our patients scored mean 50 (range 32-56) on BBS, the healthy sample scored mean 55 (range 52 – 56). The TUG results were mean 11 s (range 5-34) in our sample and mean 8 s (7– 10) for the healthy sample (78). This may indicate that balance limitations in activities appear earlier and more severely among patients with PA. This is further supported by our finding that even the patients with mainly low activity limitation (Study II) had a lower fast-gait speed (1.36 m/s) than a sample of healthy 76-year old women (1.46 m/s) (65). It may be speculated whether the slower gait speed indicates caution and, in part, preparation for more prompt reactions to perturbations when moving around.

The interviews showed that the patients perceived balance limitations mainly in outdoor activities, especially on uneven or slippery surfaces and when moving downhill or downstairs. These activities are more or less difficult for everyone. However, the fear of falling indicated by the present participants is probably not as frequent as in the general population. A population-based study of persons with RA reports a 50% fear of falling (35), while in the present work 64% of the participants recruited in the health-care system indicated such fear (Study II). The differences are probably due to different recruitment of samples. The fear is understandable considering impairments of the lower extremities and the hands that may result in poor reactive movements to prevent falling. Such impairments do not seem to be reduced through general physical exercise (79), but may require exercise programs targeting balance issues. Such programs have resulted in balance improvements among the elderly (80,81). Awareness of low bone density may also affect fear of falling. As fear of falling and falling can be risk factors for each other (45) it seems reasonable to recognize these among patients with PA. While the literature is scarce as regards falls and their consequences among persons with RA, an increased incidence of hip fractures compared to the normal population has been reported (82,83). One study reports that 18 % of falls result in fractures among persons with RA (35) compared to 10-13 % among elderly persons (84,85).

The 18 activities of the BAQ-PA cover only three of nine ICF domains of activity and participation: mobility; self-care and community, social and civic life. These represent areas traditionally related to balance difficulties and may reflect the preconception of the interviewer, who also analyzed the interview data. However, a certain overlap between domains exists and may thus be covered by the activities of the suggested BAQ-PA. Further, the option of adding individual activities with balance limitations may serve the purpose of covering additional domains (Study II).

The purpose of the interviews in Study II was to identify activities with perceived balance limitations in order to construct a questionnaire on their basis. ‘Taking involuntary sidesteps’ was not considered as an activity and thus not included. However, this element could be included in all the activities retained in the suggested BAQ-PA, although not specifically elicited. During the subsequent validating process it gradually became obvious that not only the activity itself, but also how the limitations manifest themselves was important to the participants. One example of this was that taking involuntary sidesteps, which is an adequate strategy to prevent falling, was considered as balance failure. To plan interventions it is thus of interest not only which activities are limited regarding balance, but also how limitations manifest themselves. Thus in the suggested BAQ-PA, a question which roughly covers this was added.

Several aspects of perceived limitations, such as degree of difficulty, frequency of performance and relevance of the activity, are of importance to the sensitivity of an assessment (86, 56). The BAQ-PA definitely covers the first aspect through 18 activity statements with fixed answers on degree of difficulty. The other aspects are considered to be covered through the three additional questions on individual difficulties and the possibility to choose three areas for preferred improvement. The degree of fear of falling could have been better penetrated by a graded question. This might be an issue of the further development of the BAQ-PA.

5.2 METHODOLOGICAL CONSIDERATIONS

One strength of the present study is that patients were recruited from specialized rheumatology as well as from primary health care. Although the samples were small, they displayed a wide variety in demographics and disability. An additional strength is the use of many assessments validated for patients with PA or for the elderly. Processes for validation and reliability assessment suggested in theoretical works on measurement properties were followed. Thus it is suggested that the internal validity and external validity of the present work are acceptable.

As to external validity, the sample recruitments were mainly initiated from the patients, who reacted to information on the study that was posted at their health care unit. This may have resulted in a selection of patients who had an interest in their health and/or balance difficulties. This may on one hand have resulted in the samples being biased by inclusion of those with good functioning, but this might have been balanced by those with poor functioning, particularly related to balance issues. The results of Study II cannot be generalized to men. Our intention to include a representative proportion of men failed, one reason perhaps being that they do not consider balance to be a difficulty; or that they do not visit physiotherapy departments as much as women do. Thus, the BAQ-PA should still be valid for the majority of those with PA for assessing activities with balance limitations. To elucidate PA-specific balance difficulties, it might have been more relevant to investigate a sample of patients below 65, as many elderly persons, as part of the natural ageing have several impairments related to the postural control system and are more prone to chronic diseases and resulting disability – including balance difficulty (87,88).

It would have been wise to include some capacity tests, which provoke other aspects of balance through e.g. external or manipulated perturbations or cognitive attention. The reported activities with balance limitations on uneven surfaces (Study II) strengthen the case for such supplements. A more sensitive test than walking on an Airex mat in Study I could have been the Sensory Oriented Mobility Assessment Instrument (70). Other tests more provocative for the postural control system could have been the Functional Gait Assessment (89) or dual tasks.

It may seem surprising that pain was not included in the present work, either in the description of the participants or as a covariate of activities with balance limitations or their assessment. However, pain ratings obtained in Study I had, surprisingly, very weak correlations with the balance test results (data not shown). This may in part be explained by none of the patients reporting recent inflammatory pain sites (data not shown). Similarly, medication, which might be a contextual factor influencing balance, was not reported.

5.3 CLINICAL IMPLICATIONS

When assessing activities with balance limitations among patients with PA it is important to recognize individual difficulties and preferences. Using the BAQ-PA is a good start to identify such aspects. The more explicitly the individual balance difficulties are expressed, the better the exercise efforts can be chosen. The BAQ-PA questions on how the difficulties manifest themselves and those on fear of falling and previous falls give important information for further tests of balance capacity and eventually an individually-tailored exercise program.

To adequately test patients with severe activity limitation, the BBS and the TUG should be preferred, while the IMF and the Figure of eight are more suitable for those with moderate and low activity limitation. The one-leg stance might be useful for screening purposes as it correlates highly with self reported balance difficulties and might also give a rough indication of weight shifting, which is essential for many activities. However, when used for this purpose 10 s may be a sufficient test time (90). Other, more demanding, tests may be useful for patients with moderate and low activity limitation (70,89) as this category may increase with more efficient drug treatment.

Traditionally balance exercise programs for patients with PA, similarly to the tests used, may have contained elements that did not provoke the postural control system sufficiently. The results of Study II indicate more demanding balance exercises. Thus, moving downhill, on uneven or moving surfaces, and managing unexpected obstacles may provoke reactive movements. Further, exercises in half or full darkness, those including dual tasks or falling techniques are relevant examples. Outdoor exercises are adequate. Pool exercises do not provoke reactive movements (31). The individual activities chosen for improvement may strengthen self-efficacy and keep the fear of falling at a manageable level. For persons with a history of several falls, a multi-professional effort may be required.

5.4 FUTURE STUDIES

Intense research on balance and falls that mainly concentrates on elderly people may benefit other groups as well. However, there is still a need to elucidate and further probe the definitions of balance. Laboratory investigations may be needed for analysis of postural control among patients with PA in order to better understand what occurs during balance capacity tasks. Further, there is a need to develop exercise models and outcome assessment methods for specific patient groups such as those with PA. Adequate capacity tests with higher biomechanical demands should be developed or identified and validated for patients with PA and different degree of activity limitation. It is also important to investigate whether the activities with balance limitations identified and assessed in the present work among patients with PA are arthritis-specific, and whether the findings are valid also for younger and middle-aged people with PA of either gender. The BAQ-PA should be evaluated for sensitivity to change and fall prediction.

5.5 CONCLUSIONS

- The TUG and the BBS are applicable and most sensitive for patients with severe activity limitation, and the Figure of eight and the IMF for patients with moderate and low activity limitation.

- When using the BAQ-PA for female patients with PA, the patient's perspective on individual activities and wishes for improvements should be carefully penetrated. For exercise planning, a question on how balance difficulties manifest themselves as well as information from the questions on fear of falling and previous falls is important.

- When assessing indirect balance with capacity tests it is important to bear in mind the biomechanical demands and the level of activity limitation for which the tests are intended. The capacity tasks investigated for assessing balance on both feet stance, unperturbed or with eyes closed are not relevant for the majority of patients with PA.

6 ACKNOWLEDGEMENTS

Jag vill uttrycka mitt varmaste tack till alla som gjorde detta arbete möjligt och ett särskilt tack vill jag rikta till:

Alla patienter som medverkade och delade med sig av sina värdefulla erfarenheter.

Karin Harms Ringdahl och Lena Nilsson Wikmar vid Sektionen vid Sjukgymnastik för att jag fick möjlighet att utföra mitt avhandlingsarbete där.

Min huvudhandledare, Christina H Opava (f d Stenström), för att du ledde mig framåt med din föredömliga forskarkunskap och pedagogiska förmåga. Tryggt, tydligt och tålmodigt stödde du mig genom min slow research education.

Min bihandledare, Elisabeth Olsson, med din solida forskarkunskap och erfarenhet. Fastän du kom in sent i min utbildning pekade du med stort engagemang på knutpunkterna i arbetet.

Min externa mentor, Brita Klefbeck, för ditt kloka stöd samt mina medförfattare Ulrika Bogren och Jenny Bolin.

Alla nuvarande och gamla medlemmar i Gula forskningsgruppen vid Sektionen för Sjukgymnastik för ni delade med er av er kunskap i alla intressanta och lärorika diskussioner i reumatologisk sjukgymnastik, och inte minst för gott kamratskap.

Vanja Landin vid Sektionen för Sjukgymnastik för all vänlighet och service i administrativa frågor.

Alla före detta kollegor i Reuma-gruppen vid Södersjukhuset, där allt började, och vid Huddinge Universitetssjukhus för allt intresse och hjälpsamhet.

Sjukgymnasterna vid Hälsopoolen, särskilt Anne-Marie Hävermark och Åsa Björklund för allt stöd och all hjälpsamhet genom åren. Sjukgymnasterna i Reuma-gruppen på Eskilstuna länssjukhus för allt intresse och vänlighet vid mina besök, och särskilt min vän Christina Emilson, för alla fina sammankomster. Sjukgymnasterna i Reuma-gruppen på Karolinska Universitetssjukhuset, och särskilt min vän Li Alemo-Munters för all hjälp och intressanta samtal.

Alla sjukgymnaster på Reumatologkliniker i landet som delade med sig av sina värdefulla synpunkter.

Mina närmaste chefer på Hälso- och sjukvårdsnämndens förvaltning, Bengt Haglund och Birgitta Hjelte för stöd och uppmuntran och också alla mina intresserade kollegor där.

Barbro och Hasse för att ni är ni, Marieann och Ulla för alla stärkande golfrundor, och Ing-Mari och Karin för givande diskussioner och konsertbesök.

Min familj och mina vänner för att ni alltid finns där, ni vet vilka ni är.

Centrum för Vårdvetenskap och Reumatikerförbundet för finansiellt stöd.

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Balans-enkät för personer med reumatisk ledsjukdom

Ange Dina balanssvårigheter vid aktiviteterna nedan. Utgå från Din egen vardag och de aktiviteter som Du brukar utföra och det sätt Du brukar utföra dem på. Markera Dina balanssvårigheter enligt skalan nedan.

Aktivitet:	**0 inga svårigheter**	**1 nästan inga svårigheter**	**2 vissa svårigheter**	**3 ganska stora svårigheter**	**4 stora svårigheter**	**5 mycket stora svårigheter**	**6 kan inte utföra alls**
Ta på skor i stående	☐	☐	☐	☐	☐	☐	☐
Ta på strumpor i stående	☐	☐	☐	☐	☐	☐	☐
Ta på under-kläder i stående	☐	☐	☐	☐	☐	☐	☐
Stå med fötter tätt ihop	☐	☐	☐	☐	☐	☐	☐
Vrida på huvudet i stående	☐	☐	☐	☐	☐	☐	☐
Titta upp i taket i stående	☐	☐	☐	☐	☐	☐	☐
Stå i en buss som åker	☐	☐	☐	☐	☐	☐	☐
Gå/röra sig i folksamlingar	☐	☐	☐	☐	☐	☐	☐
Gå/röra sig i mörker	☐	☐	☐	☐	☐	☐	☐
Vrida på huvudet gående	☐	☐	☐	☐	☐	☐	☐
Vända sig helt om i gående	☐	☐	☐	☐	☐	☐	☐
Gå/röra sig på halt väglag	☐	☐	☐	☐	☐	☐	☐
Gå/röra sig på ojämnt underlag	☐	☐	☐	☐	☐	☐	☐
Ta ett stort kliv över något	☐	☐	☐	☐	☐	☐	☐
Gå nerför en trappa	☐	☐	☐	☐	☐	☐	☐
Kliva upp/ner på köksstege	☐	☐	☐	☐	☐	☐	☐
Dansa	☐	☐	☐	☐	☐	☐	☐
Cykla	☐	☐	☐	☐	☐	☐	☐
Andra aktiviteter med balanssvårigheter:							
	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐

I vilka av dessa aktiviteter skulle du helst vilja förbättra din balans? Välj ut tre och rangordna dem nedan:

1……

2……..

3……

Hur yttrar sig dina balanssvårigheter i aktiviteterna ovan?

…….

…….

…….

* * * * * * *

- Är du rädd för att ramla vid någon/några aktivitet/er i det dagliga livet? Ja □ Nej □
- Om ja vid vilken/vilka:…….....

  ……....

- Har Du ramlat det senaste året? Ja □ Nej □
- Om ja, hur många gånger:……
- Ange kortfattat hur fallet/fallen gick till.....

  ……

  ……