Hand Function and Activity Limitation According to Health Assessment Questionnaire in Patients with Rheumatoid Arthritis and Healthy Referents: 5-Year Followup of Predictors of Activity Limitation (The Swedish TIRA Project)

MATHILDA A. BJÖRK, INGRID S.M. THYBERG, THOMAS SKOGH, and BJÖRN U.C. GERDLE

ABSTRACT. ***Objective.*** This study identifies baseline predictors of future activity limitation in rheumatoid arthritis (RA). To reinforce the utility of instruments assessing functional ability/activity limitation, we used reference data from healthy referents.

Methods. This study includes 189 patients (69% women) with recent-onset RA (onset of joint swelling not more than 12 months at diagnosis) in a prospective cohort ("the Swedish TIRA project") during 27 months from 1996 through 1998. Regular followups were done for a period of 5 years, and 123 healthy persons (50% women) were recruited as referents. Hand function was assessed by the "grip ability test (GAT)" and "signals of functional impairment" (SOFI). Grip force was measured with the electronic device Grippit™. Activity limitation was assessed with the Swedish version of the Health Assessment Questionnaire (HAQ).

Results. Throughout the study and for both sexes, GAT, grip force, SOFI-hand, and HAQ were significantly different for the patients compared to healthy referents. In the healthy referents, HAQ was mainly related to age and GAT, whereas in RA HAQ was most obviously linked to grip force. Five years after diagnosis only 8% of HAQ outcome was explained by the baseline measures: HAQ, grip force, SOFI-lower limb, sex, walking speed, and GAT.

Conclusion. Our study provides valuable reference data for several functional ability and activity limitation measures. The HAQ score was explained by different variables in healthy referents compared to patients with RA. Five years after diagnosis only 8% of HAQ outcome was explained by the variables assessed at inclusion. (First Release Jan 15 2007; J Rheumatol 2007;34:296–302)

Key Indexing Terms:
RHEUMATOID ARTHRITIS DISABILITY LONGITUDINAL STUDIES
SEX DIFFERENCES REFERENCE VALUES

The progressive nature of rheumatoid arthritis (RA) often leads to severe disability[1,2], including work disability and an economic burden for society[3]. Identification of early predictors of disease and disability progression in RA attracts great interest[4,5]. The disease course develops most rapidly during the first years[1,6]; however, early initiation of therapy is associated with mitigated disease and disability within the first 3 months after diagnosis[7]. We recently reported analogous rapid improvements in hand function[8] and health-related quality of life[9]. In a longer time perspective, contradictory conclusions have been drawn. Five years after diagnosis, Combe, *et al* reported improvements regarding disability compared to baseline[10], although other researchers have found signs of functional deterioration 5 years after diagnosis[11,12].

According to the International Classification of Functioning, Disability and Health (ICF), disability is an umbrella term[13] that includes a wide range of measurements, such as hand function assessments highlighting impairment and the Health Assessment Questionnaire (HAQ) focusing on activity limitations[14]. The HAQ is commonly used as an outcome variable and seems to have a less favorable course in women[4,7,15].

Hand function is a complex concept that can be measured

From the Division of Occupational Therapy, Department of Neuroscience and Locomotion, Faculty of Health Sciences, Linköping, Sweden.

Supported by grants from The Vårdal Foundation, the Swedish Research Council (project number K2006-74X-14594-04-03), the Research Council of Southeast Sweden (FORSS), the Swedish Rheumatism Association, and Karin Svensson's and Siv Olsson's research foundations at the County Council of Östergötland.

M.A. Björk, BSc, OT, Division of Occupational Therapy, Department of Neuroscience and Locomotion, Faculty of Health Sciences, Linköping University and The Vårdal Foundation, The Swedish Institute for Health Sciences; I.S.M. Thyberg, PhD; Thomas Skogh, MD, PhD, Division of Rheumatology/AIR, Department of Molecular and Clinical Medicine; B.U.C. Gerdle, MD, PhD, Division of Rehabilitation Medicine, Department of Neuroscience and Locomotion, Faculty of Health Sciences, Linköping University, and Pain and Rehabilitation Centre, University Hospital, Linköping, Sweden.

Address reprint requests to M. Björk, Faculty of Health Sciences, Division of Occupational Therapy, Department of Neuroscience and Locomotion, SE-581 85 Linköping, Sweden. E-mail: matbj@inr.liu.se

Accepted for publication October 16, 2006.

by variables such as grip force, grip ability, and range of motion. These different aspects correlate weakly to one another in the bivariate context[8]. We earlier reported that different hand function measures affect women and men with RA in different ways because men are stronger and women usually have greater flexibility in their finger joints[8]. In early arthritis, hand dysfunction is a strong predictor of a worse prognosis[16]. We have found that all the different aspects of hand function correlate with HAQ up to the third year after diagnosis[8], but the capacities of hand function tests to predict HAQ in a longer time perspective have not been studied in detail.

When attempting to predict disease outcome, different methods have been used: univariate analysis[10,17]; logistic regression[17,18]; and generalized estimating equation (GEE)[5]. Hoogendoorn, *et al*[19] highlight the benefit of using a modeling approach to increase the precision of the analysis instead of traditional statistics when analyzing predictors of an outcome. One approach is to use a technique that finds latent variables in large, longitudinal data[20]. Projection methods — e.g., principal component analysis (PCA) and projections to latent structures (PLS) — project a set of cases onto a few latent variables to uncover an underlying pattern. Projection methods have several other advantages: they are robust to outliers and they deal with missing data as well as noisy and highly collinear data and data with nonlinear relationships[21], making them useful to predict longterm outcomes of HAQ.

Our study has 3 main goals: (1) to compare hand function and HAQ between healthy referents and patients with RA in women and men; (2) to analyze the relationship between hand function and HAQ; and (3) to determine whether patient characteristics at diagnosis can predict the patient's HAQ score 5 years after the diagnosis of RA.

MATERIALS AND METHODS

Patients. The Swedish TIRA Project (Swedish acronym for "early intervention in rheumatoid arthritis") started in 1996 in cooperation between 10 rheumatology units where 320 patients with recent-onset RA (onset of joint swelling ≤ 12 months but ≥ 6 weeks) were recruited during a 27-month period[7]. The patients fulfilled ≥ 4/7 RA classification criteria[22] or at least exhibited morning stiffness ≥ 60 minutes, symmetrical arthritis, and arthritis of small joints. Followups were done after 3, 6, 12, 18, 24, 36, 48, and 60 months (M3–M60). At all followups, the patients met with a physician, an occupational therapist, and a physiotherapist and were given individual treatment based on their needs. At the 5-year followup (M60), 8 of the 10 rheumatology units still participated in the TIRA project with a total study population of 251 patients. The 130 women [mean age 53 yrs at inclusion; range 18–81 yrs, standard deviation (SD) 15 yrs] and 59 men (58 yrs; range 18–80 yrs, SD 13 yrs) remaining in the project at M60 were included in our study.

Patient characteristics. The erythrocyte sedimentation rate (ESR) and serum level of C-reactive protein (CRP) were analyzed at all planned visits. A 28-joint count of tender and swollen joints[23] was registered, and the physician's global assessment of disease activity (PGA) was estimated on a 5-degree scale (0–4), where 0 corresponds to no activity and 4 represents high activity[24]. The patient's well-being during the last week was self-reported on a 100-mm visual analog scale (VAS). Similarly, the average pain related to the rheumatic disease during the last week was reported by VAS, where 0 represented no pain and 100 mm maximal pain. Walking speed was defined as the time it took to walk (with or without assistive devices) 20 meters as fast as possible. Range of motion was measured using the instrument "signals of functional impairment" (SOFI). The test is divided into 3 parts: upper limb function (SOFI-upper limb), lower limb function (SOFI-lower limb), and hand function (SOFI-hand). The scoring is an ordinal rating scale 0–2, where 0 indicates "full function" and 2 "cannot perform." The possible range in score is 0–12 in SOFI-upper limb function and 0–16 in SOFI-lower limb function[25].

Healthy referents. Healthy referents were recruited from staff at the hospitals in Linköping and Norrköping and through pensioners' associations: 62 women (mean age 59 yrs; range 21–84 yrs, SD 15 yrs) and 61 men (mean 60 yrs; range 21–89 yrs, SD 15 yrs) with self-perceived normal hand function. The referents were recruited so as to have the same age distribution as the patients in the TIRA cohort at M36.

Hand function. Grip force (newtons, N) was measured using the electronic instrument Grippit (AB Detektor, Göteborg, Sweden). Peak and average values were achieved during a 10-second period for both hands. The test-retest scores have previously been shown to be high regarding peak as well as average values[26].

SOFI-hand, which is one of the 3 parts in SOFI[25], was used to measure the range of motion in the hands. It consists of 4 items: "grip a plastic tube," "bend fingers around a pencil," "make a round pincer grip," and "oppose the tip of the thumb to the base of the 5th finger." In the first item a larger tube was used for men than for women. In the SOFI-hand, the possible range in score is 0–16, where a low score indicates a full function. The index has been evaluated regarding reliability, validity, and sensitivity and was found to be acceptable[25].

Grip ability was assessed using the grip ability test (GAT) developed by Dellhag and Bjelle[27]. GAT consists of 3 items: "put a flexigrip stocking over the non-dominant hand," "put a paper clip on an envelope," and "pour water from a jug." The score (10–276) is based on the time consumption of the 3 items. A high score corresponds to decreased hand function. The reliability (intra-/inter-observer tests) and internal consistency of GAT have shown to be high[27].

Health Assessment Questionnaire (HAQ). The HAQ measures activity limitation and was self-reported by the TIRA patients at the time of inclusion and at the followups. It consists of 20 questions in 8 subcategories: dressing and grooming, arising, eating, walking, hygiene, reach, grip, and common daily activities. The response alternatives for each of the 20 questions are "without any difficulty" (score = 0), "with some difficulty" (score = 1), "with much difficulty" or "with use of an assistive device" (score = 2), and "unable to do" (score = 3). The highest score obtained for any question of a given subcategory determines the score for the subcategory. The questionnaire then generates a score from 0 to 3, based on the sum of the scores for the various subcategories divided by the number of subcategories responded to. The Swedish version of HAQ, used in the present study, has been found to be valid and reliable[14].

Ethical considerations. The study protocol was approved by the local ethics committees associated with the participating units. All patients and healthy referents also gave written informed consent to participate.

Statistical analyses. A 3-way ANOVA was used to analyze differences in the development of hand function and HAQ between different followups (M0–M60) and differences between women and men. Differences in hand function and HAQ between the TIRA patients and healthy referents were tested with student t-tests, and differences in pharmacological treatment were calculated in a cross-tabulation. A correction of the p values with Tukey's method was performed to reduce the risk of mass significance. Projections to latent structures using SIMCA-P+ version 11.0 (Umetrics Inc. Umeå, Sweden) was used to regress HAQ using the different hand function measurements as X variables in cross-sectional analysis. To regress HAQ after 5 years longitudinally with patient characteristics at diagnosis as X variables, a PLS based technique [projections to latent structures discriminate analysis (PLS-DA)] was used[29]. In the longitudinal analyses, HAQ at M0 and M60 was categorized into "unaffected HAQ" and "affected HAQ"; these 2 groups formed the classes in the PLS-DA. The cutoff limits were based on the HAQ scores in the healthy referents. Accordingly, the 95% confidence interval in

the healthy referents' HAQ scores (i.e., 0–0.0835) was categorized as "unaffected" HAQ, and higher value was categorized as "affected" HAQ. The PLS-DA identified variables at M0 that can separate "unaffected" from "affected" HAQ at M60. Two concepts were further used to describe the results of both the PLS and PLS-DA analyses: R^2 and Q^2. R^2 describes the goodness of fit — the fraction of sum of squares of all the variables explained by a component. Q^2 describes the goodness of prediction — the fraction of the total variation of the variables that can be predicted by a component[21]. The variable influence on projection (VIP) value gives information about the relevance of each X variable, for both the X and Y-model parts. X-variables with a VIP ≥ 0.80 affect the model the most. A p value < 0.05 was considered as a significant difference in all tests.

RESULTS

Dropouts in the TIRA cohort. Sixty-two (25%) of the 251 patients included at the 8 rheumatology units at M0 did not participate in the study at M60. The dropouts were significantly older (p = 0.001) with a mean age of 64 years, SD 15, compared to the patients in the study group (mean 54 yrs, SD 15). The proportion of men was higher among the dropouts (45% vs 31%, p = 0.045) and the dropouts had significantly (p = 0.030) lower ESR (mean 28 mm/h, SD 19 vs 36 mm/h, SD 24). There were no other significant differences between the dropouts and the included patients concerning the variables listed in Table 1.

Pharmacological treatment. Ongoing medication was registered at all followup visits. At the time of inclusion, 3.9% of the women and 3.4% of the men [nonsignificant (NS) sex difference] were taking disease modifying antirheumatic drugs (DMARD). At the same occasion, 44.6% and 45.8%, respectively, (NS) were prescribed DMARD. At the 3-year followup, 65.3% of the women and 74.6% (NS) of the men were taking DMARD, and at M60 the corresponding proportions were 58.5% and 64.4% (NS).

Nonsteroidal antiinflammatory drugs (NSAID) were taken by 76.3% of women and 81.4% of men at time of inclusion (NS). At M36, 58.5% of both women and men took NSAID. At M60, 41.3% of the women and 43.6% of the men (NS) took NSAID.

Hand function and HAQ in patients and referents. The patient characteristics including hand function and HAQ at diagnosis (M0) and after 5 years (M60) are displayed in Table 1. All variables measured except walking speed, SOFI-upper limb, and SOFI-lower limb had significantly improved in patients at M60. SOFI-hand, GAT, grip force, and HAQ in healthy referents were measured at one occasion (Table 1).

According to the 3-way ANOVA, there were no sex differences in progress of GAT, grip force, or SOFI-hand from M0-M60. There were no differences in GAT between women and men at any followups (p > 0.05). According to SOFI-hand, men had a more affected range of motion than women at M0 (p = 0.032), M3 (p = 0.037), and M6 (p = 0.001); thereafter there were no significant differences. At all followups, men had a grip force higher than women (p < 0.001). As measured by GAT and Grippit, both women and men had significantly more affected scores at M0 compared to the subsequent followups. Measured by SOFI-hand women and men had a significantly worse score at M0 compared to all followups except M60, when the score tended to deteriorate again (Figure 1).

Table 1. Patient characteristics, hand function and HAQ in women and men at diagnosis (M0) and after 5 years (M60). Hand function and HAQ in healthy women and men. Data are presented as mean and standard deviation (SD).

	Healthy Referents		Patients			
			Diagnosis (M0)		After 5 Years (M60)	
	Mean (SD)		Mean (SD)		Mean (SD)	
	Women n = 62	Men n = 61	Women n = 130	Men n = 59	Women n = 130	Men n = 59
Patient characteristics						
Age, yrs	59 (15)	60 (15)	53 (15)	58 (13)		
ESR, mm/h			35 (25)	37 (24)	21 (19)	25 (21)
CRP, mg/l			27 (27)	32 (32)	14 (21)	19 (23)
Swollen joints, 0–28			9 (6)	10 (5)	2 (4)	3 (4)
Tender joints, 0–28			9 (8)	10 (7)	3 (5)	3 (6)
PGA, 0–4			2.0 (0.8)	2.1 (0.7)	1.0 (0.8)	1.0 (0.9)
Pain, VAS 0–100 mm			48 (23)	53 (29)	40 (26)	39 (25)
Wellbeing, VAS 0–100 mm			46 (25)	41 (26)	37 (25)	37 (24)
Walking speed, s			14 (7)	14 (8)	14 (7)	13 (4)
SOFI-upper limb, 0–12			0.8 (1.6)	1.6 (2.3)	0.8 (1.3)	1.5 (2.2)
SOFI-lower limb, 0–16			2.3 (2.2)	2.1 (2.0)	2.0 (2.4)	2.0 (1.9)
Hand function						
Grip force, N	198 (66)	343 (110)	92 (66)	185 (113)	121 (77)	218 (103)
SOFI-hand, 0–16	0.1 (0.3)	0.6 (1.1)	2.5 (2.8)	3.2 (2.9)	2.0 (2.2)	2.6 (2.2)
GAT, 10–276	17 (4)	18 (4)	27 (20)	26 (10)	22 (14)	22 (8)
HAQ, 0–3	0.07 (0.2)	0.05 (0.1)	0.9 (0.6)	0.8 (0.5)	0.8 (0.6)	0.5 (0.5)

ESR: erythrocyte sedimentation rate; CRP: serum C-reactive protein (mg/l); PGA: Physician's global assessment of disease activity; VAS: visual analog scale; SOFI: signals of functional impairment; GAT: grip ability test; HAQ: Health Assessment Questionnaire.

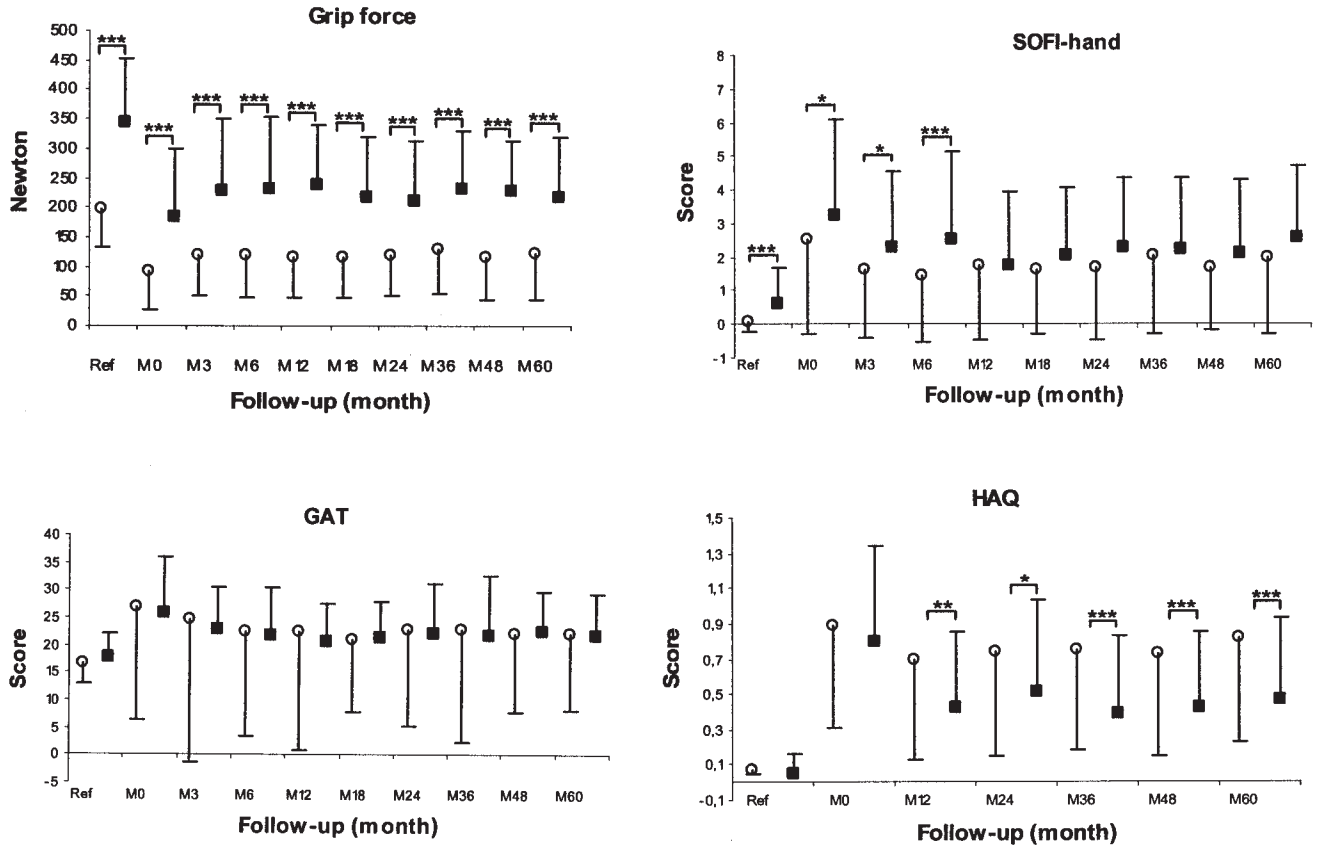

Figure 1. Mean value of grip force (right hand average value), SOFI-hand, GAT, and HAQ at the different followups in TIRA (M0-60) and at one occasion for healthy referents. In GAT, SOFI-hand and HAQ a high score indicates an increased disability. Bars represent ± 1 SD. Differences between women and men; *p < 0.05, **p <0.01, ***p < 0.001. —○—: Women; —■—: Men.

The progress of HAQ in the TIRA cohort is significantly different ($p < 0.001$) in women compared to men (Figure 1). In women, the HAQ score improved significantly from M0 to M3 and then remained stable until M60, when it deteriorated significantly. In men, the HAQ score improved significantly during the first year and was thereafter stable without any significant changes. At M0, there was no significant difference ($p = 0.12$) between the HAQ scores in women and men with RA, but at the following followups M12-M60 men had a significantly better score than women. The patients consistently had a significantly worse HAQ score than the referents.

In the healthy referents, men had a grip force higher than women ($p < 0.001$), whereas women had a significantly better range of motion according to SOFI-hand ($p < 0.001$). Neither GAT nor HAQ differed significantly between healthy women and men ($p = 0.09$ and $p = 0.43$, respectively). All of the 3 hand function assessments (GAT, Grippit, and SOFI-hand) differed significantly between the patients and referents at all followups.

Relationship between HAQ and hand function — cross-sectional analyses. To understand the cross-sectional relationship between different aspects of hand function and HAQ in healthy referents and in the TIRA cohort, HAQ was regressed in a number of PLS models using the different hand function variables as predictors. In addition, sex and age were included as variables in the analyses.

In healthy referents, one component explaining 40% of the variation in HAQ ($Q^2 = 0.13$) was identified. GAT (VIP = 1.60) and age (VIP = 1.11) were the important predictors (VIP > 0.80) (Table 2). In the TIRA cohort at M0, 2 significant components explained 38% of the variation ($Q^2 = 0.34$) in HAQ, with all 3 hand function variables identified as important predictors: grip force (VIP = 1.43), SOFI-hand (VIP = 1.14), and GAT (VIP = 1.09). At M60 one significant component was identified in the PLS, explaining 35% of the variation in HAQ ($Q^2 = 0.34$). Grip force (VIP = 1.68) and GAT (VIP = 1.03) were still important predictors (Table 2).

Sex was not an important predictor of HAQ in healthy referents or in patients with RA. In both healthy referents and patients with RA, GAT was an important predictor of HAQ. Furthermore, there were some differences in important predictors of HAQ between the referents and RA patients; however, in the group with RA, the same predictor — grip force — was identified at M0 and M60.

Predictors of HAQ at M60 in patients — longitudinal analysis. A PLS-DA was calculated to investigate whether an unaffected HAQ (score 0–0.0835) or affected HAQ (score >

Table 2. Projections to latent structures (PLS) of health assessment questionnaire (HAQ) as the dependent variable (Y) and hand function variables, sex, and age as predictors (X variables) in healthy referents and in patients with RA at diagnosis (M0) and 60 months after diagnosis (M60). For each variable, a variable influence of projection (VIP) is given, and a variable with a VIP value > 0.80 is considered to be an important predictor.

Variables	Healthy Referents VIP	Patients M0 VIP	Patients M60 VIP
Grip force (N)	0.78	1.43	1.68
SOFI-hand (0-12)	0.72	1.14	0.71
GAT (10–276)	1.60	1.09	1.03
Sex	0.26	0.62	0.65
Age	1.11	0.29	0.41
R^2/Q^2	0.40/0.13	0.38/0.34	0.35/0.34

GAT: grip ability test; SOFI: signals of functional impairment.

0.0835–3) at M60 may be explained by variables at M0. It resulted in one significant component, explaining 8% of the group belonging in HAQ. The strongest predictor of HAQ at M60 was HAQ at M0 (VIP = 1.97). Other important predictors at M0 were grip force (VIP = 1.75), SOFI-lower limb (VIP = 1.41), sex (VIP = 1.39), walking speed (VIP = 1.27), and GAT (VIP = 1.20) (Table 3).

Because the laboratory variables and clinical signs (tender joints, swollen joints, PGA, CRP, and ESR) at inclusion had a VIP value < 0.8, these were not important variables when explaining HAQ at M60 (Table 3).

Table 3. Variables with variable influence on projection (VIP) values of component 1 when HAQ group at M60 was regressed in partial least squares discriminate analyses at M60 in the TIRA-cohort. At the bottom line is given R^2 and Q^2. The variables with VIP > 0.80 (above the dotted line) are most important.

Type of Variable	Variables	Patients
Y (M60)	HAQ (group 0 or 1) at M60	VIP
X (M0)	HAQ (group 0 or 1)	1.97
X (M0)	Grip force	1.75
X (M0)	SOFI-lower limb	1.41
X (M0)	Sex	1.39
X (M0)	Walking speed	1.27
X (M0)	GAT	1.20
X (M0)	Wellbeing	0.78
X (M0)	CRP	0.63
X (M0)	SOFI-hand	0.63
X (M0)	ESR	0.49
X (M0)	Tender joints	0.42
X (M0)	PGA	0.37
X (M0)	Pain intensity	0.30
X (M0)	Age	0.22
X (M0)	SOFI-upper limb	0.15
X (M0)	Swollen joints	0.09
R^2/Q^2		0.080/0.014

HAQ: Health Assessment Questionnaire; SOFI: signals of functional impairment; GAT: grip ability test; CRP = serum C-reactive protein (mg/l); ESR: erythrocyte sedimentation rate; PGA: Physician's global assessment of disease activity. HAQ group 0 indicates an unaffected HAQ score and group 1 an affected HAQ score (see test for details).

DISCUSSION

During the last decade, management of patients with RA has made tremendous progress in terms of early accurate diagnosis, early aggressive medication with traditional DMARD, introduction of new potent biological antirheumatic pharmacotherapy, and structured clinical followup of outcome measures. The scientific documentation on pharmacotherapy and its effects on inflammatory activity and radiological progression are extensive, although there are fewer studies that highlight nonpharmacological management, functioning, and disability. We previously reported that hand function, similar to most other variables studied in the Swedish TIRA project, improved within 3 months after inclusion in the cohort and then remained stable but still affected in relation to healthy referents until the 3-year followup[8]. The present study reveals that the stagnation regarding hand function also persisted after 5 years in both women and men.

Nordenskiöld and Grimby[26] reported the grip force in women with longstanding RA (mean duration 12 yrs) to be about 50% of that seen in healthy referents. In the present study, 50% grip force reduction was found in patients with early RA at inclusion, but within 3 months it improved to approximately 60–70% of the healthy referents' grip force. This relationship was found in both women and men. The lesser degree of grip force reduction seen in the present study as compared to the results obtained by Nordenskiöld and Grimby[26] is probably explained by more aggressive early interventions. Apart from its relation to sex[26], grip force is also explained by anthropometric measurements like the size of the hand, forearm, weight, height, and age[30]. In our study, the reference material was matched with regard to age distribution of the patients with RA 36 months after inclusion. A limitation in the study is that the group of healthy referents consists of 50% men and the TIRA cohort of 31% men. A power calculation showed that the groups of both men and women are sufficient in size to detect differences between referents and patients. We found women compared to men had a more favorable SOFI-hand score[8] that persisted until the 5-year followup. This sex difference appears to be constitutional since it was seen among the healthy referents as well. GAT, in contrast, did not reveal any sex differences, neither in RA patients nor in healthy referents. Another bias may be that the patients in the TIRA cohort may become familiar with the hand function tests during the followups, but since the tests are so simple this has probably not affected the result.

HAQ is a commonly used outcome variable in longitudinal studies and is used to reflect activity limitations[1,10,12]. Krishnan, *et al* reported that there were no significant differences in HAQ score between healthy women and men in a Finnish population[31]. This agrees with the results in our study.

A limitation of our study is that we do not have knowledge about the healthy referents' general health and its influence on the HAQ score. Since we know that they perceived a normal hand function, this hopefully is not a large bias in the result. At inclusion, HAQ in the TIRA cohort did not differ significantly between the sexes, but from the 12-month followup and onwards women had a significantly higher average score than men, indicating a more reduced function.

Several previous studies have similarly reported that women with RA have more pronounced disability according to HAQ than men[15,32]. Disability due to affected hand function occurs in over 80% of patients with RA with a mean disease duration of 8 years[33]. Reduced grip force in RA is associated with activity limitation[34]. Because reduced grip force correlates with increased HAQ, Thyberg, *et al* hypothesized that the difference in HAQ between women and men is explained by the grip force reduction rather than by sex per se[35]. Our results support that the grip force is an important predictor of HAQ in both a cross-sectional and longitudinal perspective (Table 2). Interestingly, in the cross-sectional perspective, HAQ was explained by different hand function variables in healthy referents compared with RA patients at baseline and after 5 years. Hence, GAT was the strongest predictor of HAQ in the referents, whereas grip force was the strongest predictor in RA patients. In contrast, Dellhag and Bjelle[12] identified a stronger correlation between grip ability and HAQ than grip force and HAQ in patients with longstanding RA (disease duration 6–10 years). The explanation for this discrepancy is not immediately obvious.

In the longitudinal PLS-DA analysis in this study, patient characteristics at inclusion could explain — only to a small extent (8%) — HAQ 5 years later. In line with previous reports[10,17], baseline HAQ is the best predictor of HAQ 5 years later. Tightly following baseline HAQ, we showed that grip force at baseline was the most important predictor of 5-year HAQ, a finding strengthening our notion that HAQ strongly depends on grip force[35].

Agreeing with Häkkinen, *et al*[36], we found that function in the lower extremities (SOFI-lower limb) was an important predictor of HAQ at the 5-year followup. Our study showed high correlations between the early RA patients' self-reported variables at baseline and the 5-year follow-up, corroborating previous results from the same cohort in a shorter time perspective[9]. Furthermore, agreeing with previous studies[17,35], our results showed that HAQ at the 5-year followup was not explained by clinical signs of inflammation or laboratory assessments at baseline.

To conclude, our study strengthens the evidence that grip force is a strong predictor of HAQ, in both cross-sectional and longitudinal analyses. Nevertheless, despite early treatment and improvements in hand function during the first 3 months after diagnosis, both women and men continue to have an affected hand function after 5 years as compared to healthy persons.

ACKNOWLEDGMENT

We thank all TIRA coworkers in Eskilstuna, Jönköping, Kalmar, Lindesberg, Linköping, Motala, Norrköping, Oskarshamn, Örebro, and Västervik for their fruitful cooperation. We also thank Ms. Ylva Billing for excellent cooperation and Olle Eriksson for statistical advice.

REFERENCES

1. Eberhardt KB, Fex E. Functional impairment and disability in early rheumatoid arthritis — development over 5 years. J Rheumatol 1995;22:1037-42.
2. Thyberg I, Hass UA, Nordenskiöld U, Skogh T. Survey of the use and effect of assistive devices in patients with early rheumatoid arthritis: a two-year followup of women and men. Arthritis Rheum 2004;51:413-21.
3. Hallert E, Husberg M, Jonsson D, Skogh T. Rheumatoid arthritis is already expensive during the first year of the disease (the Swedish TIRA project). Rheumatology Oxford 2004;43:1374-82.
4. Kobelt G, Jonsson L, Lindgren P, Young A, Eberhardt K. Modeling the progression of rheumatoid arthritis: a two-country model to estimate costs and consequences of rheumatoid arthritis. Arthritis Rheum 2002;46:2310-9.
5. Welsing PM, Landewe RB, van Riel PL, et al. The relationship between disease activity and radiologic progression in patients with rheumatoid arthritis: a longitudinal analysis. Arthritis Rheum 2004;50:2082-93.
6. Lindqvist E, Jonsson K, Saxne T, Eberhardt K. Course of radiographic damage over 10 years in a cohort with early rheumatoid arthritis. Ann Rheum Dis 2003;62:611-6.
7. Hallert E, Thyberg I, Hass U, Skargren E, Skogh T. Comparison between women and men with recent onset rheumatoid arthritis of disease activity and functional ability over two years (the TIRA project). Ann Rheum Dis 2003;62:667-70.
8. Björk M, Thyberg I, Haglund L, Skogh T. Hand function in women and men with early rheumatoid arthritis. A prospective study over three years (the Swedish TIRA project). Scand J Rheumatol 2006;35:15-9.
9. Thyberg I, Skogh T, Hass U, Gerdle B. Recent-onset rheumatoid arthritis: a 1-year observational study of correlations between health-related quality of life and clinical/laboratory data. J Rehabil Med 2005;37:159-65.
10. Combe B, Cantagrel A, Goupille P, et al. Predictive factors of 5-year health assessment questionnaire disability in early rheumatoid arthritis. J Rheumatol 2003;30:2344-9.
11. Wiles N, Dunn G, Barrett E, Silman A, Symmons D. Associations between demographic and disease-related variables and disability over the first five years of inflammatory polyarthritis: a longitudinal analysis using generalized estimating equations. J Clin Epidemiol 2000;53:988-96.
12. Dellhag B, Bjelle A. A five-year followup of hand function and activities of daily living in rheumatoid arthritis patients. Arthritis Care Res 1999;12:33-41.
13. World Health Organization. International classification of functioning, disability and health: ICF. Geneva, 2001.
14. Ekdahl C, Eberhardt K, 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;17:263-71.
15. Deighton CM, Surtees D, Walker DJ. Influence of the severity of rheumatoid arthritis on sex differences in health assessment questionnaire scores. Ann Rheum Dis 1992;51:473-5.
16. Schumacher HR Jr, Habre W, Meador R, Hsia EC. Predictive factors in early arthritis: long-term follow-up. Semin Arthritis Rheum 2004;33:264-72.
17. Jansen LM, van Schaardenburg D, van Der Horst-Bruinsma IE, Bezemer PD, Dijkmans BA. Predictors of functional status in

patients with early rheumatoid arthritis. Ann Rheum Dis 2000;59:223-6.
18. Ulvestad E. Modelling autoimmune rheumatic disease: a likelihood rationale. Scand J Immunol 2003;58:106-11.
19. Hoogendoorn WE, Bongers PM, de Vet HC, Twisk JW, van Mechelen W, Bouter LM. Comparison of two different approaches for the analysis of data from a prospective cohort study: an application to work related risk factors for low back pain. Occup Environ Med 2002;59:459-65.
20. Escalante A, Del Rincon I, Cornell JE. Latent variable approach to the measurement of physical disability in rheumatoid arthritis. Arthritis Rheum 2004;51:399-407.
21. Eriksson L, Johansson E, Kettanen-Wold N, Wold S. Multi- and megavariate data anaysis. Principles and applications. Umeå: Umetrics Academy, 2001.
22. Arnett FC, Edworthy SM, Bloch DA, et al. The American Rheumatism Association 1987 revised criteria for the classification of rheumatoid arthritis. Arthritis Rheum 1988;31:315-24.
23. Fuchs HA, Pincus T. Reduced joint counts in controlled clinical trials in rheumatoid arthritis. Arthritis Rheum 1994;37:470-5.
24. Scott DL. A simple index to assess disease activity in rheumatoid arthritis. J Rheumatol 1993;20:582-4.
25. Eberhardt KB, Svensson B, Mortiz U. Functional assessment of early rheumatoid arthritis. Br J Rheumatol 1988;27:364-71.
26. Nordenskiöld UM, Grimby G. Grip force in patients with rheumatoid arthritis and fibromyalgia and in healthy subjects. A study with the Grippit instrument. Scand J Rheumatol 1993;22:14-9.
27. Dellhag B, Bjelle A. A grip ability test for use in rheumatology practice. J Rheumatol 1995;22:1559-65.
28. Fries JF, Spitz PW, Young DY. The dimensions of health outcomes: the health assessment questionnaire, disability and pain scales. J Rheumatol 1982;9:789-93.
29. Eriksson L, Johansson E, Kettanen-Wold N, Wold S. Introduction to multi- and megavariate data analysis using the projection methods (PLA & PLS). Umeå: Umetrics AB, 1999.
30. Fraser A, Vallow J, Preston A, Cooper RG. Predicting 'normal' grip strength for rheumatoid arthritis patients. Rheumatology Oxford 1999;38:521-8.
31. Krishnan E, Sokka T, Hakkinen A, Hubert H, Hannonen P. Normative values for the Health Assessment Questionnaire disability index: benchmarking disability in the general population. Arthritis Rheum 2004;50:953-60.
32. Sokka T, Krishnan E, Hakkinen A, Hannonen P. Functional disability in rheumatoid arthritis patients compared with a community population in Finland. Arthritis Rheum 2003;48:59-63.
33. Bodur H, Yilmaz O, Keskin D. Hand disability and related variables in patients with rheumatoid arthritis. Rheumatol Int 2005:1-4.
34. Nordenskiöld U. Daily activities in women with rheumatoid arthritis. Aspects of patient education, assistive devices and methods for disability and impairment assessment. Scand J Rehabil Med Suppl 1997;37:1-72.
35. Thyberg I, Hass U, Nordenskiold U, Gerdle B, Skogh T. Activity limitation in rheumatoid arthritis correlates with reduced grip force regardless of sex: the Swedish TIRA project. Arthritis Rheum 2005;53:886-96.
36. Hakkinen A, Kautiainen H, Hannonen P, Ylinen J, Arkela-Kautiainen M, Sokka T. Pain and joint mobility explain individual subdimensions of the health assessment questionnaire (HAQ) disability index in patients with rheumatoid arthritis. Ann Rheum Dis 2005;64:59-63.