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Association of Physical Function and Physical Activity in Women with Rheumatoid Arthritis

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Abstract

Objective—The purpose of this study was to **explore** the associations between measures of physical activity (PA) and measures of physical function (PF) in women with rheumatoid arthritis (RA). We hypothesized that the strength of the associations between PA and PF would be moderate, and that after controlling for social and biomedical characteristics, the associations would decrease.

Methods—Forty seven women with RA participated in the cross-sectional analysis of this study (age 58 ± 6 years). Social and biomedical characteristics explored included age, ethnicity, disease duration, marital and educational status, height, weight, comorbidity, and disease activity. PF was measured by the self-reported Health Assessment Questionnaire (HAQ) and by a battery of performance-based measures that included the self-selected gait speed, the 5-chair rise test, and the single leg stance test. PA was measured by a portable activity monitor worn for 10 days, and was characterized in 2 ways: daily average number of steps, and daily energy expenditure during moderate levels of PA.

Results—Correlations between measures of PA and PF were small to moderate (**zero-order correlations**= .189 to .479). After controlling for social and biomedical characteristics, the correlations became smaller (**semi-partial correlations**= .095 to .277), and only HAQ remained significantly associated with PA.

Conclusions—Associations between measures of PA and measures of PF are explained, in part, by social and biomedical characteristics in women with RA. The results indicate that measures of PF and PA may represent different constructs and support the need to measure PA in rehabilitation research in RA.

Patients with rheumatoid arthritis (RA) have fatigue, pain, limited joint mobility, impaired muscle strength, and decreased aerobic fitness, all which limit their functioning [1-3]. Rehabilitation treatments are prescribed to counteract the functional limitations of these patients. As a result, functional measures have been a useful benchmark by which to evaluate the effectiveness of rehabilitation in RA. Measures of physical function (PF) have been used as the primary endpoint in research and clinic rehabilitation. The use of PF measures in patients with RA has received official support. PF is a proposed criteria in the definition of improvement to be used in RA trials by the American College of Rheumatology and the international committee Outcome Measures in Rheumatoid Arthritis Clinical Trials (OMERACT) [4]. In clinical practice, the Centers for Medicare & Medicaid Services launched the Physician Quality Reporting Initiative to financially reward providers to their ability to assess several quality measures in RA, including patient functional status [5]. While PF measures are informative about the patient's impairments, limitations related to movement, and the ability to perform everyday activities, they do not provide information about the amount of daily activity one performs, defined as physical activity (PA).

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PA includes all body movements that result in energy expenditure. It includes recreational and occupational activities, sports, structured exercises, activity during leisure time, household activities, and any activity that requires the action of skeletal muscles. The benefits of PA are well known [6]. Regular PA improves general health, prevents cardiovascular and other chronic diseases such as type-2 diabetes, hypertension, depression, and osteoporosis, and reduces mortality from all causes [7-9]. While the information about the benefits of PA in patients with RA is limited compared to the general population [10-13], the increased morbidity and mortality from cardiovascular disease in this group[14-17] justifies a focus on fitness in general and PA specifically as an important goal of rehabilitation. Consequently, to make sure that these goals are met, the levels of PA of these patients should be assessed.

Regardless of the overwhelming benefits of PA and the apparent need for further investigate the effects of PA in patients with RA, measures of PA are rarely used in this population. The underutilization of measures of PA may be due to the evidence from studies that reported significant associations between PF and PA [17-22] and generated the impression that measures of PF offer relevant information about PA. Clinicians may think that the increased pain, stiffness, and limited mobility captured by measures of PF may adversely affect the amount of PA. If true, measures of PF should predict the amount of PA and could perhaps serve as an indirect measure of PA. To date, the apparent distinction between PF (patient's ability to perform activities) and PA (amount of activities or movements) has not been investigated using concurrent measures of PF and PA in subjects with RA. Furthermore, as PF and PA are both affected by social and biomedical characteristics such as age, level of education, obesity, and disease activity [15,23,24], their associations may be affected by these social and biomedical patient characteristics. The purpose of this study was to **explore** the associations between measures of PA and PF. On the basis of previous literature in other populations [15,23,24], we hypothesized that the strength of the associations between PA and PF would be moderate, and that after controlling for social and biomedical characteristics, the associations would decrease.

PATIENTS and METHODS

This was a cross-sectional study. Subjects were recruited from an original cohort of 104 women with RA [25]. The study investigated cardiovascular disease and associated risk factors. This ancillary study was planned before the 5-year follow-up visit of the parent study, and all women who came back for the follow-up visit were invited to participate. Of the fifty-six returning for follow-up, 53 agreed to participate. The 3 women who declined stated they had insufficient time to complete the study. The study took place from November 2007 to July 2008. Eligibility criteria included age older than 30 years, diagnosis of RA according with the American College of Rheumatology criteria[1] for at least 2 years, and no cardiovascular events prior to recruitment (myocardial infarction, angina, or stroke). Study participants signed informed consent approved by the University of Pittsburgh Institutional Review Board.

Procedures

Subjects participated in one testing session. Trained study personnel administered demographic, history, self-reported questionnaires, and performed phlebotomy. A certified physical therapist administered the performance-based tests of PF and instructed the subjects in how to wear a portable PA monitor. Social variables included age, ethnicity, marital and educational status. Biomedical factors included body mass index (calculated as mass/height^2 in kg/m^2), disease duration, disease activity, and comorbidities. Data on comorbidities were recorded using questions originally designed for the parent trial and were thus weighted more heavily on items related to cardiovascular disease. The number of comorbidities was calculated as the total number out of 8 conditions: heart attack, surgery on arteries of legs, stroke, transient ischemic attack, high blood pressure, diabetes, joint surgery for RA, and cancer. Disease Activity was measured by the Modified Disease Activity Score (DAS-28) [26]. The DAS-28 includes 4 parameters in its calculation: number of joints tender to the touch (out of 28 joints), number of swollen joints (out of 28 joints), erythrocyte sedimentation rate using the Westergren technique, and the patient assessment of disease activity using a 100 mm visual analog scale. The DAS 28 is generally accepted as a reliable, valid and responsive measure of disease activity in patients with RA [26].

Measures of Physical Function

PF was measured by performance-based and self-reported measures to better capture the broad dimension of the construct PF. While self-reported measures assess one's perception of the ability to perform functional tasks, performance-based measures assess a person's ability to complete a task. We used the Health Assessment Questionnaire (HAQ) as the self-reported measure of PF. The HAQ is a widely used and validated tool to quantify functional disability in RA [27]. The HAQ-DI queries about 20 activities of daily living including dressing and grooming, rising, eating, walking, hygiene, reach, grip, and community activities. It is expressed on a scale from 0 (no functional disability) to 3 (severe functional disability).

Performance-based PF was measured by 3 tests that were selected for ease of performance in a clinical setting: self-selected gait speed, timed chair rise test, and single leg stance test. Self-selected gait speed was measured by recording the time each subject needed to pass two tape markers on the floor placed 4 meters apart, located in the central part of a longer path of 7 meters. This configuration was used to avoid measurement during the acceleration or deceleration phases of the task. Participants were timed twice, and the faster speed was recorded. For the timed chair rise, participants were seated in a chair without armrests with their arms crossed over the chest. They were timed during 5 repetitions of rising to a full upright position and sitting back down in the chair without assistance. The single leg stance test consisted of recording the time participants balanced on one leg while keeping the hands on the hips. The test lasted up to 30 sec and was stopped if: a) swing leg touched the floor; b) tested foot displaced on the floor; c) swing lower-leg touched the tested limb; or d) arms swung away from the hips. If a subject was not able to balance on one leg, the score was 0 sec. The single leg stance score of the 2 legs were averaged. The performance-based tests cover important domains of lower extremity physical function such as walking ability, muscle strength and power, and balance. They have been shown to be reliable, responsive to interventions, and have the ability to discriminate from low to high functional ability in individuals at various ages and functional levels [28-32].

Measures of Physical Activity

PA was objectively measured by the SenseWear Professional v 6.1 (Body Media Inc, Pittsburgh PA). The SenseWear armband (SWA) is a portable activity monitor that combines multi-sensors data, such as accelerometry, heat flux, skin temperature, and galvanic signal data. The SWA has shown to yield reliable and valid measures of PA [33-36]. Participants were asked to wear the SWA on the back of their right arm (over the triceps muscle area) for 10 consecutive days. They took the SWA off only during showering or water exercises, period in which they recorded the activity performed in a log in order to input into the software accurate information about the off time. After the 10-day period, subjects returned the SWA and the log by mail and the data was downloaded. PA was characterized in 2 ways. First, we used activity related energy expenditure, which is the averaged daily energy expenditure during moderate PA (PAEE) and represents the amount of calories burned during moderate activities (activities performed at 3MET level or greater). Second, we used the daily average number of steps, representing the amount of lower extremity movement.

Data Analysis

Multiple lineal regressions were used to test the hypotheses. Measures of PA (PAEE and number of steps) were the dependent variables, measures of PF were the independent variables (HAQ, gait speed, 5-chair rise, and single leg stance test), whereas social and biomedical factors (age, ethnicity, marital and educational status, BMI, disease duration, disease activity, and comorbidities) were potential covariates. PA variables were checked for normality using the Shapiro-Wilk test. PAEE was not normally distributed and was square root-transformed, which resulted in normal distribution. Pearson or Spearman correlations were used to describe the bivariate relationships between the potential covariates and PA and PF. Covariates were controlled in the multiple linear regressions only if the bivariate correlation between them and both PF and PA were significant.

Separate multiple linear regression models were then built for each of the 2 dependent variables; 4 models with PAEE as the dependent variable, and 4 models with number of steps as the dependent variable. Each model had 2 steps. In step 1, we entered the PF measure. In step 2, we entered the covariates. Goodness-of-fit was evaluated by testing the residuals for normality and homoscedasticity. To test the hypotheses that the strength of the associations between PA and PF was moderate, we observed the zero-order correlation (same as Pearson correlation) of step 1, whereas to test if the associations between PA and PF would be partially accounted for social and biomedical characteristics, we observed the semi-partial correlations of step 2. The 2-step approach was needed to derive the p-values of t statistics for the contribution of PF during each step. The semi-partial correlation represents the explained variance in PA after PF was controlled for social and biomedical factors. We have chosen to assess the semi-partial correlation rather than the standardized regression coefficients, so its value could be squared and interpreted as the percentage of variance in PA uniquely accounted for PF [37]. Due to the small sample size, we based our findings on the strength of the associations and percentage of explained variance rather than on statistical significance. The SPSS (SPSS Inc. Chicago, IL) statistical software was used for all calculations.

RESULTS

Characteristics of the sample are reported in Table 1. From the 53 subjects who entered the trial, we were able to obtain complete data on 47 subjects. The 6 subjects with incomplete data did not wear the SWA for a full 7 days; their data was considered not representative of a full week of PA and thus excluded them from analysis. The bivariate correlations between social and biomedical characteristics and PA and PF are presented in Table 2. Age, education, comorbidities, and disease duration were the variables most commonly associated to PA and PF and controlled in the regression models.

Table 3 shows the linear regression results for the PF variables predicting PA. The associations between measures of PA and PF in Step 1 were small **to moderate. The** zero-order correlations ranged from .189 to .479 (absolute values), explaining no more than 23% (square of .479) of variance in PA. The correlations indicated that subjects with better PF were more physically active. The only correlations not statistically significant were for 5-chair rise to predict PAEE, and for single leg stance to predict number of steps. Results show that after controlling for the social and biomedical factors the correlations became smaller (absolute values of semi-partial correlations ranged from .095 to .277). The only semi-partial correlations that remained significant was for HAQ predicting the number of steps, suggesting that subjects with low HAQ (better PF) had higher daily number of steps.

Visual observation of the residuals plots revealed that the data fit the linear model assumptions.

DISCUSSION

To our knowledge, this is the first study in RA that purposely investigated the association between measures of PF and PA while accounting for social and biomedical factors. The findings indicate that measures of PF provide **little** information about PA, especially after accounting for social and biomedical factors. The findings suggest the need for inclusion of measures of PA with measures of PF in rehabilitation research of patients with RA. This may be particularly important as efforts to reduce cardiovascular risk in patients with RA focus on improving aerobic fitness.

Despite the vital importance of PA on health benefits [7,8,10-12], measures of PA are seldom used in arthritis. Conn et al conducted a meta-analysis on studies testing interventions to increase PA in arthritis patients [38]. They identified only 38 studies (from which 16 were in patients with RA) that tested PA interventions on PA behavior. The inclusion criteria were broad and accepted to include studies that measured PA in several ways: self-reported (e.g. diary, questionnaire), directly or indirectly measured (e.g. doubly labeled water, indirect calorimetry, activity monitors), and even studies that measured subsets of PA such as episodic exercise. Results indicated a moderate positive effect from PA interventions on PA behavior. The authors stated that their meta-analysis included only a small number of trials because most studies did not include measures of PA.

Most published studies in PA in the general population have been longitudinal and demonstrated that increased PA associates with less functional decline and reduction of adverse health outcomes and mortality [18,24,39-42]. In longitudinal studies, the outcomes of PA and PF have not always been parallel. For example, a randomized trial in patients with RA investigated the effect of a 1-year coaching program for healthy PA. They reported improvements in perceived health status and muscle strength, but no change in self-reported PA [43]. Cross-sectional studies have reported inconsistent associations between PF and PA in various patient populations. In patients with total hip replacement, 3 studies reported associations from small to moderate (r = .14 to .62) between self-reported PF and PA measured by portable activity monitoring system [20] and by questionnaires [18,44]. In subjects with multiple sclerosis, the associations between self-reported PF and PA (measured by questionnaire and activity monitor) ranged from small to moderate (r = .21 to .54) [21]. In older adults the association between performance-based PF and PA measured by doubly labeled water was moderate (r = .68) [19]. In RA, the use of different statistics to calculate associations and cut-offs to determine PF and PA limited direct comparison. A study in patients with RA from 21 countries reported that physical inactivity was more prevalent in patients with functional limitations (Risk Ratio of 2.4). Functional limitation was defined as HAQ score ≥ 1, whereas PA was self-reported by querying about the frequency of exercise. Response of weekly exercise once or more a week was considered regular exercise and less than once a week physical inactivity [17]. In this study the risk ratio was calculated from univariate generalized linear model adjusting for age and sex. Perhaps the associations between PF and PA in this study would have been attenuated if they had adjusted for additional factors such as education, disease activity, and disease duration.

The strength of associations in these combined studies ranged from small to moderate (r = .14 to .68). The highest association indicates that measures of PF explain at most 46% (0.68 squared) of the variance of measures of PA, suggesting that perhaps they do not represent the same construct. In our study the associations between PF and PA ranged from .19 to .48, explaining at most 23% of variance in PA. Unique in our study, was the investigation of the associations after controlling by social and biomedical factors that have been previously shown to relate to PF or PA [15,23,24,45]. When controlling for these factors, the associations were considerably tapered (semi-partial correlations ranged from .095 to .277), indicating that some associations were in part due to these factors. Although tapered, one should be careful not to judge the findings based on the statistical significance. With a larger sample size, the unique contribution of PF to PA in the final steps would likely be statistically significant. However, the larger semi-partial correlation after accounting for social and biomedical factors, explain, at most, 8% of the variance in PA (.277 squared), which seems to support the statement that measures of PF provide little information on PA.

There are several explanations for the variability in the ranges of associations between studies. The relatively low association between PF and PA in our study could be explained by either having a somewhat young group of subjects (mean age 57), or only women in our sample. With regards to aging, a study assessed PF and PA in a group of nonagenarians compared to a group of subjects 20 years younger. They reported higher correlation coefficients for PF and PA for the nonagenarians group (r = .78) than for the younger group (r = .52) [19]. In respect to sex, Manini et al used a group of older community dwellers to determine whether higher activity energy expenditure, assessed by using doubly labeled water, was associated with a reduced decline in mobility limitation [24]. Across sex-specific tertiles of activity energy expenditure, men in the lowest activity group experienced twice the rate of mobility limitation as men in the highest activity group. Conversely, women in the lowest and highest activity groups exhibited similarly high rates of mobility limitation. The findings did not change after adjustment for potential confounders. Therefore, it is likely that the results of our study would have been different if we had included men.

An alternative reason for the different magnitude of associations may be the difference in the methodology to assess PA and PF. Some studies have used self-reported instruments to measure both PF and PA. When using the same type of instrument (i.e., self-reported measures) the associations may be inflated by the problem of common method variance. Moreover, for measures of PF, the use of performance-based versus self-reported methods to measure PF is also relevant. Both methods have pros and cons: self-reported methods are easy to use and not influenced by the tester, but are affected by pain and psychological factors such as expectations, cognitive status, and education level; performance-based methods identify early deficits in PF and are less affected by pain and psychological factors, but are criticized for measuring PF in an artificial situation and being influenced by the subject's motivation [46-48]. While there is continuous debate favoring one or the other method, there is consensus that performance-based and self-report measures only correlate modestly and probably measure different constructs of the domain PF [46,49,50]. As a result, the method chosen to measure PF may influence its association with PA.

Regarding the measures of PA, the method most commonly used in the studies has been self-reported questionnaires and diaries. Although questionnaires and diaries are inexpensive and easy to use, their limitations include inconsistent patient recall, overestimation of PA, underestimation of sedentary pursuits, and seasonal variation, all which result in inadequate psychometrics [51]. Questionnaire may also be complex and subjects may not understand the phenomenon investigated. A recent qualitative study described variation in understanding of intensity of PA among patients with RA [52]. The authors reported discrepancies between subjects and investigators regarding the understanding of PA intensity. They suggested that health professionals and RA patients should reach a common understanding of ways to determine PA intensity to accurately prescribe and assess PA using questionnaires and diaries. Although measurement method may influence the associations between PA and PF, we are not aware of studies, including the ones reviewed in this discussion, that have tested whether different associations are a function of the tools selected to measure PF and PA. We have tried to compare the strength of associations across studies that used different methods and could not identify any pattern. This is an area that needs further investigation.

The fact that only HAQ remained significantly associated with PA after controlling for social and biomedical factors was intriguing. A recent study disputed the notion that the HAQ mainly assesses functioning. Hakkinen et al performed a study in which they linked the HAQ items with components of the World Health Organization International Classification of Functioning, Disability and Health (ICF) instrument [53]. According to the ICF classification, disability comprises 3 main components: body functions and structures, activity limitations, and participation restriction. Results of the study demonstrated that 16 of the 20 items included in the HAQ belong to the activity component, while the other items fall within the participation component. They concluded that the use of the HAQ instrument gives a rather narrow perspective on functioning according with the ICF classification. Therefore, the associations between HAQ and PA may have remained significant because they both measure the component activity limitations while the other measures of PF used in this study are related to the component body functions and structures. This latter observation may also help to explain the significant association between self-reported PA and PF measured by the HAQ in the study performed in patients with RA from 21 countries discussed above [17].

This study has limitations. Because our sample only included women, the findings should not be generalized to men with RA. The age of this sample is typical of many adults with RA, though future studies should investigate the associations of PA and PF in young and elderly subjects with RA. The cross-sectional design precludes ascertainment of temporal and causal relationships. Longitudinal studies should determine if improvement in PF will increase PA. We may also not have accounted for all factors that may affect the associations. Larger studies with broader inclusion criteria should improve our understanding of the associations between measures of PF and PA in subjects with RA.

We report herein the new finding that the associations between PF and PA in RA are small and explained in part by subject's social and biomedical characteristics. To date, measures of PA have been infrequently utilized in this population. Replication of our findings will further justify measuring PA in patients with RA in rehabilitation research and clinical practice.

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REFERENCES

1. Arnett FC, Edworthy SM, Bloch DA. The American Rheumatism Association 1987 revised criteria for the classification of rheumatoid arthritis. Arthritis Rheum. 1988; 31:315–324. [PubMed: 3358796]
2. Hochberg MC, Chang RW, Dwosh I, et al. The American College of Rheumatology 1991 revised criteria for the classification of global functional status in rheumatoid arthritis. Arthritis & Rheumatism. 1992; 35(5):498–502. [PubMed: 1575785]
3. Roubenoff R, Roubenoff RA, Cannon JG, et al. Rheumatoid cachexia: cytokine-driven hypermetabolism accompanying reduced body cell mass in chronic inflammation. J Clin Invest. 1994; 93:2379–2386. [PubMed: 8200971]
4. Felson DT, Anderson JJ, Boers M, et al. American College of Rheumatology. Preliminary definition of improvement in rheumatoid arthritis. Arthritis Rheum. 1995; 38:727–735. [PubMed: 7779114]

5. Centers for Medicare & Medicaid Services. Physician Quality Reporting Initiative. Measures Groups Specifications Manual. 2009:49–55.
6. 2008 Physical Activity Guidelines for Americans. U.S. Department of Health and Human Services; 2008.
7. Erlichman J, Kerbey AL, James WP. Physical activity and its impact on health outcomes. Paper 2: Prevention of unhealthy weight gain and obesity by physical activity: an analysis of the evidence. Obes Rev. 2002; 3:273–287. [PubMed: 12458973]
8. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. CMAJ. 2006; 174:801–809. [PubMed: 16534088]
9. US Department of Health and Human Services, CfDCaPNCfCDPaHP. Physical Activity and Health: A Report of the Surgeon General. Atlanta, Ga: p. 146-148.
10. Metsios GS, Stavropoulos-Kalinoglou A, Veldhuijzen van Zanten JJ, et al. Rheumatoid arthritis, cardiovascular disease and physical exercise: a systematic review. Rheumatology (Oxford). 2008; 47:239–248. [PubMed: 18045810]
11. Metsios GS, Stavropoulos-Kalinoglou A, Panoulas VF, et al. Association of physical inactivity with increased cardiovascular risk in patients with rheumatoid arthritis. Eur J Cardiovasc Prev Rehabil. 2009; 16:188–194. [PubMed: 19238083]
12. Tourinho TF, Capp E, Brenol JC, et al. Physical activity prevents bone loss in premenopausal women with rheumatoid arthritis: a cohort study. Rheumatol Int. 2008; 28:1001–1007. [PubMed: 18317768]
13. Turesson C, Jacobsson LT, Matteson EL. Cardiovascular co-morbidity in rheumatic diseases. Vasc Health Risk Manag. 2008; 4:605–614. [PubMed: 18827910]
14. Kitas GD, Erb N. Tackling ischaemic heart disease in rheumatoid arthritis. Rheumatology (Oxford). 2003; 42:607–613. [PubMed: 12709534]
15. Mancuso CA, Rincon M, Sayles W, et al. Comparison of energy expenditure from lifestyle physical activities between patients with rheumatoid arthritis and healthy controls. Arthritis Rheum. 2007; 57:672–678. [PubMed: 17471544]
16. Roubenoff R, Walsmith J, Lundgren N, et al. Low physical activity reduces total energy expenditure in women with rheumatoid arthritis: implications for dietary intake recommendations. Am J Clin Nutr. 2002; 76:774–779. [PubMed: 12324290]
17. Sokka T, Hakkinen A, Kautiainen H, et al. Physical inactivity in patients with rheumatoid arthritis: data from twenty-one countries in a cross-sectional, international study. Arthritis Rheum. 2008; 59:42–50. [PubMed: 18163412]
18. Beaule PE, Dorey FJ, Hoke R, et al. The value of patient activity level in the outcome of total hip arthroplasty. J Arthroplasty. 2006; 21:547–552. [PubMed: 16781408]
19. Frisard MI, Fabre JM, Russell RD, et al. Physical activity level and physical functionality in nonagenarians compared to individuals aged 60-74 years. J Gerontol A Biol Sci Med Sci. 2007; 62:783–788. [PubMed: 17634327]
20. Morlock M, Schneider E, Bluhm A, et al. Duration and frequency of every day activities in total hip patients. J Biomech. 2001; 34:873–881. [PubMed: 11410171]
21. Motl RW, McAuley E. Longitudinal analysis of physical activity and symptoms as predictors of change in functional limitations and disability in multiple sclerosis. Rehabil Psychol. 2009; 54:204–210. [PubMed: 19469611]
22. Wagenmakers R, van, dA-S I, Groothoff JW, et al. Reliability and validity of the short questionnaire to assess health-enhancing physical activity (SQUASH) in patients after total hip arthroplasty. BMC Musculoskelet Disord. 2008; 9:141. [PubMed: 18928545]
23. James NT, Miller CW, Fos PJ, et al. Health status, physical disability, and obesity among adult Mississippians with chronic joint symptoms or doctor-diagnosed arthritis: findings from the Behavioral Risk Factor Surveillance System, 2003. Prev Chronic Dis. 2008; 5:A85. [PubMed: 18558035]
24. Manini TM, Everhart JE, Patel KV, et al. Activity energy expenditure and mobility limitation in older adults: differential associations by sex. Am J Epidemiol. 2009; 169:1507–1516. [PubMed: 19383938]

25. Schott LL, Kao AH, Cunningham A, et al. Do carotid artery diameters manifest early evidence of atherosclerosis in women with rheumatoid arthritis? J Womens Health (Larchmt). 2009; 18:21–29. [PubMed: 19105681]
26. Prevoo MLL, van't Jof MA, Kuper HH. Modified disease activity scores that include twenty-eight-joint counts. Arthritis & Rheumatism. 1995; 38:44–48. [PubMed: 7818570]
27. Bruce B, Fries JF. The Stanford Health Assessment Questionnaire: a review of its history, issues, progress, and documentation. J Rheumatol. 2003; 30:167–178. [PubMed: 12508408]
28. Curb JD, Ceria-Ulep CD, Rodriguez BL, et al. Performance-based measures of physical function for high-function populations. J Am Geriatr Soc. 2006; 54:737–742. [PubMed: 16696737]
29. Cesari M, Kritchevsky SB, Newman AB, et al. Added value of physical performance measures in predicting adverse health-related events: results from the Health, Aging And Body Composition Study. J Am Geriatr Soc. 2009; 57:251–259. [PubMed: 19207142]
30. Simonsick EM, Newman AB, Nevitt MC, et al. Measuring higher level physical function in well-functioning older adults: expanding familiar approaches in the Health ABC study. J Gerontol A Biol Sci Med Sci. 2001; 56:M644–M649. [PubMed: 11584038]
31. Guralnik JM, Seeman TE, Tinetti ME, et al. Validation and use of performance measures of functioning in a non-disabled older population: MacArthur studies of successful aging. Aging (Milano). 1994; 6:410–419. [PubMed: 7748914]
32. Jette AM, Jette DU, Ng J, et al. The Musculoskeletal Impairment (MSI) Study Group: Are performance-based measures sufficiently reliable for use in multicenter trials? J Gerontol. 1999; 54:M3–M6.
33. Cereda E, Turrini M, Ciapanna D, et al. Assessing energy expenditure in cancer patients: a pilot validation of a new wearable device. JPEN J Parenter Enteral Nutr. 2007; 31:502–507. [PubMed: 17947607]
34. Cole PJ, LeMura LM, Klinger TA, et al. Measuring energy expenditure in cardiac patients using the Body Media Armband versus indirect calorimetry. A validation study. J Sports Med Phys Fitness. 2004; 44:262–271. [PubMed: 15756165]
35. Jakicic JM, Marcus M, Gallagher KI, et al. Evaluation of the SenseWear Pro Armband to assess energy expenditure during exercise. Med Sci Sports Exerc. 2004; 36:897–904. [PubMed: 15126727]
36. Papazoglou D, Augello G, Tagliaferri M, et al. Evaluation of a multisensor armband in estimating energy expenditure in obese individuals. Obesity (Silver Spring). 2006; 14:2217–2223. [PubMed: 17189549]
37. Pedhazur, EJ. Multiple regression in behavioral research: Explanation and prediction. 2nd ed.. Holt, Rinehart, and Winston; New York: 1982.
38. Conn VS, Hafdahl AR, Minor MA, et al. Physical activity interventions among adults with arthritis: meta-analysis of outcomes. Semin Arthritis Rheum. 2008; 37:307–316. [PubMed: 17888500]
39. Gregg EW, Cauley JA, Stone K, et al. Relationship of changes in physical activity and mortality among older women. JAMA. 2003; 289:2379–2386. [PubMed: 12746361]
40. Pahor M, Blair SN, Espeland M, et al. Effects of a physical activity intervention on measures of physical performance: Results of the lifestyle interventions and independence for Elders Pilot (LIFE-P) study. J Gerontol A Biol Sci Med Sci. 2006; 61:1157–1165. [PubMed: 17167156]
41. Stuck AE, Walthert JM, Nikolaus T, et al. Risk factors for functional status decline in community-living elderly people: a systematic literature review. Soc Sci Med. 1999; 48:445–469. [PubMed: 10075171]
42. Wannamethee SG, Shaper AG, Walker M. Changes in physical activity, mortality, and incidence of coronary heart disease in older men. Lancet. 1998; 351:1603–1608. [PubMed: 9620713]
43. Brodin N, Eurenius E, Jensen I, et al. Coaching patients with early rheumatoid arthritis to healthy physical activity: a multicenter, randomized, controlled study. Arthritis Rheum. 2008; 59:325–331. [PubMed: 18311770]
44. Wagenmakers R, Stevens M, van, dA-S I, et al. Predictive value of the Western Ontario and McMaster Universities Osteoarthritis Index for the amount of physical activity after total hip arthroplasty. Phys Ther. 2008; 88:211–218. [PubMed: 18029392]

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45. Plasqui G. The role of physical activity in rheumatoid arthritis. Physiol Behav. 2008; 94:270–275. [PubMed: 18234247]
46. Stratford PW, Kennedy D, Pagura SM, et al. The relationship between self-report and performance-related measures: questioning the content validity of timed tests. Arthritis Rheum. 2003; 49:535–540. [PubMed: 12910560]
47. Terwee CB, van der Slikke RM, van Lummel RC, et al. Self-reported physical functioning was more influenced by pain than performance-based physical functioning in knee-osteoarthritis patients. J Clin Epidemiol. 2006; 59:724–731. [PubMed: 16765276]
48. Terwee CB, Mokkink LB, Steultjens MP, et al. Performance-based methods for measuring the physical function of patients with osteoarthritis of the hip or knee: a systematic review of measurement properties. Rheumatology (Oxford). 2006; 45:890–902. [PubMed: 16461441]
49. Elam JT, Graney MJ, Beaver T, et al. Comparison of subjective ratings of function with observed functional ability of frail older persons. Am J Public Health. 1991; 81:1127–1130. [PubMed: 1951822]
50. Cress ME, Schechtman KB, Mulrow CD, et al. Relationship between physical performance and self-perceived physical function. J Am Geriatr Soc. 1995; 43:93–101. [PubMed: 7836655]
51. Verbunt JA, Huijnen IP, Koke A. Assessment of physical activity in daily life in patients with musculoskeletal pain. Eur J Pain. 2009; 13:231–242. [PubMed: 18547847]
52. Brodin N, Swardh E, Biguet G, et al. Understanding how to determine the intensity of physical activity--an interview study among individuals with rheumatoid arthritis. Disabil Rehabil. 2009; 31:458–465. [PubMed: 18720128]
53. Hakkinen A, Arkela-Kautiainen M, Sokka T, et al. Self-report functioning according to the ICF model in elderly patients with rheumatoid arthritis and in population controls using the multidimensional health assessment questionnaire. J Rheumatol. 2009; 36:246–253. [PubMed: 19040312]

Table 1

Social, biomedical, physical function and physical activity sample characteristics

N = 47	**Mean ± SD or Median (Q25-Q75)**
Social and Biomedical	
Age	56.5 ± 7.0
BMI	27.9 ± 6.5
Education (years)	15.7 ± 2.7
Ethnicity- n of white (%)	45 (96)
Marital status- n married (%)	35 (75)
Comorbidities -n (%)	
None	16 (34)
1	23 (49)
2	8 (17)
Disease activity (DAS-28)	3.0 ± 0.81
Disease duration (years)	14.3 ± 8.4
Physical Functioning	
Health Assessment Questionnaire	0.74 ± 0.58
Gait Speed (m/s)	1.2 (1.1 – 1.4)
5-chair rise (s)	12.3 (11.0 – 16.0)
Single leg stance test (s)	19.0 (6.4 – 26.6)
Physical Activity	
PAEE[†] (kcal/day)	199 (103 – 317)
Daily Average Number of Steps	7151 ± 2637

[†]Daily Average Physical Activity Energy Expenditure

Table 2

Bivariate correlations between social and biomedical characteristics and measures of physical activity and physical function. When not stated otherwise, the values represent Pearson moment correlation coefficients.

	Physical Activity		Physical Functioning			
N=47	**PAEE†**	**# of Steps**	**HAQ**	**Gait Speed**	**5-Chair Rise**	**Single Leg Stance**
Age	−.238*	−.250*	.266*	−.253*	.228	−.286*
BMI	−.027	−.178	.104	−.357**	.115	−.231
Education	.266*	.312*	−.279*	.342**	−.377**	.236
Marital Status ‡	−.187	−.036	.087	−.074	.022	.034
Comorbidities ‡	−.109	−.277*	.341**	−.170	.334*	−.075
DAS-28	−.068	−.019	.271*	−.170	.195	−.271*
RA Duration	−.091	−.299*	.370**	.063	.423**	−.225

†Square root of daily energy expenditure during moderate physical activity;

‡Spearman Rho;

*p < .05;

**p < .01

Table 3

Results of the multiple linear regression models for physical function variables to predict PAEE and number of steps (N= 47).

Dependent Variable	Step	Controlled Variables	Independent Variable	Zero-order Correlations	Semi-partial Correlations	P value
PAEE †	1		HAQ	−.376		.009
	2	Age, Education				
			HAQ		−.269	.056
PAEE †	1		Gait Speed	.365		.012
	2	Age, Education				
			Gait Speed		.248	.080
PAEE †	1		5-Chair Rise	−.189		.204
	2	Education				
			5-Chair Rise		−.095	.513
PAEE †	1		Single Leg Stance	.308		.035
	2	Age				
			Single Leg Stance		.250	.084
Number of Steps	1		HAQ	−.478		.001
	2	Age, Education, Comorbility, DD				
			HAQ		−.277	.041
Number of Steps	1		Gait Speed	.386		.007
	2	Age, Education				
			Gait Speed		.264	.060
Number of Steps	1		5-Chair Rise	−.479		.001
	2	Education, Comorbility, DD				
			5-Chair Rise		−.254	.059
Number of Steps	1		Single Leg Stance	.222		.134
	2	Age				

Dependent Variable	Step	Controlled Variables	Independent Variable	Zero-order Correlations	Semi-partial Correlations	P value
			Single Leg Stance		.170	.248

†Square root of daily energy expenditure during moderate physical activity; HAQ: Health Assessment Questionnaire; DD: Disease Duration