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Comparing Approaches of Experienced Ability With Self-Reported and Objectively Measured Physical Activity

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Background: Physical functioning can be assessed by different approaches that are characterized by increasing levels of individual appraisal. There is insufficient insight into which approach is the most informative in patients with ankylosing spondylitis (AS) compared with control subjects.

Objective: The objective of this study was to compare patients with AS and control subjects regarding 3 approaches of functioning: experienced ability to perform activities (Bath Ankylosing Spondylitis Functional Index [BASFI]), self-reported amount of physical activity (PA) (Baecke questionnaire), and the objectively measured amount of PA (triaxial accelerometer).

Methods: This case-control study included 24 AS patients and 24 control subjects (matched for age, gender, and body mass index). Subjects completed the BASFI and Baecke questionnaire and wore a triaxial accelerometer. Subjects also completed other self-reported measures on disease activity (Bath AS Disease Activity Index), fatigue (Multidimensional Fatigue Inventory), and overall health (EuroQol visual analog scale).

Results: Both groups included 14 men (58%), and the mean age was 48 years. Patients scored significantly worse on the BASFI (3.9 vs 0.2) than their healthy peers, whereas PA assessed by Baecke and the accelerometer did not differ between groups. Correlations between approaches of physical functioning were low to moderate. Bath Ankylosing Spondylitis Functional Index was associated with disease activity (r = 0.49) and physical fatigue (0.73) and Baecke with physical and activity related fatigue (r = 0.54 and r = 0.54), but total PA assessed by accelerometer was not associated with any of these experience-based health outcomes.

Conclusions: Different approaches of the concept physical functioning in patients with AS provide different information. Compared with matched control subjects, patients with AS report more difficulties but report and objectively perform the same amount of PA.

Key Words: ankylosing spondylitis, physical functioning, BASFI, physical activity, limitations, accelerometer, appraisal

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Ankylosing spondylitis (AS) is a chronic inflammatory rheumatic disease, characterized by inflammation of the sacroiliac joints and spine and, to lesser extent, of the peripheral joints.[1] Important symptoms comprise pain and (morning) stiffness, fatigue, and reduced mobility, which cause limitations in the physical function of patients. Physical function has shown to be one of the most important health variables associated with different aspects of health-related quality of life in AS, including social roles such as work participation.[2,3] As a consequence, the Assessment in Ankylosing Spondylitis International Society included the domain "physical function" in the core outcomes domains that should be measured in all trials as well as in clinical record keeping.[4,5] To measure physical function, the Bath Ankylosing Spondylitis Functional Index (BASFI) is proposed.[6] The BASFI was selected as the preferred measure out of several self-reported questionnaires asking the respondent to estimate the experienced ability or difficulty to perform a series of tasks and activities. Next to the BASFI, there are various other instruments available to qualify or measure performed activities in daily life.[7]

When trying to understand the differences in instruments to assess a specific construct or domain, for example, that of physical functioning, it is important to understand the level of individual appraisal that is involved in the assessment (Figure). The level of appraisal not only depends on the measure or test itself but also differs across people and over time, and this can greatly affect how people answer, given questions or items.[8] On this line, the BASFI possesses a high level of appraisal, as every respondent rates the items to his/her individual perspective on his/her ability to perform the task or activity. When interpreting the general briefing of the BASFI, "indicate your level of ability with each of the following activities during the past week," this will be a highly subjective evaluation influenced not only by adaptation but also by needs. Other instruments, like the Baecke questionnaire for the measurement of habitual physical activity (PA), has a more fixed construct and asks respondents to give an indication of the perceived amount of PA they perform in different life areas.[9] Finally, an accelerometer or activity monitor offers the opportunity to objectively measure performed PA. It is considered to be the most valid technique to assess PA with information on activity patterns in terms of frequency, duration, and intensity.[10]

Although it has never been studied as such, one might postulate that the 3 approaches to measure a same domain (physical functioning) highlight different aspects and provide different but likely additional information. While experienced ability to perform activities is probably more related to different aspects of self-reported health-related quality of life, PA in patients with AS is important as they already have an increased risk for cardiovascular comorbidities, and possible physical inactivity may pose an extra risk.[11,12]

In a previous published study, we observed no differences between AS and healthy subjects for PA while using accelerometers.[13] This prorogated the question whether patients and control subjects would differ in approaches requiring different levels of appraisal to assess physical functioning, what the correlation between approaches is, and to what extent differences between approaches could be explained. Hence, in this study, we compared patients with AS and control subjects with regard to approaches

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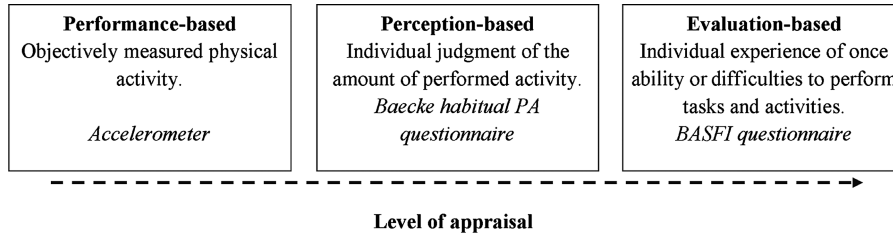

FIGURE 1. Different methods to assess the construct ''physical functioning'' and their relation to the level of appraisal.

for physical functioning (performed PA, perceived PA, and experienced ability) and, second, explored possible differences within patients regarding the approaches and their relation with demographic and health-related variables.

MATERIALS AND METHODS

This study reports on additional data and analyses of a cross-sectional case-control study that explored body composition and PA in patients with AS.[13]

Patients and Control Subjects

Twenty-four AS patients (14 males), with an average age of 48 (SD, 11) years, symptom duration of at least 5 years, and diagnosed according to the modified New York criteria, were recruited through the rheumatology departments of Maastricht University Medical Centre +, Máxima Medisch Centrum, Eindhoven, and Atrium Medisch Centrum, Heerlen, the Netherlands. Patients were excluded when they were on anti–tumor necrosis's factor α therapy or had comorbidities that might affect energy balance, such as diabetes, inflammatory bowel disease, or malignancies. Patients were compared with 24 healthy adults, matched for age, gender, and body mass index (BMI). For 14 of 24 patients, the matched control was a healthy first-degree relative. Because this complicated inclusion substantially, the remaining control subjects were recruited from the general population using poster advertisements around the university. The study was approved by the medical ethics committee of Maastricht University Medical Centre +.

Measures of Physical Functioning

Accelerometer

Objectively measured PA was assessed using the triaxial accelerometer for movement registration (Tracmor; Philips Research, Eindhoven, the Netherlands). The Tracmor contains 3 uniaxial piezo-electric accelerometers, measures 7.2 × 2.6 × 0.7 cm, and weighs 22 g (battery included). It is attached to the lower back of the subject by means of an elastic belt.[10] It measures minute-by-minute accelerations (expressed as kilocounts [kcounts]) in the anteroposterior, mediolateral, and longitudinal axis of the trunk. Subjects were instructed to wear the Tracmor for 7 consecutive days, with a minimum of 10 h/d, during waking hours, except during water activities. First, the wearing time (which is the time in minutes subjects wore the accelerometer) was assessed. Second, the total activity per day was calculated by dividing the total amount of kcounts by the number of days the accelerometer registered at least 10 hours' activity. To measure the intensity of the PA of patients, the total amount of kcounts was divided by the total wearing time, which provided kcounts per minute.

Baecke Questionnaire

This questionnaire was used to assess the self-reported level of perceived habitual PA.[9] The questionnaire consists of 16 questions, addressing 3 domains of PA, which are PA at work, sports during leisure time, and PA during leisure excluding sports. The questions in each section are scored on a 5-point scale displaying (*a*) broad categories of frequency (from "never" to "always" or for other items "very often") or (*b*) time engaged (per week, month or year). Total sum scores for each domain range from 1 to 5, and the sum of these 3 domains combined provides an indication of the total level of PA.

Bath Ankylosing Spondylitis Functional Index

The BASFI asks about the level of experienced ability or difficulties to perform 10 activities during the last week. The total score is an average of the 10 items and ranges from 0 to 10 (higher score indicating worse functioning).[6]

Demographic and Health-Related Variables

Age, gender, and height were noted when patients received the accelerometer. Weight was measured in the morning, after an overnight fast to the nearest 0.1 kg. Subjects filled out several questionnaires during the week they wore the accelerometer. The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) was included to assess disease activity. It is based on 6 questions that give a total score ranging from 0 (indicating no disease activity) to 10 (higher score indicating higher disease activity).[14] Fatigue was measured by the Multidimensional Fatigue Inventory (MFI), which consists of 20 theses that can be scored to produce 5 dimensions: general fatigue, physical fatigue, mental fatigue, reduced motivation, and reduced activity.[15] The scores of each subscale range from 0 (totally agree) to 5 (totally disagree) (higher score indicating more fatigue). General health was assessed by the EuroQol visual analog scale (EQ-VAS), which asks to indicate today's health on a 0 (death) to 100 (full health) vertical rating scale.[16]

Statistical Analyses

Comparisons between patients and control subjects were performed using χ^2 for the categorical variable gender and independent Kruskal-Wallis tests for the variables age, total activity counts, time of PA and intensity of PA, Baecke questionnaire, BASDAI, BASFI, MFI, and EQ-VAS. As all measures of PA were slightly skewed to the right (a few patients and control subjects having higher physical activities), normality of the data could not be assumed. Within patients, first Spearman correlations (2-tailed) were performed between the approaches: PA (total activity and intensity of activity), Baecke questionnaire (all domains), and BASFI. Next, Spearman correlations were computed between BASFI, Baecke questionnaire, and PA measured with an accelerometer with demographic and health-related variables (age, BMI, diagnose duration, BASDAI, MFI general fatigue, and EQ-VAS) (Table 1). For all correlations, coefficients until 0.40 were qualified as weak, 0.41 and 0.75 as moderate, and more than 0.75 as strong.[17] All analyses were performed in SPSS version 19.0, SPSS, Chicago, IL.

RESULTS

In total, 48 subjects (24 patients and 24 matched control subjects) were included. Table 2 shows that patients and control

TABLE 1. Spearman Correlations Between Physical Functioning, Total PA Measured With the Baecke Questionnaire, Different Dimensions of PA Measured With Accelerometers, and (Disease) Characteristics of 24 AS Patients

	BASFI	Baecke (Total PA)	Total Activity a Day	Intensity of Activity
Age	0.24	0.51[a]	0.11	0.07
BMI	0.46[a]	0.04	−0.20	−0.23
Disease duration	0.07	−0.02	−0.21	−0.22
BASDAI	0.49[a]	−0.22	−0.10	−0.02
MFI-20-Pf	0.73[a]	−0.54[a]	−0.33	−0.23
MFI-20-Mf	0.40	−0.48[a]	−0.12	−0.10
MFI-20-Rm	0.48[a]	−0.34	−0.17	−0.14
MFI-20-Ra	0.53[a]	−0.54[a]	−0.32	−0.40
MFI-20-G	0.35	−0.25	−0.08	−0.06
EQ-VAS	−0.39	0.30	0.30	0.17

[a]Correlation is significant at the 0.05 level (2-tailed).

MFI-20-G, Ph, Mf, Rm, Ra indicates general fatigue, physical fatigue, mental fatigue, reduced motivation, reduced activity.

subjects did not differ with regard to age, gender, BMI, aspects of PA (total PA a day and intensity of activity), and PA measured with the Baecke questionnaire. In addition, no statistical differences between patients and control subjects were found regarding the wearing time of the accelerometer. However, patients scored significantly worse on the BASDAI, all dimensions of the MFI except mental fatigue, overall health (EQ-VAS), and the BASFI.

Correlations Between Accelerometer, Baecke Questionnaire, and BASFI

Total activity per day assessed by the accelerometer correlated significantly with intensity in patients ($r > 0.90$) ($P < 0.05$). Furthermore, within patients, total activity per day as well as intensity (accelerometer) correlated moderately with Baecke (total PA) ($r = 0.45$ and 0.41, respectively) and BASFI (-0.47 and -0.41 respectively). Between Baecke (total PA) and BASFI, the correlation was weak ($r = 0.39$).

Correlations Between Measures for Physical Functioning and Other Health Outcomes

Although there were no significant correlations between accelerometer-assessed PA (total activity per day and intensity) with any demographic or self-reported health variables, the BASFI and Baecke (total PA) showed moderate to strong correlations with several aspects of fatigue. In addition, the BASFI correlated moderately with BASDAI and BMI and Baecke (total PA) moderately with age.

TABLE 2. Characteristics of Patient and Control Subjects

	Patient (AS) (n = 24), Median (IQR) min–max	Control (n = 24), Median (IQR) min–max	*P*
Gender (male:female), n	14:10	14:10	NS
Age, y	47 (15.5), 23–62	49 (17.5), 18–65	NS
Diagnosis duration, y	20.5 (22.0), 5–44	N/A	N/A
BMI, kg/m^2	26.0 (4.6), 18.1–39.6	25.5 (1.6), 20.5–31.5	NS
Accelerometer			
Wearing time, h/d	14.9 (1.4), 11.23–16.96	14.6 (0.97), 8.6–16.57	NS
Total activity a day, kcounts/d	277 (105), 156–567	295 (75), 165–474	NS
Intensity of activity, kcounts/min	0.30 (0.09), 0.18–0.64	0.33 (0.09), 0.22–0.52	NS
Baecke (work)	2.6 (1.3), 0–4.1	2.6 (1.1), 1.5–4	NS
Baecke (sport)	2.6 (1.3), 1–4.8	3.0 (1.4), 1.0–4.5	NS
Baecke (leisure)	3.0 (1.0), 1.8–4	3.3 (0.6), 2.5–4.5	NS
Baecke (total PA)	8.4 (1.4), 4.5–12.4	8.4 (1.6), 7.5–11	NS
BASFI	3.85 (2.1), 0.4–7.6	0.1 (0.4), 0–0.9	<0.001
BASDAI	4.1 (3.7), 1.1–7.3	0.4 (1.1), 0–2.6	<0.001
MFI-20 (physical fatigue)	11.0 (7.8), 4–20	5.0 (3.3), 4–10	<0.001
MFI-20 (mental fatigue)	8.0 (9.5), 4–16	4.5 (4.3), 4–16	NS
MFI-20 (reduced motivation)	7.0 (6.8), 4–16	4.0 (1.3), 4–8	0.001
MFI-20 (reduced activity)	8.0 (7.5), 4–17	4.0 (1.0), 4–7	<0.001
MFI-20 (general fatigue)	14.0 (5.3), 4–20	5.5 (5.3), 4–14	<0.001
EQ-VAS (general health)	79.0 (23.8), 35–100	95.0 (17.3), 70–100	0.003

IQR indicates interquartile range; N/A, not applicable; NS, not significant.

DISCUSSION

Despite more limitations in experienced ability to perform tasks and activities (BASFI), patients with AS compared with control subjects showed similar amounts of self-reported (Baecke questionnaire) as well as objectively assessed PA (accelerometer). Within patients, objectively measured total PA showed only a moderate correlation with Baecke (total PA) and the BASFI. This indicates that the 3 approaches measure different aspects of physical functioning. Objectively measured PA was not related to any health- or disease-related measure, whereas Baecke (total PA) and BASFI showed moderate associations with different aspects of fatigue (MFI) or disease activity (BASDAI). Although the 3 approaches that we have chosen to address physical functioning differ in the "level of appraisal," they also differ in the "areas of functioning" they address. While the 3-axial accelerometer addresses almost all activities and participation roles performed, the BAECKE concentrates more on time spent in social roles (sports. work, leisure) and the BASFI on difficulties with specific physical tasks (reaching, standing, walking, …).[18] This becomes clear when we link the content of the BASFI and BAECKE to the International Classification of Functioning, Disability and Health (ICF) and indicate which of these categories are registered by the accelerometer (Appendix A). As can be seen, BASFI and BAECKE address quite different aspects of functioning. The accelerometer, on the other hand, does not address all ICF categories that are scored in BASFI or BAECKE and likely registers a number of activities not specified in any of the questionnaires. This likely also contributes to the observed moderate correlations between the measures.

An explanation of the equal PA levels might be found in the guideline for physiotherapy of AS patients, which in general urges patients to engage in a form of physical exercise, as the latter temporarily diminishes pain and stiffness symptoms.[19] On this account, it seems that AS patients give a good adherence to the guideline since it has recently been shown that 7 of 10 patients with spondyloarthritis met the recommendations of PA and health, which have been stated by the World Health Organization, that is, 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity PA per week.[20] Although the correlations between objectively assessed PA, self-reported PA, and experienced ability to perform activities were moderate in patients, our study is the first to compare different approaches of measuring physical functioning between patients with AS and control subjects. In patients with rheumatoid arthritis, a recent report including 171 patients also revealed modest but statistically significant correlations between a self-reported questionnaire (Yale Physical Activity Survey) and uniaxial accelerometer measures.[21] However, no experienced-based measure was included. The selection of a triaxial accelerometer over other commercially available motion sensors such as pedometers and uniaxial accelerometers is based on the knowledge that subjects can perform in more types of activities than walking/running alone. Hence, a triaxial accelerometer can provide more information and also shows a better relationship with energy expenditure caused by PA than uniaxial accelerometers.[22] However, for use in clinical practice, uniaxial accelerometers or pedometers might also give relevant information; this issue would need further study.

The triaxial accelerometer allowed to compare total activity a day and the intensity of activity between patients and control subjects but revealed no differences in these dimensions. Moreover, high correlations between total activity and intensity were observed, indicating that both dimensions more or less measured the same. When further exploring differences between the approaches to assess physical functioning within patients, no relation was found with health- or disease-related variables and objectively measured PA, whereas both Baecke total PA and BASFI correlated with aspects of fatigue (MFI) and the BASFI also with the BASDAI. Although it might not be surprising that experience-based health measures, such as BASDAI and MVI, are more strongly associated with the experience-based than with the objective functioning outcomes, this finding further supports the importance to distinguish the different levels of measurement. The influence of pain and stiffness (BASDAI) on self-reported ability for tasks and activities (BASFI) is well recognized[23,24]; however, the role of fatigue in physical function had not yet been emphasized. It can be expected that the energy cost to perform PA is higher in patients with AS compared with control subjects. This was previously shown among patients with rheumatoid arthritis who spent more energy on similar activities such as treadmill walking compared with control subjects.[25] It is obvious that the present case-control study cannot conclude whether fatigue is a consequence or cause of experienced difficulties with abilities. In this line, recent studies also pointed to the role of psychological factors such as perceived helplessness and coping in reported limitations in functioning.[26,27]

Some limitations need to be considered when interpreting the present results. Most importantly, the sample size was small, and as a result, little differences in PA between patients and control subjects might be missed, and it limited a full exploration of all relationships and interactions. In addition, as the participants partly included family matched control subjects, the performed PA might have been influenced by the PA behavior of one's relative. The possible influential role of relatives on PA-related behavior has been recognized in various populations.[28] However, Rhodes and Blanchard[29] found that PA behavior and the intention to engage in PA especially in patients with arthritis compared with a nondiseased population were not so much influenced by perceived approval from persons in their environment but more by the level of self-efficacy or level of control. One could argue that the BASFI has not been validated in a healthy population; however, it includes essential daily tasks that require PA that are likely equally relevant for healthy persons. Here, it was surprising that patients, despite having more limitations in activities that are common for functioning in daily life, did not report and perform less PA than did the control subjects.

Also, when considering the prognostic relevance of the 3 approaches with regard to relevant outcomes, such as social participation, falls and fractures, cardiovascular disease, or mortality, we lack long-term data to reveal possible differences.

In conclusion, regarding physical functioning in patients with AS, different approaches to measure experienced abilities or actual performed activity provide different information, but their exact role with regard to long-term mental or physical outcome, including cardiovascular disease and mortality, needs to be further explored. However, despite a decreased experienced ability to perform activities and worse reported disease-related outcomes, patients with AS do not differ in their self-reported or objectively assessed PA compared with control subjects.

KEY POINTS

1. Different approaches that capture the concept of physical functioning provide different information.
2. Compared with matched control subjects, patients with AS experience a decreased ability to perform activities but perform and report the same level of PA.

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REFERENCES

1. Sieper J, Braun J, Rudwaleit M, et al. Ankylosing spondylitis: an overview. *Ann Rheum Dis*. 2002;61(suppl 3):iii8–iii18.
2. Boonen A. A review of work-participation, cost-of-illness and cost-effectiveness studies in ankylosing spondylitis. *Nat Clin Pract Rheumatol*. 2006;2:546–553.
3. van der Heijde DM, Revicki DA, Gooch KL, et al. Physical function, disease activity, and health-related quality-of-life outcomes after 3 years of adalimumab treatment in patients with ankylosing spondylitis. *Arthritis Res Ther*. 2009;11:R124.
4. van der Heijde D, Bellamy N, Calin A, et al. Preliminary core sets for endpoints in ankylosing spondylitis. Assessments in Ankylosing Spondylitis Working Group. *J Rheumatol*. 1997;24:2225–2229.
5. van der Heijde D, Dougados M, Davis J, et al. Assessment in Ankylosing Spondylitis International Working Group/Spondylitis Association of America recommendations for conducting clinical trials in ankylosing spondylitis. *Arthritis Rheum*. 2005;52:386–394.
6. Calin A, Garrett S, Whitelock H, et al. A new approach to defining functional ability in ankylosing spondylitis: the development of the Bath Ankylosing Spondylitis Functional Index. *J Rheumatol*. 1994;21:2281–2285.
7. Westerterp KR. Assessment of physical activity: a critical appraisal. *Eur J Appl Physiol*. 2009;105:823–828.
8. Schwartz CE, Rapkin BD. Reconsidering the psychometrics of quality of life assessment in light of response shift and appraisal. *Health Qual Life Outcomes*. 2004;2:16.
9. Baecke J, Burema J, Frijters J. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *Am J Clin Nutr*. 1982;36:936–942.
10. Plasqui G, Joosen AM, Kester AD, et al. Measuring free-living energy expenditure and physical activity with triaxial accelerometry. *Obes Res*. 2005;13:1363–1369.
11. Han C, Robinson DW, Hackett MV, et al. Cardiovascular disease and risk factors in patients with rheumatoid arthritis, psoriatic arthritis, and ankylosing spondylitis. *J Rheumatol*. 2006;33:2167–2172.
12. Panagiotakos D, Chrysohoou C, Pitsavos C, et al. Risk factors of stroke mortality: a 40-year follow-up of the Corfu cohort from the Seven-Countries Study. *Neuroepidemiology*. 2003;22:332–338.
13. Plasqui G, Boonen A, Geusens P, et al. Physical activity and body composition in patients with ankylosing spondylitis. *Arthritis Care Res*. 2012;64:101–107.
14. Garrett S, Jenkinson T, Kennedy LG, et al. A new approach to defining disease status in ankylosing spondylitis: the Bath Ankylosing Spondylitis Disease Activity Index. *J Rheumatol*. 1994;21:2286–2291.
15. Smets E, Garssen B, Bonke B, et al. The Multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. *J Psychosom Res*. 1995;39:315–325.
16. Szende A, Oppe M, Devlin N. *EQ-5D Value Sets: Inventory, Comparative Review and User Guide*. Dordrecht, The Netherlands: Springer Verlag; 2007.
17. Fleiss JL. *The Design and Analysis of Clinical Experiments*. New York, NY: Wiley Online Library; 1986.
18. ICF. *International Classification of Functioning, Disability and Health*. Geneva, Switzerland: World Health Organization; 2001.
19. Dagfinrud H, Kvien T, Hagen K. Physiotherapy interventions for ankylosing spondylitis. *Cochrane Database Syst Rev*. 2008;1.
20. Haglund E, Bergman S, Petersson IF, et al. Differences in physical activity patterns in patients with spondyloarthritis. *Arthritis Care Res*. 2012.
21. Semanik P, Lee J, Manheim L, et al. Relationship between accelerometer-based measures of physical activity and the Yale Physical Activity Survey in adults with arthritis. *Arthritis Care Res*. 2011;63:1766–1772.
22. Plasqui G, Westerterp KR. Physical activity assessment with accelerometers: an evaluation against doubly labeled water. *Obesity*. 2007;15:2371–2379.
23. Boonen A, Cruyssen B, de Vlam K, et al. Spinal radiographic changes in ankylosing spondylitis: association with clinical characteristics and functional outcome. *J Rheumatol*. 2009;36:1249–1255.
24. Landewé R, Dougados M, Mielants H, et al. Physical function in ankylosing spondylitis is independently determined by both disease activity and radiographic damage of the spine. *Ann Rheum Dis*. 2009;68:863–867.
25. de Carvalho MRP, Tebexreni AS, Salles CAF, et al. Oxygen uptake during walking in patients with rheumatoid arthritis—a controlled study. *J Rheumatol*. 2004;31:655–662.
26. Boonen A. Towards a better understanding of the role of psychological variables in arthritis outcome research. *Arthritis Res Ther*. 2010;12:106.
27. Brionez TF, Assassi S, Reveille JD, et al. Psychological correlates of self-reported functional limitation in patients with ankylosing spondylitis. *Arthritis Res Ther*. 2009;11:R182.
28. Downs DS, Hausenblas HA. Elicitation studies and the theory of planned behavior: a systematic review of exercise beliefs. *Psychol Sport Exerc*. 2005;6:1–31.
29. Rhodes RE, Blanchard CM. Just how special are the physical activity cognitions in diseased populations? Preliminary evidence for integrated content in chronic disease prevention and rehabilitation. *Ann Behav Med*. 2007;33:302–311.