

## Physical Activity in Rheumatoid Arthritis: A Systematic Review

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**Background:** Physical activity is associated with improved health outcomes in many populations. It is assumed that physical activity levels in the rheumatoid arthritis (RA) population may be reduced as a result of symptoms of the disease. The objective of this review is to establish the current evidence base for levels of physical activity in the RA population. **Methods:** A systematic review was performed of 7 databases (Embase, MEDLINE, AMED, Biomedical Reference Collection Expanded, CINAHL, Nursing and Allied Health Collection, and SportsDiscus) up to February 2011 to examine the evidence in the area. **Results:** One hundred and thirty-six studies were identified through electronic searching. One hundred and six were excluded based on title and/or abstract analysis and a further 14 were excluded based on full text analysis. Sixteen studies meeting the criteria were deemed suitable for inclusion. The results of the included studies indicate that the level of physical activity may be lower among individuals with RA when compared with healthy controls or normative data. **Conclusions:** There are a number of methodological considerations at play within the studies reviewed which prohibits definitive conclusion on the physical activity levels of this population group. Given the known health benefits of physical activity, further research in this area appears indicated.

**Keywords:** energy expenditure, measurement tools, physical activity assessment

Rheumatoid arthritis (RA) is a chronic, systemic, autoimmune, inflammatory disorder and is the most common type of inflammatory arthritis.<sup>1,2</sup> It affects approximately 0.3%–0.8% of the European population<sup>3</sup> and a worldwide prevalence of approximately 1%.<sup>1,4</sup> Women are affected up to 5 times more frequently than men and the onset of the disease generally tends to occur between the ages of 40–60 for both sexes.

“Physical activity” and “exercise” are terms that describe different concepts. However, they are often confused with one another, particularly by health professionals, and the terms are sometimes used interchangeably. By definition, physical activity is ‘any bodily movement produced by skeletal muscles that results in energy expenditure’<sup>5</sup>. Under this broad concept, activities involved in leisure-time, exercise, sport, transportation, and work must be considered. Exercise is a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness.<sup>5</sup>

To quantify physical activity, proxy measures are used. The most common of these measures are movement (eg, step counts) and energy expenditure.<sup>6</sup> Expressing physical activity in terms of these measures appears

logical given the definition of physical activity<sup>5</sup> contains both the terms “movement” and “energy expenditure.” Approximately 65% of daily energy expenditure is accounted for by basal and resting metabolic rates. The thermic response to food (absorption, digestion, transport, and storage) accounts for about 10% of total daily energy expenditure; the remaining 25% is accounted for by physical activity.<sup>7</sup> This activity related energy expenditure (AEE) is the most variable component of total energy expenditure and is the easiest to manipulate.<sup>8</sup>

These percentages related to healthy individuals however and resting energy expenditure (REE), which is the amount of calories required by the body during a non active period, can be significantly altered by a number of factors including chronic inflammatory disease.<sup>9–11</sup> For example, rheumatoid cachexia, which relates to the loss of muscle mass and strength and concomitant increase in fat mass,<sup>12</sup> is a significant concurrent problem within this population group (affecting approximately two-thirds of individuals) and has also been shown to increase REE.<sup>13</sup> In this manner, the proportion of total energy expenditure (TEE) attributed to physical activity is reduced.

A great deal of the research conducted to date in the area of activity in RA has focused on the effect of exercise training with benefits reported in functional ability and other RA-related disease outcomes.<sup>14–20</sup> However; much less research has been conducted in the broader category of physical activity.

It is well recognized that many health benefits, in particular cardiovascular benefits, are associated with an

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active lifestyle.<sup>21–23</sup> Those with RA are at an increased risk of mortality related to cardiovascular events,<sup>24–26</sup> therefore an active lifestyle in this population is especially necessary.

It is of extreme importance that physical activity and not just a single component of it, exercise, is researched however. Recommendations for the health benefits of an active lifestyle<sup>27–29</sup> are based upon levels of physical activity and physical activity intensity, irrespective of the proportion of physical activity attributable to exercise. Recently conducted studies of physical activity have consistently documented a decreased incidence of cardiovascular disease in more physically active subjects in a graded manner.<sup>30–32</sup> Therefore, it is imperative that an outline of the physical activity levels in the RA population is reported on.

As well as the proportion of TEE attributable to physical activity which is reduced in the RA population, it is generally assumed that daily physical activity, in terms of movement is also reduced in patients with RA as a result of joint pain, restricted mobility, fatigue, reduced muscle mass, strength and endurance.<sup>8,12</sup> However, there is little research available assessing free living physical activity levels in individuals with RA or comparing the levels between those with RA and healthy controls. Thus, a systematic review was conducted to examine the levels of physical activity among individuals with RA.

## Methods

A systematic review was conducted by 1 of the authors (MT) to identify all published literature relating to the measurement and reporting of levels of physical activity and/or energy expenditure in people with RA.

Based on the recommendations of the Cochrane handbook for systematic reviews,<sup>33</sup> the databases Embase and MEDLINE were searched for relevant texts. AMED, Biomedical Reference Collection Expanded, CINAHL, Nursing and Allied Health Collection, and SportsDiscus were also searched.

The search strategy involved combining 2 sets of keywords. For Embase, Emtree terms were used. In this case the search consisted of rheumatoid arthritis AND leisure OR energy expenditure OR physical activity. For MEDLINE, MeSH terms were used. In this case the search consisted of arthritis, rheumatoid AND leisure activities OR motor activity OR energy metabolism. For the other EBSCO databases searched, the search strategy consisted of the use of the following terms in the subject terms: rheumatoid arthritis AND leisure activit\* OR physical activit\* OR energy expendit\*, where \* indicates the wildcard character and denotes the use of all possible suffixes.

The results included all publications published up to Jan 31, 2011 that included at least 1 search term from each of the 2 categories. The search was extended by secondary searching of the reference lists of papers retrieved to identify any additional references for recovery. Only English language publications were included.

The electronic searches identified 136 studies. The titles of all identified articles were examined for relevance. If it was not clear from the title if the study was relevant, the abstract was also examined. To be included in the review, studies had to 1) measure and report on free living physical activity levels or total/activity related energy expenditure levels for at least 24 hours; 2) be related to the RA population with all subjects included in studies fulfilling the criteria set down by the American College of Rheumatology, 1987<sup>34</sup>; and 3) be related to the adult population. Studies which were 1) interventional in nature with the objective of increasing the levels of physical activity, 2) not designed with purpose of collecting new data, or 3) not published in full text format were not included.

As demonstrated by the flowchart (Figure 1), 106 of the publications examined were excluded as they clearly not relevant based on article title and/or abstract. Thirty papers were retrieved in full text for further analysis as based upon the information provided in the title and/or abstract, the articles potentially met the inclusion criteria. After inspection of the full texts, 14 publications were excluded leaving 16 publications deemed suitable for inclusion in this review.

As no randomized controlled trials were included in this review, a system to appraise nonrandomized studies had to be applied. The system which was applied was based on the Newcastle-Ottawa Quality Assessment Scale,<sup>35</sup> with some modifications made to best serve the nature of the articles assessed, similar to that proposed by Smedslund and Birger Hagen.<sup>36</sup> As referred to by Juni et al,<sup>37</sup> the incorporation of quality scores lacks statistical or empirical justification and for this reason scores of “met,” “unclear,” and “not met” were used. The quality of the studies was assessed by 1 of the authors (MT) and another researcher uninvolved in the development of the review. Any disagreements in findings between the 2 reviewers were resolved by consensus. Interreviewer disagreements centered on the representativeness aspect of the scale. The assessment tool used is outlined in the Appendix.

## Results

A total of 16 studies published between 2001 and 2011 that examined free living physical activity in RA were included in this review. The majority of the studies were cross-sectional in nature (N = 15) with 1 utilizing a cohort study design.

A total of 1890 RA subjects (range 12–298) were included in this review. Descriptive characteristics of these participants are presented in Table 1. Table 2 outlines details regarding the methodology of the included studies as well as the main pertinent findings.

The quality of the studies included in this review based on the modified Newcastle Ottawa Scale are outlined in Table 3. Due to the nature of the assessment scale, it is inappropriate to apply quality scores. However, no study achieved fulfillment of all of the quality criteria. Blinding of subjects was not achieved by any of

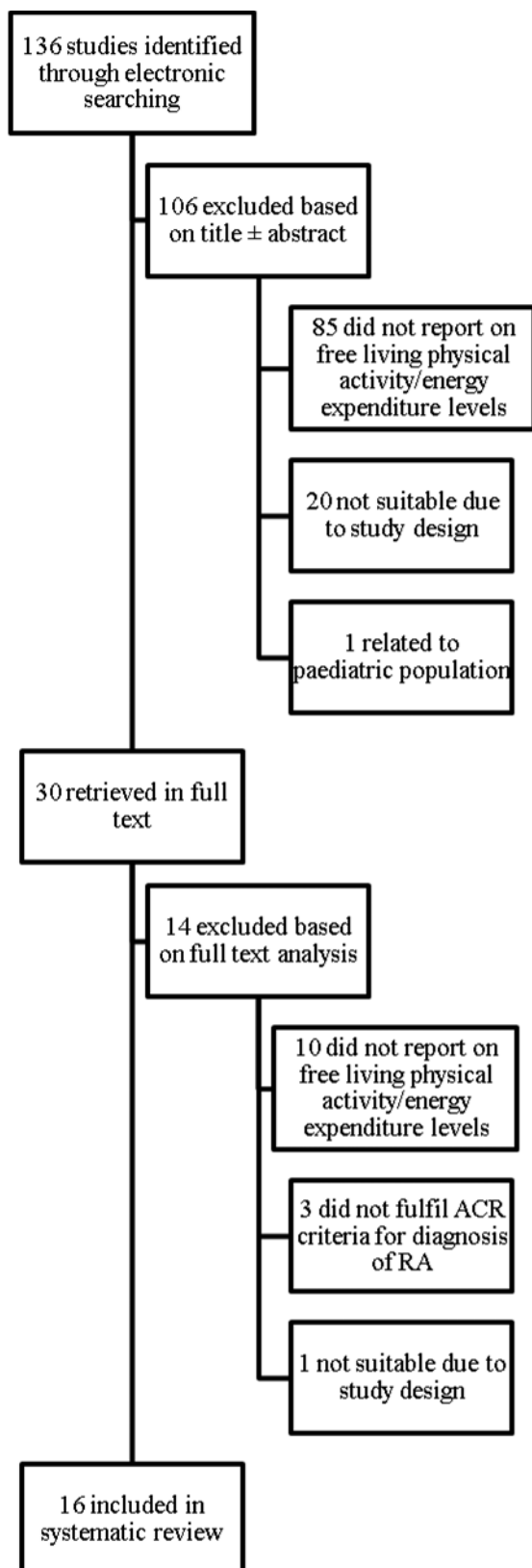


Figure 1 — caption to come.

the studies included, although the authors of this review acknowledge the difficulties of blinding in nonrandomized studies. A number of studies ( $n = 9$ ) did not use a control group. Of those which did, 6 out of 7 studies<sup>10,38–42</sup> successfully matched groups for age and gender. The exception was the study conducted by Raftery et al,<sup>43</sup> in which it is unclear. Greene et al<sup>42</sup> and Raftery et al<sup>43</sup> used patient populations as controls, and Lemmey et al<sup>38</sup> used both patient and healthy population controls while the remainder used solely healthy populations. Three<sup>39,40,44</sup> of the four studies which completed a follow up of subjects, were able to complete follow up of all subjects or maintain numbers lost to less than 20%. In addition, only 2 studies<sup>39,45</sup> clearly demonstrated that the sample included was truly representative of the average patient with RA. All studies included in this review ensured that participants had a formal diagnosis of rheumatoid arthritis according to the American College of Rheumatology (ACR) criteria<sup>34</sup> and this was included as an aspect of their inclusion criteria. Although a misprint indicates that this may not be the case in the studies conducted by Eurenus et al,<sup>44,46</sup> correspondence with the authors verify that all patients included have a diagnosis in accordance with ACR criteria.

Four of the studies<sup>10,43,47,48</sup> in the review used objective measurement tools while the remaining 12 used only subjective outcome measures. The use of differing measurement tools leads to greatly differing output styles also. They include kJ/day,<sup>10</sup> hrs/week,<sup>49</sup> hrs/day,<sup>42</sup> mins/day,<sup>42,49</sup> MJ/day,<sup>47</sup> kcals/week,<sup>41</sup> mins/week,<sup>45,50</sup> kcals/day,<sup>48</sup> METmin per week<sup>51</sup> and METhours/day,<sup>52</sup> as well as exercise level,<sup>38</sup> physical activity level,<sup>47</sup> sum score of outcome measure,<sup>44,46</sup> meeting of national recommendations,<sup>50</sup> daily average number of steps,<sup>48</sup> number of steps taken,<sup>43</sup> vigor of steps,<sup>43</sup> time spent standing,<sup>43</sup> total energy in arbitrary units,<sup>43</sup> participation in activity domains,<sup>39</sup> and % in different physical activity categories.<sup>40</sup>

## Discussion

The results of this systematic review indicate that physical activity levels among the RA population may be decreased when compared with healthy controls and is lower than the current international recommendations outlined to maintain a healthy lifestyle.

There are a number of methodological considerations at play in the studies reviewed which prohibits us from conclusively defining the physical activity levels of this population group, and thereby definitively stating that the physical activity levels of this population are decreased.

## Measurement Tools

The measurement tools and consequently output styles used varied greatly in each of the studies reviewed, from objective measures and output styles to subjective measures and output styles, with or without validation specific to this population group. Although some of these findings can be converted to allow for comparison,

**Table 1 Descriptive Characteristics of Participants**

Author (year), location	Study design	Subjects/ controls (N)	FA participants age (years)	Sex ratio female: male	Disease activity	Disease duration (months)
Lemmey et al (2001), United Kingdom	Cross-sectional	73/82	52.9 ± 12.9 mean ± SD	46:27	Not reported on	Not reported on
Roubenoff et al (2002), USA	Cross-sectional	20/20	47 ± 14 mean ± SD	All female	Not reported on	92.4 ± 78
Semanik et al (2004), USA	Cross-sectional	185/0	70 (60–88) mean (range)	All female	Not reported on	211.2 (7.2–792), 151.2 average (range), SD
Eurenius et al (2005), Sweden	Cross-sectional	298/0	57 (19–90) median (range)	225:73	Not reported on	Not reported on
Hagfors et al, 2005,	Cross-sectional	32/0	Not reported on	29:4 (of 33 initially included)	Not reported on	Not reported on
Greene et al, 2006, USA	Cross-sectional	52/30	61.0 ± 14.5 mean ± SD	47:5	Not reported on	Not reported on
Wikstrom et al (2006), Sweden	Cross-sectional	144/144	60.4 ± 13.3 mean ± SD	111:33	4.61 ± 1.31 mean ± SD (DAS-28)	7.5 ± 2.8 mean ± SD
Eurenius et al (2007), Sweden	Cross-sectional	98/0	57 (19–84) median (range) based on 102 initially included	72:26	Not reported on	15 (4–78) median (range) based on 102 initially included
Mancuso et al (2007), USA	Cross-sectional	121/120	49 (19–72) mean (range)	102:19	Not reported on	Not reported on
Van den Berg et al (2007), Netherlands	Cross-sectional	252/0	Not reported on	165:87	Not reported on	Not reported on
Tourinho et al (2008), Brazil	Cohort	71/29	38.1 ± 6.62 mean ± SD	All female	Not reported on	88 ± 50
Raftery et al (2009), United Kingdom	Cross-sectional	12/12	Not reported on	All female	Not reported on	Not reported on
Stavropoulos—Kalinoglou (2009), United Kingdom	Cross-sectional	150/0	Males: 60 (59–64) Females: 59 (55–64) median (IRQ)	102:48	Males 4.4 (2.6–5.3) Females 3.8 (2.9–5.1) median (IRQ)	Males: 84 (48–144) Females: 108 (60–168) median (IRQ)
Hurkmans et al (2010), Netherlands	Cross-sectional	271/0	62 ± 14 mean ± SD	178:93	3.5 ± 4.6 mean ± SD (RADAI)	120 ± 96 mean ± SD
Piva et al (2010), USA	Cross-sectional	47/0	56.5 ± 7 mean ± SD	All female	3.0 ± 0.81 mean ± SD	171.6 ± 100.8 mean ± SD
Elkan et al (2011), Sweden	Cross-sectional	61/0	60.8 (57.3–64.4) mean (CI)	All female	3.3 (3.0–3.6) mean (CI)	72 (24–180) median (IRQ)

**Table 2 Methodology and Results**

Author (year), location	Inclusion criteria for subjects	Measurement tool	Variable recorded	Results
Lemmey et al (2001), United Kingdom	Met ACR criteria for RA Adult population	8 point physical activity scale	Exercise level	RA participants had exercise level of $0.8 \pm 0.7$ SD Non RA rheumatic participants had exercise level of $0.7 \pm 0.1$ SD Age and sex matched healthy controls had exercise level of $5.4 \pm 1.7$ SD
Roubenoff et al (2002), USA	Met ACR criteria for diagnosis of RA Stable drug regimen	DLW Caltrac accelerometer	kJ/day kJ/day	DLW: RA patients $2849 \pm 1075$ kJ/day, Controls: $3883 \pm 1732$ kJ/day Caltrac accelerometer: RA patients $1264 \pm 992$ kJ/day, Controls: $2280 \pm 1469$ kJ/day
Semanik et al (2004), USA	Free of disease flare up for $\geq 3$ months before entry to study English speaking Aged $\geq 60$ years Cognitively intact Women Able to walk household distances	Paffenbarger Physical Activity and Exercise Index Yale Physical Activity Survey (YPAS)	kJ/day Hours per week and mins per day spent in selected physical activities by intensity	Paffenbarger questionnaire: RA patients $2188 \pm 1397$ kJ/day, Controls: $3150 \pm 1611$ kJ/day Low intensity ( $<3.0$ METs): $68.0$ mean minutes/day Moderate intensity ( $3.0$ – $5.5$ METs): $117.0$ mean minutes/day High intensity ( $\geq 6.0$ METs): $12.9$ mean minutes/day 10 hours less per week in physical activity than community dwelling elderly women with musculoskeletal impairments
Eurenius et al (2005), Sweden	Confirmed diagnosis of RA Disease duration $\leq 6.5$ years Included on Swedish RA register	Specially designed self report questionnaire	Sum score for self-report physical activity questionnaire	Median sum score for self-reported physical activity was $12.5$ (range 2–30) 47% of subjects did not meet recommendations on healthy physical activity behavior

*(continued)*

**Table 2 (continued)**

Author (year), location	Inclusion criteria for subjects	Measurement tool	Variable recorded	Results
Hagfors et al, 2005	RA according to American College of Rheumatology criteria No other condition demanding medical attention Disease duration of at least 2 years Clinically the disease must have been characterized as stable and under adequate control Unchanged DMARDs for $\geq 3$ months Unchanged corticosteroids for $\geq 4$ weeks Unchanged NSAIDs for $\geq 10$ days Oral corticosteroids $\leq 12.5$ mg daily DAS28 score $> 2.0$	3-day Activity Register (AR; 32 subjects) DLW (9 subjects)	Total Energy Expenditure (TEE; MJ/day) Physical Activity Level (PAL)	TEE via AR: $9.29 \pm 1.27$ MJ/day TEE via DLW: $10.76 \pm 2.59$  PAL via AR: $1.53 \pm 0.09$ PAL via DLW: $1.68 \pm 0.15$
Greene et al, 2006, USA	Older than 30 years of age Classified as having RA according to American College of Rheumatology criteria Reported less than 1 hour of morning stiffness Comprehended English	Physical Activity and Disability Survey (PADS)	Time spent lying down (hr/day) Exercise time (min/day) Leisure activity time (hr/day) Household activity time (hr/day) Total physical activity time (hr/day)	RA individuals: Lying down: $5.6 \pm 3.4$  Exercise: $22.4 \pm 37.4$ Leisure: $1.5 \pm 2.3$ Household: $1.5 \pm 1.3$ Total Physical Activity: $3.4 \pm 3.0$
Wikstrom et al (2006), Sweden	Diagnosis of RA according to ACR revised 1987 criteria Disease duration of 1 year or less	Leisure Activity Scale	Interest, performance, importance and change due to illness in leisure activity domains	Subjects performed in fewer leisure activity domains ( $8.2 \pm 3.1$ ) compared with controls ( $9.9 \pm 2.6$ ).
Eurenius et al (2007), Sweden	Confirmed diagnosis of RA Disease duration $\leq 6.5$ years Included on Swedish RA register Had to be able to perform at least 3 of 5 tests of bodily function and complete 1 of 2 questionnaires	Specially designed self report questionnaire	Sum score for self report physical activity questionnaire	36% of subjects did not meet recommendations on healthy physical activity behaviors Median physical activity score at baseline was 14 (range 5–30). At 1 year follow up, no statistically significant changes were found, with a median physical activity score of 13.25 (range 1–27.5).

(continued)

Table 2 (continued)

Author (year), location	Inclusion criteria for subjects	Measurement tool	Variable recorded	Results
Mancuso et al (2007), USA	18 years of age or older	Paffenbarger Physical Activity and Exercise Index	kcal/week	RA patients 1474 ± 1198 kcal/week. Controls 1958 ± 1940 kcal/week (mean ± SD)
	Fluent in English or Spanish			At 1 year follow up: RA patients 1459 ± 1368 kcal/week. Controls 1928 ± 1501 kcal/week (mean ± SD)
	Met ACR 1987 revised criteria for RA			Subjects expended statistically significantly less kcal/week than controls
	Currently employed for salary			
Van den Berg et al (2007), Netherlands	Rheumatologist confirmed diagnosis of RA according to 1987 ACR criteria	Short Questionnaire to Assess Health (SQUASH)—Enhancing physical activity	Mins/week	RA population reported significantly less minutes of physical activity per week than the general population—RA patients: 1535 min/week, general population: 1869 min/week.
			Meeting national recommend-ations	Similar results were obtained for the RA and general populations regarding meeting public health recommendations
			% in different physical activity categories	Sedentarism: 17.3% Mild physical activity: 57.7%
Tourinho et al (2008), Brazil	Premenopausal women Fulfilled the criteria for RA, according to the American College of Rheumatology	Specific questionnaire to individuals about physical activity they usually do		Moderate physical activity: 25% Intense physical activity 0%
	Not in situations previously defined as deterrents of bone loss or increase			Women with RA were statistically significantly more likely to be sedentary ( $P = .044$ ) and less likely to be moderately active ( $P = .004$ ) than healthy women.
			Total energy (arbitrary units)	Mean total energy: RA: 298 units; FM: 307 units
Rafferty et al (2009), United Kingdom	Fulfilled the American College of Rheumatology (ACR) criteria for RA No other disabling conditions	Numact activity monitor	Number of steps taken Vigor of steps Time spent standing (secs)	Mean total number of steps: RA: 9916; FM: 11397 Mean vigor of steps: RA: 28.2; FM: 26.6 Mean time standing: RA: 15949 secs; FM: 15549

(continued)

**Table 2 (continued)**

Author (year), location	Inclusion criteria for subjects	Measurement tool	Variable recorded	Results
Stavropoulos-Kalinoglou (2009), United Kingdom	RA diagnosis (1987 revised ACR (American College of Rheumatology) criteria)	IPAQ	METmin per week	Males: 2607 (2179–3412) METmin per week Females: 2369 (1959–2978) METmin per week
Hurkmans et al (2010), Netherlands	Diagnosis of RA according to the criteria of the American College of Rheumatology	Short Questionnaire to Assess Health (SQUASH)—Enhancing physical activity	Mins / week	Patients with RA were physically active for an average of 1717 mins per week
Piva et al (2010), USA	Older than 30 years Diagnosis of RA according with the American College of Rheumatology criteria	SenseWear Professional v 6.1 Armband	keals/day	Participants expended an average of 199 keals/day at moderate intensity activity (3METs and above)
	Diagnosis for at least 2 years No cardiovascular events before recruitment		Daily average number of steps	Participants expended an average of 7151 steps
Elkan et al (2011), Sweden	RA diagnosis in conjunction with ACR criteria Disease duration $\geq$ 1 year	Short self-administered version of IPAQ	MET-hours/day	The total physical activity level was 40.00 [37.4–44.7; median (IQR)] MET-hours/day This corresponds to the activity of healthy Swedish women of same age. However, physical activity measurement was not conducted in similar manner in both studies. In 21% of the RA population, physical activity levels were considered low.
	Could not have: current malignancy, severe heart failure, severe renal failure, chronic obstructive lung disease with emphysema, earlier gastric ulcer or intestinal surgery or known eating disorder			



**Table 3 Quality of Studies Included**

	1	2	3	4	5	6	7	8
Lemmey et al, 2001	Unclear	Met	Not met	Met	Met	Met	N/A	Met
Roubenoff et al, 2002	Unclear	Met	Not met	Met	Met	Met	N/A	Met
Semanik et al, 2004	Unclear	Met	Not met	Met	Met	Met	N/A	N/A
Eurenius et al, 2005	Not met	Met	Not met	Met	Met	Met	N/A	N/A
Hagfors et al, 2005	Not met	Met	Not met	Met	Met	Met	N/A	N/A
Greene et al, 2006	Not met	Met	Not met	Met	Met	Met	N/A	Met
Wikstrom et al, 2006	Met	Met	Not met	Unclear	Met	Met	Met	Met
Eurenius et al, 2007	Not met	Met	Not met	Met	Met	Met	Met	N/A
Mancuso et al, 2007	Unclear	Met	Not met	Met	Met	Met	Not met	Met
van den Berg et al, 2007	Unclear	Met	Not met	Met	Met	Met	N/A	N/A
Tourinho et al, 2008	Unclear	Met	Not met	Unclear	Met	Met	Met	Met
Raftery et al, 2009	Unclear	Unclear	Not met	Not met	Met	Met	N/A	Unclear
Hurkmans et al, 2010	Met	Met	Not met	Met	Met	Met	N/A	N/A
Piva et al, 2010	Unclear	Met	Not met	Met	Met	Met	N/A	N/A
Stavropoulos-Kalinoglou et al, 2010	Unclear	Met	Not met	Met	Met	Met	N/A	N/A
Elkan et al, 2011	Unclear	Met	Not met	Met	Met	Met	N/A	N/A

*Note.* Key: 1: Representativeness; 2: Ascertainment of exposure; 3: Subjects blinded to study aims; 4: Duration covering full range of variation; 5: Diagnosis; 6: Adequate use of statistics; 7: Attrition; 8: Comparability.

Abbreviations: N/A, not assessed.

some, in particular some of those reported by subjective measures, do not lend themselves to conversion, making accurate comparison difficult. Furthermore, some of the tools measured TEE (thereby encompassing more than physical activity) while some only examined specific aspects of certain physical activities. Therefore, efforts to compare what is measured by each are hampered further.

The decision of which measurement tool to accurately account for physical activity levels or energy expenditure levels has been the cause of debate.<sup>53</sup> Subjective methods are generally not as expensive and are easier to administer than objective measures of physical activity. However, they are also subject to numerous disadvantages including misrepresentation, misinterpretation, accuracy in recall, and intensive effort and motivation on the part of the subject.<sup>54</sup> Prince et al<sup>55</sup> assessed the comparison of direct versus self report measures for assessing physical activity in adults using a range of subjective and objective measures and found a generally low to moderate correlation between the 2 methods. The Doubly Labeled Water (DLW) method is the gold standard criterion for measuring energy expenditure and gives most accurate information.<sup>56,57</sup> However, due to the high cost of isotopes, the cost and complexity of analysis with gas isotope-ratio mass spectroscopy, there is limited applicability of the DLW method in large population studies.<sup>54</sup>

The ideal method of physical activity measurement should be accurate, precise, objective, simple to use, robust, time efficient, cause minimal intrusion into habitual activity patterns, be socially acceptable, allow for continuous and detailed recording of usual activity

patterns, and finally, should be applicable to large population groups.<sup>58</sup> When working with a clinical population, particularly a condition like RA where joint involvement is a feature of the disease, ease of use must be a major consideration. This is highlighted by the high percentage of RA patients necessitating the use of aids, appliances and assistive devices in activities of their daily living.<sup>59,60</sup>

### Terminology

By definition, *physical activity* is 'any bodily movement produced by skeletal muscles that results in energy expenditure,' whereas *exercise* is 'a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness'.<sup>5</sup> However, Lemmey et al<sup>38</sup> used both the terms 'exercise' and 'physical activity' interchangeably within the text. This makes it difficult to compare the findings of this study with normative data and also with other studies which have assessed physical activity or exercise in a RA population. However, this is the oldest of the studies included in this systematic review and it must be noted that authors of more recent texts appear more aware of the differences between the 2 terms when reporting the findings of their studies.

### Comparison With National Guidelines/Recommendations

Eurenius et al,<sup>44,46</sup> Mancuso et al,<sup>41</sup> and van den Berg et al<sup>50</sup> indicated that the majority of the RA population

which they assessed, although not as active as their normative comparisons, met the national guidelines for physical activity. Each of the studies gave overall time in activity values. The American College of Sports Medicine (ACSM) recommendation is for the accumulation of 30 minutes of moderate-intensity lifestyle physical activity in short segments (10-minute bouts) on most, if not all, days of the week.<sup>28</sup> Furthermore, the ACR also supports these recommendations for people with RA.<sup>29</sup> However, none of the studies took into account the recommendation of the activity to be of minimum 10-minute bout in duration, thereby assessing if the ACSM guidelines were met.

In a recent study conducted by Esliger et al,<sup>61</sup> 7 consecutive days of accelerometry measurements were gathered from a group of 94 adolescents. The results of minute by minute or cumulative physical activity monitoring indicated that 100% of the subjects were averaging  $\geq 30$  minutes moderate to vigorous physical activity (MVPA) per day, with 98% averaging  $\geq 60$  minutes MVPA daily. In comparison when the data were analyzed to include bouts of MVPA  $\geq 10$  minutes continuously, only 6% achieved  $\geq 30$  minutes MVPA daily and only 2% achieved  $\geq 60$  minutes MVPA per day. These findings indicate the importance of being stringent in the measurement of 10 minute bouts of activity rather than minute by minute activity, when aiming to determine whether ACSM guidelines have been reached.

The results highlighted in this review indicate that physical activity may be reduced in this population. These findings are based across an international spectrum and using a variety of physical activity outcome measures, both subjective and objective in nature. However, as highlighted by the quality assessment (Table 3) methodological flaws exist in each of the studies reviewed. For this reason, the validity of the evidence is questionable and an overall conclusion cannot be made.

## Limitations

According to the Cochrane handbook for systematic reviews,<sup>33</sup> a systematic review should be undertaken by more than 1 person, to increase the likelihood that errors are detected. However while the authors attempted to follow the Cochrane approach to systematic review methodology, unfortunately it was not feasible in all aspects of the methodology and in this review it was only possible to have 2 reviewers assess the quality of the studies.

Recommendations for future research include

- Use of objective measurement tools in the assessment of free living physical activity in this population
- Larger sample sizes when measuring with objective measures and sample size calculations. This will allow the results of the study to be reported with confidence
- Subject data should be compared with controls, if possible patient controls. The use of controlled data as opposed to normative data ensures that the

data from both groups will have been gathered in an identical manner and therefore differences can be reported on with confidence. Furthermore, it has been shown that patients with 1 disease may be undertreated for other diseases<sup>62,63</sup> so it is important that both groups be drawn from patient population groups. However, it is likely that the use of control data from other rheumatology populations will not find large changes, as both groups will have large degrees of disability. The use of control data from nondisabled disabled populations will likely to be most representative of the differences in physical activity levels in the RA population compared with their peers

- Use of outcome measures that have been proven valid and reliable in both the RA population and also for control populations
- Physical activity monitoring of moderate intensity of 10-minute bouts. There is evidence that lifestyle physical activity needs to be continuous 10-minute bouts of self selected moderate intensity activity to provide cardiovascular and other health benefits<sup>28</sup>
- The definitions of “physical activity” and “exercise” as described by Caspersen et al<sup>5</sup> should be strictly implemented as defined. This will ensure that study findings are more easily comparable
- Use of easily modifiable output styles from outcome measures. This will also assist in ensuring that findings from various studies are more easily comparable.

## Conclusion

This systematic review reports on the levels of physical activity in the RA population and outlines the differences between this population and national recommendations and both healthy and other rheumatology patient control populations. The findings of this systematic review indicate that physical activity levels among individuals with RA may lower than those recommended and also when compared with healthy controls. This finding occurs irrespective of the measurement tool used. However, although the findings appear to indicate this, we cannot report this with confidence due to the limitations of measurement and as we have reported, many recommendations for future research which have not been applied in the studies carried out on this topic to date.

This review identifies the variability in physical activity measurement and lack of objective measurement of physical activity in RA and describes evidence that clearly supports the necessity of objective monitoring of physical activity levels within this population. In addition, the reporting of physical activity levels in total volume values as well as moderate intensity levels that occur in 10 minute bouts may allow greater comparability with specific regard to health benefits induced by physical activity.<sup>28</sup>

Furthermore, the necessity of intervention to improve the physical activity levels within the RA population appears evident on the basis of the findings of this review. Individuals with RA are at an excessive cardiovascular disease risk compared with the general population,<sup>25,26</sup> and therefore fostering appropriate physical activity appears fundamental and should be a priority to improve mortality rates in this population.

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## Appendix

### Quality Checklist

Based on Newcastle-Ottawa scale (available at: [http://www.ohri.ca/programs/clinical\\_epidemiology/oxford.htm](http://www.ohri.ca/programs/clinical_epidemiology/oxford.htm)) and modified Newcastle-Ottawa scale used by (Smedslund and Birger Hagen, 2010).

1. Representativeness: Sample is truly representative of the average patient with rheumatoid arthritis
2. Ascertainment of exposure: Physical activity was adequately measured and participants were exposed to a variety of physical activity opportunities
3. Subjects blinded to study aims: The participants were not informed that physical activity levels and/or energy expenditure levels would be recorded
4. Duration covering full range of variation: Recorded levels for at least 1 week is preferred but recordings covering at least 2 weekdays AND 1 weekend day (ie, periods with substantial variation) are acceptable
5. Diagnosis: Participants have a formal diagnosis of rheumatoid arthritis according to the ACR criteria (Arnett et al, 1988). As autocorrelations were not relevant in all of the included studies, the changing of the wording of the following criteria was deemed necessary
6. Adequate use of statistics: Statistical analysis is clearly described and appropriate
7. Attrition: Complete follow up of all subjects or subjects lost to follow up are unlikely to introduce bias: number lost less than 20%. The use of studies with controls did occur in the conducting of this review, thus inclusion of a methodology quality criteria relating to this was deemed relevant.
8. Comparability: Participants and controls are adequately comparable in terms of health status (differing) AND age and gender (similar).

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