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ORIGINAL ARTICLE - OBSERVATIONAL RESEARCH

Physical activity and the association with fatigue and sleep in Danish patients with rheumatoid arthritis

K. Løppenthin[1,2] · B. A. Esbensen[1,4] · M. Østergaard[2,4] · P. Jennum[4,5] · A. Tolver[6] · M. Aadahl[3,7] · T. Thomsen[1,2] · J. Midtgaard[3,8]

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Abstract The aim of this study was to examine physical activity behavior in patients with rheumatoid arthritis and to identify potential correlates of regular physical activity including fatigue, sleep, pain, physical function and disease activity. A total of 443 patients were recruited from a rheumatology outpatient clinic and included in this cross-sectional study. Physical activity was assessed by a four-class questionnaire, in addition to the Physical Activity Scale. Other instruments included the Multidimensional Fatigue Inventory (MFI), the Pittsburgh Sleep Quality Index and the Health Assessment Questionnaire. Disease activity was obtained from a nationwide clinical database. Of the included patients, 80 % were female and mean age was 60 (range 21–88 years). Hereof, 22 % ($n = 96$) were regularly physically active, and 78 % ($n = 349$) were mainly sedentary or having a low level of physical activity. An inverse univariate association was found between moderate to vigorous physical activity, and fatigue (MFI mental, MFI activity, MFI physical and MFI general), sleep, diabetes, depression, pain, patient global assessment, HAQ and disease activity. The multivariate prediction model demonstrated that fatigue-related reduced activity and physical fatigue were selected in >95 % of the bootstrap samples with median odds ratio 0.89 (2.5–97.5 % quantiles: 0.78–1.00) and 0.91 (2.5–97.5 % quantiles: 0.81–0.97), respectively, while disease activity was selected in 82 % of the bootstrap samples with median odds ratio 0.90. Moderate to vigorous physical activity in patients with rheumatoid arthritis is associated with the absence of several RA-related factors with the most important correlates being reduced activity due to fatigue, physical fatigue and disease activity.

Keywords Physical activity · sleep · fatigue · rheumatoid arthritis

Introduction

It is well established that regular physical activity is important for disease prevention and health promotion in the general population as well as in clinical subpopulations. Patients with rheumatoid arthritis (RA) comprise such a population for whom physical activity has been shown to contribute to increased muscle strength, aerobic capacity and pain reduction [1, 2] and may be associated with a reduction in cardiovascular risk factors [3, 4]. Substantial

✉ K. Løppenthin
katrine.bjerre.loeppenthin@regionh.dk

1 Research Unit of Nursing and Health Science, Glostrup Hospital, University of Copenhagen, Ndr. Ringvej 57, 2600 Glostrup, Denmark

2 Center for Rheumatology and Spine Diseases, Copenhagen Center for Arthritis Research, Glostrup Hospital, University of Copenhagen, Glostrup, Denmark

3 Department of Public Health, Faculty of Health and Medical Sciences, University of Copenhagen, Glostrup, Denmark

4 Department of Clinical Medicine, Faculty of Health and Medical Sciences, University of Copenhagen, Glostrup, Denmark

5 Department of Clinical Neurophysiology, Danish Center for Sleep Medicine, Glostrup Hospital, University of Copenhagen, Glostrup, Denmark

6 Laboratory of Applied Statistics, Department of Mathematical Sciences, University of Copenhagen, Glostrup, Denmark

7 Research Center for Prevention and Health, The Capital Region, Copenhagen, Denmark

8 The University Hospitals Center for Health Research, Copenhagen University Hospital, University of Copenhagen, Copenhagen, Denmark

evidence exists that physical activity reduces the risk of cardiovascular diseases in the general population. In addition, physically inactive patients with RA have a worse cardiovascular profile compared to those who are regularly physically active [5]. Despite the known benefits of physical activity, a cross-sectional study of patients with RA in 21 countries documented that 60–80 % did not engage in regular physical exercise [6]. However, other studies indicate that a majority of patients with RA are meeting the international recommendations for physical activity although still not being as active as their healthy counterparts [7–9]. The mixed findings in these studies may be attributable to the use of different measures and types of physical activity. Physical activity is defined as any bodily movement that results in energy expenditure, whereas exercise is physical activity that is planned, structured, repetitive and purposive [10]. However, regardless of which activities are used to define physical activity, burgeoning evidence suggests that sedentary behavior, which is typically defined as any waking behavior characterized by an energy expenditure $\leq$1.5 METs while in a sitting or reclining position [11], constitutes a distinct and independent risk factor for cardiometabolic morbidities [12]. Thus, recent population-based studies have shown an increase in sitting time during leisure time, irrespective of an increased level of physical activity [13, 14], indicating a need to measure both physical activity and sitting time in relation to health profile.

Little understanding exists on the potential influence of disease activity and patient-reported outcomes such as fatigue and poor sleep in relation to physical activity behavior including exercise and sedentary behavior. Fatigue and poor sleep are known to affect 40–70 % of patients with RA, and their association with reduced quality of life and poor mental health is well documented [15, 16]. However, their association with physical activity behavior remains unexplored. Accordingly, there is a need to take into account not only different dimensions of physical activity (frequency, duration and intensity) and sitting time, but also different dimensions of fatigue, sleep and other disease-related factors in the examination of physical activity behavior in patients with RA. Thus, the aim of this study was to examine physical activity behavior in patients with RA and to identify potential RA-related correlates of physical activity behavior including different fatigue dimensions, sleep, pain, physical function and disease activity.

Materials and methods

The study was designed as a cross-sectional study using validated self-reported questionnaires and physician-generated assessments of disease activity score.

Study sample

We included 500 patients with RA, all meeting the 2010 American College of Rheumatology/European League Against Rheumatism criteria for RA [17] and aged $\geq$18 years.

Recruitment

Patients who attended the Rheumatology Clinic at Glostrup Hospital, University of Copenhagen, between June and September 2011 and who met the inclusion criteria were invited consecutively to participate in the study, of these 22 declined. As we aimed for a representative sample of the RA population, and in order to make it possible to include both demographic and several disease-specific parameters in the statistical analyses, we included 500 patients, corresponding to 50 % of the RA population in the outpatient clinic. The 500 patients who accepted were given a self-administered questionnaire containing information about frequency, duration and intensity of physical activity, fatigue, sleep, pain, physical function and demographic and clinical factors. If the time schedule did not allow for immediate completion of the questionnaire, or if they preferred to complete the questionnaire at home, the patients were given a stamped addressed envelope and asked to return by ordinary mail. Follow-up telephone calls with encouragement to answer and return the questionnaire were made to patients who had not returned within 14 days.

The study was reported to the Danish Data Protection Agency (j.no.glo-2011-7) and the Ethics Committee of the Capital Region of Denmark (J.no. H-4-2010-FSP). All patients were given oral and written information, and the study was performed in compliance with the Helsinki Declaration.

Patient-reported outcomes

The study comprised five standardized questionnaires covering different outcomes related to physical activity, fatigue, sleep, pain and physical function.

Leisure Time Physical Activity Level

The Leisure Time Physical Activity Level questionnaire constructed by Saltin and Grimby [18] was used to assess the current level of physical activity. Patients were asked to classify themselves into one of four levels (I–IV).

I. Mainly sedentary (e.g., primarily watching television, reading books or performing other passive activities)

II. Walking, cycling for pleasure or performing other forms of low to moderate exercise (irregular exercise; e.g., dog walking, gardening, golf)
III. Moderate- to high-intensity physical activity for at least 3 h per week (e.g., tennis, swimming)
IV. High-intensity exercise at least 4 h per week ("athletics"; e.g., running, high-impact aerobics).

In this study, we categorized physical activity into two groups: low (suboptimal) physical activity (corresponding to level I and II) and regular (recommended) physical activity (corresponding to level III and IV).

As the Leisure Time Physical Activity questionnaire is suitable for a simple categorization of the physical activity level, it do not allow for a more precise description of time spent on different physical activity levels. Thus, in addition to the Physical Activity Level questionnaire, we included the Physical Activity Scale (PAS), which makes it possible to determine the time spent on the different physical activity levels.

Physical Activity Scale (PAS 2) [19] was used to measure self-reported time spent on physical activity and sedentary behavior. The questionnaire measures nine intensity levels of physical activity from none (sleep) to strenuous physical activity. Patients were asked to report number of hours and minutes spent on sitting time by replying to the question: "In your leisure time, how many hours and minutes per day, do you watch television, sit down and relax, read or listen to music etc.?" which correspond to a MET intensity of 1.0. Additionally, the patients were asked to report number of hours and minutes spent each week on light to moderate physical activity (MET 3.0), moderately to vigorous activity (MET 5.0) and vigorous activity (MET 6.0). The scale has been tested by cognitive interviewing in a general Danish population [19].

Fatigue

Multidimensional Fatigue Inventory (MFI-20) [20] is a self-reported questionnaire that measures fatigue severity in recent times. It contains 20 items and consists of five fatigue domains: mental fatigue (e.g., "it takes a lot effort to concentrate on things"), reduced motivation (e.g., "I don't feel like doing anything"), reduced activity (e.g., "I get little done"), physical fatigue (e.g., "Physically I feel I am in bad condition") and general fatigue (e.g., "I feel tired"). The response options consist of five check boxes ranging from "Yes, that is true," to "No, that is not true." The scores range from 4 to 20, with higher scores indicating higher levels of fatigue. In the original validation study, Cronbach's alpha is reported to be 0.84 [20]. MFI-20 has been used in several clinical and healthy populations and may be considered as a generic instrument. However, MFI-20 has previously been used in the RA population to assess fatigue [15, 21].

Sleep

Pittsburgh Sleep Quality Index (PSQI) [22] measures self-reported sleep quality and disturbances during the previous 4 weeks. It has 19 items and measures seven components of sleep: sleep quality, sleep latency, sleep duration, sleep disturbances, use of sleeping medication, habitual sleep efficiency and daytime dysfunction. The component scores have each a range of 0–3 points and are added to yield one global PSQI score (range of 0–21 points) distinguishes good sleep (PSQI total score $\leq$5) from poor sleep (PSQI total score >5). The Cronbach's alpha is reported to be 0.80 [23]. In the RA population, PSQI has become one of the most commonly used sleep instrument in recent years.

Physical function

Health Assessment Questionnaire (HAQ) [24] includes 20 items to assess current activity limitation in eight dimensions of activities of daily living: dressing and grooming, arising, eating, walking, hygiene, reach, grip and common daily activities. Patients rate degree of difficulty, 0 = no difficulty, 1 = some difficulty, 2 = much difficulty, 3 = unable to do. The scores result in a total HAQ score with a possible range of 0 (no difficulty) to 3 (unable to do). We used the Danish version of HAQ, reporting a Cronbach's alpha of 0.93 [25]. In addition, in the HAQ questionnaire, there is also visual analog scale (VAS) for pain, fatigue and patient global assessment.

Socio-demographic and clinical variables

Demographic data such as sex, age, employment, smoking and alcohol consumption and comorbidity were obtained by a structured questionnaire designed for this study. Disease duration and disease activity score on 28 joints (DAS28) calculated based on the number of swollen and tender joints; serum C-reactive protein; and patient global assessment score were obtained from the nationwide clinical database DANBIO [26]. DAS28 was obtained close (±2 months) to the day patient's received the questionnaire.

Statistical analyses

We used nonparametric Mann–Whitney tests to compare the time spent on physical activity at different intensities (based on PAS2) across groups of patients assigned to regular (recommended) physical activity (defined as level III or IV in Leisure Time Physical Activity Level questionnaire) and low (suboptimal) physical activity (defined as level I or II). To determine whether there was an association between the level of physical activity and disease-related factors, we performed logistic regression analyses with physical activity (dichotomized as either regular or low) as the dependent variable and sex, age, MFI mental, MFI-motivation, MFI activity, MFI physical, MFI general, PSQI, diabetes, depression, pain, patient global assessment, HAQ and DAS28 as independent variables. We further used nonparametric Mann–Whitney tests to compare the level of numerical disease-related variables between groups (regular or low physical activity).

Univariate p values should be interpreted with care in order to avoid mass significance due to multiple testing.

The conservative approach would be to use a Bonferroni correction with a modified significance level of $0.05/14 = 0.0036$. Subsequently, we developed a multivariate prediction model based on all correlates using the elastic net procedure [27], which is known to at the same time shrink the regression coefficients in order to avoid overfitting the model and to encourage a sparse model with few correlates.

The goal was to predict the probability of a patient doing regular physical activity, and the model was estimated from the R package "glmnet." Because the result turned out to be rather insensitive to the choice of the elastic net penalty, alpha, we report the values obtained with the recommended default value of $\alpha = 0.5$. The penalty parameter was based on tenfold cross-validation using deviance as loss function. The statistical properties of the estimation procedure were examined using bootstrap methods. We present median, 2.5 and 97.5 % quantiles for regression coefficients (odds ratios) and the frequency that each predictor is retained in the selected model based on 2500 bootstrap samples. All statistical analyses were carried out using the software program "R: A Language and Environment for Statistical Computing."

Results

In total, 500 questionnaires were handed out, of which 57 were either not returned or had more than 50 % of the variables missing. Thus, 443 (response rate 88 %) patients were included in the study. A comparison of responders' versus non-responders showed no statistically significant difference in age, disease duration and the degree of disease activity. These data from responders as well as non-responders were obtained from the national clinical database DANBIO in which all patients' data are registered. The demographic characteristics of the patients are presented in Table 1. The mean age of the patients was 60 (range 21–88), and 80 % were female. The median disease duration was 11 years.

Table 1 Characteristics of 443 patients with RA

Parameters	Patients
Sex ($n = 443$)	
Women	356 (80 %)
Men	87 (20 %)
Age ($n = 443$)	
Mean (range)	60 (21–88)
Employment status ($n = 431$)	
Working full time/part time	161 (37 %)
Not working	270 (63 %)
Smoking ($n = 435$)	
Current	132 (30 %)
Former	182 (42 %)
Never	121 (28 %)
Comorbidities ($n = 443$)	
Diabetes	36 (8 %)
Depression	47 (11 %)
Disease duration ($n = 345$)	
Median (IQR)	11 (6–18)
Disease activity ($n = 374$)	
Median (IQR)	2.6 (1.0–3.5)
Physical function (HAQ) ($n = 409$)	
Median (IQR)	0.75 (0.25–1.25)
Pain (VAS) ($n = 418$)	
Median (IQR)	29 mm (11–57)

Physical activity behavior

The patients self-reported physical activity behavior was measured by means of the questionnaire Leisure Time Physical Activity Level, which showed that 117 (27 %) reported being sedentary (level I) and 225 (51 %) being light to moderate physically active (level II), while 89 (20 %) and 7 (2 %) patients reported regular moderate (level III) or regular vigorous activity (level IV), respectively. The patients reported a median of 4 h per day (IQR 3–5 h) sitting time. The median number of hours spent on light to moderate physical activity was 5 per week (IQR 3–11.5 h), while the median time spent on regular moderate and vigorous physical activity was 2 (IQR 1–6 h) and 0 h per week, respectively.

As illustrated in Fig. 1, greater proportions of patients reporting regular physical activity (level III and IV) tend to belong to the lowest category of hours spent on sitting time. Likewise, patients reporting being sedentary or lightly physically active (level I and II) also spent less time in vigorous physical activity. However, time spent on light and moderate physical activity displays greater variability among the patients according to the physical activity level assessed using the questionnaire Leisure Time Physical

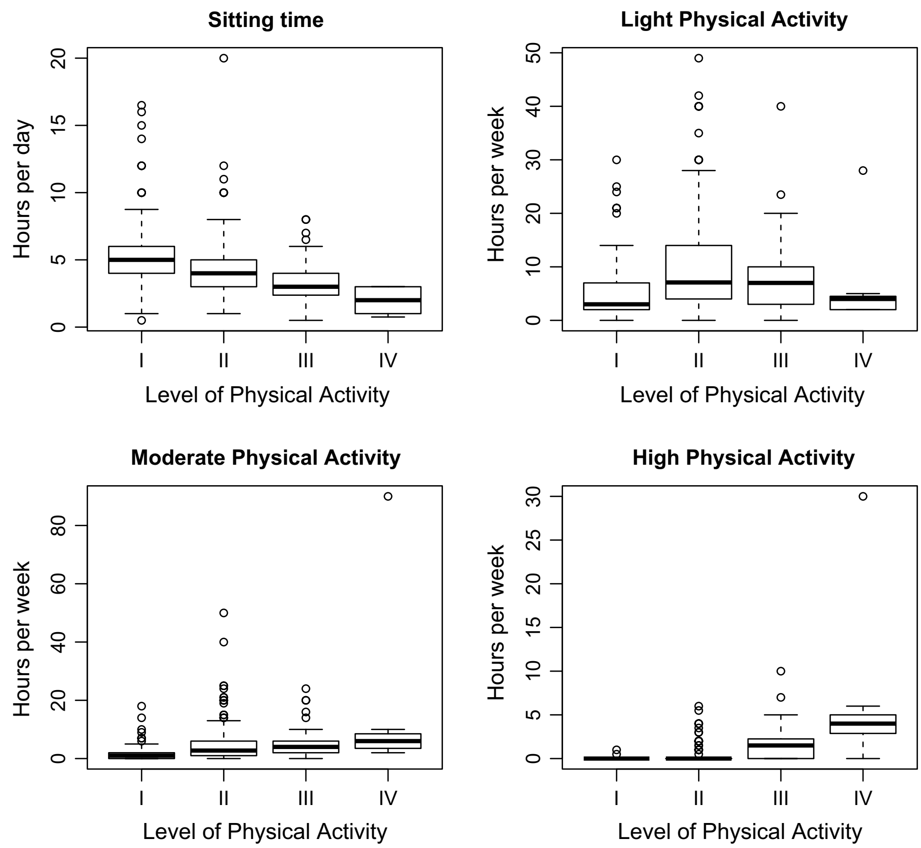

Fig. 1 Distribution between the level of physical activity (I sedentary, II moderate physical activity, III moderate physical activity, IV vigorous physical activity) and hour spent on each physical activity level (sitting time, light to moderate physical activity, moderate physical activity and vigorous physical activity)

Table 2 Comparison of median (interquartile) score for time spent on each activity level (sitting time, light to moderate physical activity, moderate physical activity and vigorous physical activity measured by means of the questionnaire Physical Activity Scale) according to regular physical activity (moderate to high intensity for physical activity for three to 4 h per week) and a low level of physical activity (mainly sedentary or low-intensity physical activity)

Variable	Regular physical activity $n = 96$ Median hours (IQR)	Low physical activity $n = 342$ Median hours (IQR)	p value
Sitting time (hours per day)	3 (2–4)	4 (3–6)	<0.001
Light to moderate physical activity (hours per week)	6 (3–10)	5 (3–12)	0.72
Moderate physical activity (hours per week)	4 (2–7)	2 (0.5–5)	<0.001
Vigorous physical activity (hours per week)	2 (0–3)	0	<0.001

Activity Level. As shown in Table 2, hours spent sitting or hours spent being physically active at moderate intensity or high physical activity was statistically significantly different between patients categorized as regular physically active compared to patients with low level of physical activity.

Correlates of physical activity

As seen in Table 3, the median scores for all dimensions of fatigue, PSQI, pain, patient global assessment score, HAQ and disease activity were lower for patients reporting regular physical activity than for those reporting a low physical activity level. Table 4 shows the results of the univariate analyses revealing that patients with a higher score on fatigue (mental fatigue, reduced activity, physical fatigue and general fatigue), pain, patient global assessment, HAQ and disease activity had statistically significantly lower odds for being regular physically active than for being physically active at a low level.

Figure 2 displays the accuracy of the elastic net procedure for building a multivariate prediction model for our data and displays two aspects of the procedure. Two variables were found to be important for predicting regular physical activity. Physical fatigue was selected for 99.7 % of the bootstrap samples, and the median odds ratio was

Table 3 Comparison of the median (interquartile) score for RA-related factors according to regular physical activity and low physical activity

Variable	Regular physical activity $n = 96$ Median (IQR)	Low physical activity $n = 342$ Median (IQR)	p value
MFI mental (score 0–20)	9 (6.0–11)	10 (7.0–13.0)	0.008
MFI-motivation (score 0–20)	10 (9.0–12.0)	11 (9.0–12.0)	0.50
MFI activity (score 0–20)	11 (10.0–13.0)	13 (11.0–15.0)	<0.0001
MFI physical (score 0–20)	10 (7.0–13.5)	15 (12.0–18.0)	<0.0001
MFI general (score 0–20)	12 (8.7–15.0)	15 (12.0–18.0)	<0.0001
PSQI (score 0–21)	6 (4.0–10.0)	7 (4.0–10.0)	0.14
Pain (score 0–100)	17 (5.0–39.5)	31 (14.0–61.0)	<0.0001
Patient global assessment (score 0–100)	29 (7.5–47)	39.5 (16–68)	0.0008
HAQ (score 0–3)	0.37 (0.0–0.8)	0.87 (0.4–1.4)	<0.0001
DAS28 (<2.6 to >5.1)	2.25 (1.8–2.9)	2.80 (2.0–3.7)	<0.0001

Table 4 Results of the univariate logistic regression analysis of disease-related factors association with regular physical activity (complete case analysis $n = 269$)

Variable	Univariate model		
	OR	95 % CI	p value
Sex (male)	2.00	1.07–3.76	0.02
Age	1.03	1.00–1.05	0.006
MFI mental	0.91	0.85–0.98	0.01
MFI-motivation	0.94	0.83–1.06	NS
MFI activity	0.68	0.59–0.78	<0.001
MFI physical	0.81	0.75–0.87	<0.001
MFI general	0.90	0.85–0.96	0.001
PSQI	0.95	0.89–1.02	NS
Diabetes	0.60	0.19–0.86	NS
Depression	0.85	0.36–1.99	NS
VAS-pain	0.97	0.96–0.99	0.0007
VAS-global	0.98	0.97–0.99	0.001
HAQ	0.36	0.22–0.60	<0.001
DAS28	0.53	0.39–0.72	<0.001

0.91 (2.5–97.5 % quantile: 0.82–0.97), while fatigue-related reduced activity was retained with probability 97.5 %, and median odds ratio was 0.89 (2.5–97.5 % quantile: 0.78–1.00). Disease activity was selected with probability 82.0 % and median odds ratio was 0.90 (2.5–97.5 %: 0.67–1.00) and age was selected with probability 78.8 % and median odds ratio was 0.99 (2.5–97.5 %: 0.96–1.00).

Discussion

A majority of the 443 patients with RA included in this study reported a low level of physical activity. Furthermore, our study reveals that engaging in regular physical activity is associated with less fatigue and pain and with lower HAQ score and disease activity. However, when controlled for potential explanatory variables, only reduced activity due to fatigue, physical fatigue and disease activity were found to be statistically significantly lower in patients being regularly physically active.

Findings from this study support previous studies documenting low levels of physical activity and increased sitting time in patients with RA compared to controls [9, 28–30]. Although no direct comparison was made in the present study, we found that 27 % of the patients in our study reported being primarily sedentary compared to 16.4 % of the Danish general population [31]. Furthermore, moderate to vigorous physical activity was lower for patients in our study compared to the general Danish population (21.6 vs. 29.2 %) [31]. However, the 2 % of the patients reporting physical activity at the highest level (level IV) was consistent with levels reported in studies carried out in the general population [32–34]. Thus, patients with RA may differ from the general population in particular through behavior that is more sedentary or at a low level of physical activity.

Our study supports previous studies, reporting that fatigue is pronounced in patients with RA. Thus, our results are in accordance with a cross-sectional study from the Netherlands [15] of 841 patients with RA reporting a high score on all the five fatigue domains included in the MFI-20. In addition, although no direct comparison with other clinical subpopulations or healthy individuals was made in this study, the stated scores correspond with MFI-20 values reported in other clinical populations [35–37]. In comparison, the general population [38, 39] including the Danish population [40] rated fatigue scores that were skewed toward the absence of fatigue on the MFI-20. However, when comparing data from patients with RA to healthy individuals, it is important to address the etiology of fatigue. In healthy individuals, tiredness can be a normal phenomenon triggered by a physical or mental effort aimed at regulating daily rhythms that disappear after rest. In

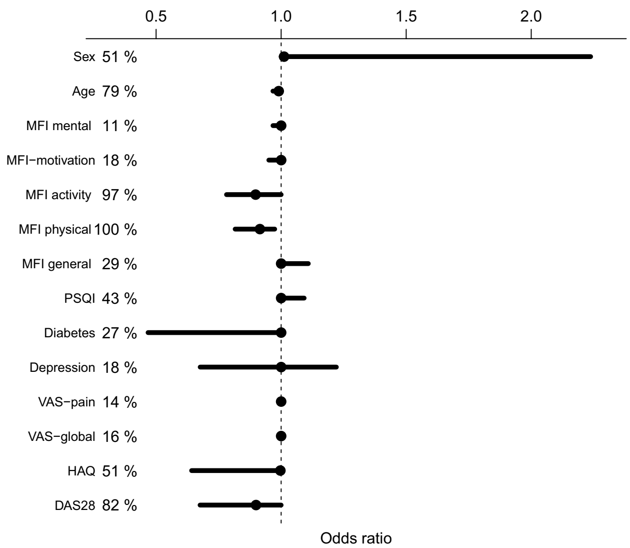

Fig. 2 Multivariate prediction model for RA-related factors association with regular physical activity. *Note* The frequency (percent out of 2500) of the elastic net procedure retained each correlate in the prediction model is displayed right to variable names. Second, the *horizontal bars* and the *black dots* show the 2.5 %, median, and 97.5 % quantile of the corresponding estimated odds ratio. When a variable is not retained in the subset of selected correlates, the corresponding odds ratio is included as the value 1 (=no effect). MFI mental: mental fatigue; MFI-motivation: fatigue related to reduced motivation; MFI activity: reduced activity related to fatigue; MFI physical: physical fatigue; MFI general: general fatigue; PSQI: Pittsburgh Sleep Quality Index: VAS-pain: visual analog scale for pain; VAS-global: visual analog scale for patient global assessment for impact of arthritis; HAQ: Health Assessment Questionnaire; DAS28: disease activity score on 28 joints

contrast, patients with RA have described fatigue as unpredictable, overwhelming and different from normal tiredness and with no particular reason [41, 42].

Notably, our study revealed that fatigue-related reduced activity (e.g., "I get little done") and physical fatigue (e.g., "Physically I feel I am in bad condition") were the most important correlates of the physical activity level. This indicates that fatigue-related reduced activity and physical fatigue are significant risk factors for sedentary behavior or for a low level of physical activity. However, more research in causal associations between physical activity and the dimensions of fatigue in patients with RA is warranted.

The fact that we found disease activity to be associated with the physical activity level is interesting, and another significant result was the lack of association between pain and the physical activity level. This suggests that while pain results in efforts to cope with everyday life [43] and increases fatigue [44], its role in physical activity may be less prominent. Thus, patients avoiding physical activity when having a flare may explain the association between disease activity and physical activity behavior. It is noteworthy that while inconsistency exists within observational studies of the association between disease activity and physical activity [7, 45–47], physical exercise interventions have shown no worsening on disease activity [48]. Furthermore, it is documented that patients with RA performing vigorous physical activity have lower joint pain [49], which support the effectiveness of physical exercise intervention trials in reducing pain in patients with RA [1, 50].

Surprisingly, a number of RA-related factors were not associated with the level of physical activity. Thus, in accordance with the lack of association between pain and physical activity, we did not find that sleep was associated with the physical activity level. This contradicts previous epidemiological [51], cross-sectional [52] and experimental [53–55] studies showing that exercise has a positive effect on sleep. Although physical activity and sleep are two distinct behaviors, studies have shown an association between reporting low level of physical activity and poor sleep [56, 57]. In addition, physical exercise has been shown to be as effective a treatment in decreasing sleep complaints as are hypnotic drugs [57]. One possible explanation for the lack of associations between the level of physical activity and sleep may be that we measured physical activity behavior and not specifically physical exercise. Thus, the documented association between physical activity and sleep has primary been shown in relation to physical exercise and may indicate that the intensity is of importance. More studies are needed to clarify the evidence for the association between sleep and physical activity and exercise in patients with RA.

Strength of our study includes that it covers a large, consecutively recruited population of patients with RA and had a response rate of 88 % and is thus representative of the background population of patients with RA. Another strength of our study is that we examined the physical activity level in relation to RA-related factors, which may help to inform future guidelines and in counseling specifically targeted at patients with RA. The limitations of our study are in line with other cross-sectional designs were exposure, and outcome refers to the same point in time. Therefore, it is not possible to determine the causality between physical activity and fatigue, and the question is whether those who engage in physical activity are less fatigued because they are physically active or vice versa. Furthermore, we used self-reported questionnaires to measure the physical activity behavior. Thus, it is possible that patients have overestimated their level of physical activity or underestimated the time spent sedentary. This risk of social desirability bias is well known when using self-report measures of physical activity and sedentary behavior. However, the Leisure Time Physical Activity Questionnaire developed by Saltin and Grimby has proven robust and independent of the context and been found to be appropriate for estimating cardiovascular morbidity [32, 58] as well as predicting risk of death in a large Danish population-based study [59]. Nevertheless, for more precise measurement of the detailed physical activity level and patterns, studies including objective measures (e.g., accelerometers) are warranted. To promote and maintain health, it is recommended that individuals undertake at least 150 min per week of moderate intensity physical activity or at least 75 min of vigorous intensity [60]. Our cutoff score for the questionnaire Leisure Time Physical Activity Level was based on these recommendations. Our dichotomization of physical activity is furthermore in accordance with a Swedish cross-sectional study [61]. However, the recommendations for physical activity are more comprehensive and include more information on intensity and duration than what our dichotomization makes possible. Thus, it cannot be ruled out that some patients who categorized themselves in level III or IV do not fulfill the health recommendations for physical activity and vice versa.

Furthermore, the two physical activity questionnaires included in this study are generic and have not previously been used in the RA population. For this reason, we evaluated the questionnaires in 41 patients with RA by means of cognitive interviewing, which indicated that patients with RA did not have difficulties in reporting their level of physical activity (data not published).

Based on our study, it seems essential that counseling on physical activity in patients with RA should focus not only on objective physiological improvements, such as reduced risk of cardiovascular diseases or better physical functioning, but also just as much on the positive patient-reported improvements that physical activity can provide. Fatigue as a key correlate for the level of physical activity highlights the importance of integrating fatigue in future exercise studies and in healthcare providers' counseling when promoting physical activity.

In conclusion, despite increased focus on the health benefits of physical activity, including documentation on safety, a majority of patients with RA report low level of physical activity. This study shows that self-reported moderate to vigorous physical activity is associated with the absence of many disease-related factors with the most important correlate for the physical activity level being reduced activity due to fatigue, physical fatigue and disease activity.

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