

Using Internet Technology to Deliver a Home-Based Physical Activity Intervention for Patients With Rheumatoid Arthritis: A Randomized Controlled Trial

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Objective. To compare the effectiveness of 2 Internet-based physical activity interventions for patients with rheumatoid arthritis (RA).

Methods. A total of 160 physically inactive patients with RA who had a computer with Internet access were randomly assigned to an Internet-based physical activity program with individual guidance, a bicycle ergometer, and group contacts (individualized training [IT] group; n = 82) or to an Internet-based program providing only general information on exercises and physical activity (general training [GT] group; n = 78). Outcome measures included quantity of physical activity (questionnaire and activity monitor), functional ability, quality of life, and disease activity (baseline, 3, 6, 9, and 12 months).

Results. The proportion of physically active patients was significantly greater in the IT than in the GT group at 6 (38% versus 22%) and 9 months (35% versus 11%; both $P < 0.05$) regarding a moderate intensity level for 30 minutes in succession on at least 5 days a week, and at 6 (35% versus 13%), 9 (40% versus 14%), and 12 months (34% versus 10%; all $P < 0.005$) regarding a vigorous intensity level for 20 minutes in succession on at least 3 days a week. In general, there were no statistically significant differences regarding changes in physical activity as measured with an activity monitor, functional ability, quality of life, or disease activity.

Conclusion. An Internet-based physical activity intervention with individually tailored supervision, exercise equipment, and group contacts is more effective with respect to the proportion of patients who report meeting physical activity recommendations than an Internet-based program without these additional elements in patients with RA. No differences were found regarding the total amount of physical activity measured with an activity monitor.

KEY WORDS. Physical activity; Exercise; Internet; Rheumatoid arthritis.

INTRODUCTION

Despite the proven health benefits of regular physical activity (1,2), the majority of the adult population in western

nations does not meet the public health recommendations for physical activity (3,4). Recent studies demonstrated that individuals with arthritis have even higher rates of sedentary behavior than the general population (5,6). This finding is remarkable because it has been extensively documented that regular exercise does not have deleterious effects and has extensive disease-specific benefits such as reduced pain, improved mental health, and delayed onset of disability in patients with rheumatoid arthritis (RA) (7–9) as well as osteoarthritis (10,11).

In addition to individually planned exercise prescription, the adoption of physical activity as part of the normal lifestyle of the patient with arthritis is now advocated often by promoting low-impact daily activities such as walking or cycling (12,13). Recently, various interventions, which were specifically aimed at promoting daily physical activity for patients with arthritis, have been evaluated. The People with Arthritis Can Exercise program (PACE) (14), which is a recreational, community-based

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physical activity program, improved mental and physical health status in patients with arthritis. In patients with symptomatic osteoarthritis, the effectiveness of a pedometer-driven walking program (15) and the extra benefit of individualized face-to-face physical activity advice in addition to usual care have been established (16).

These interventions were all delivered by means of conventional methods such as face-to-face counseling, group meetings, and written information. Although in the general population and in patients with diabetes the results of Internet-based physical activity programs using Web sites and e-mail as modes of delivery proved to be promising (17–19), no data in patients with arthritis are yet available. Therefore, the purpose of this study was to compare the effectiveness of 2 Internet-based physical activity interventions in patients with RA.

PATIENTS AND METHODS

Study design, patient recruitment and selection, and randomization. This study was a randomized, controlled trial performed between 2002 and 2004 in the rheumatology outpatient clinics of 3 hospitals (Leiden University Medical Center, Leiden; Haga-Leyenburg Teaching Hospital, The Hague; and Reinier de Graaf Hospital, Delft, The Netherlands). In these hospitals, 3 registries, comprising 765, 1,122, and 360 patients with a clinical diagnosis of RA, respectively, were sorted in ascending order by the day of the month of the patients' birthdays or by the date of their forthcoming visit to the outpatient clinic. Then 1,100 questionnaires (500 Leiden, 400 The Hague, and 200 Delft) were sent to consecutive patients from the 3 lists. After that, smaller samples of ~50 questionnaires were sent, until the target sample size of 160 patients was reached. The questionnaire comprised the following inclusion criteria: not being physically active for 30 minutes in succession at a moderate intensity level on at least 5 days a week (in accordance with the Dutch public health recommendations for physical activity [4]), the availability of a computer with Internet facilities, being able to cycle on a bicycle ergometer, and being interested in a study on a physical activity program. Medical records of the patients who returned the questionnaire and met the inclusion criteria were screened regarding the American College of Rheumatology (formerly the American Rheumatism Association) 1987 criteria for RA (20) (meeting ≥ 4 of 7 criteria at least once during the course of the disease). Eligible patients were then sent an information leaflet about the trial and were invited for an assessment regarding the final inclusion criterion, namely, not having cardiopulmonary conditions that would not allow moderately intensive exercise. No details were given regarding the level of individual guidance and counseling, group contacts, and availability of exercise equipment with the 2 interventions. All patients gave written informed consent, and the medical ethics committees of the 3 centers approved the study protocol. Randomization was performed using a randomization list created by a random digit generator, using blocks of 4 patients, with stratification for center and sex. The randomization process was carried out by an indepen-

dent physical therapist who was not responsible for recruiting the patients.

Interventions and cointerventions. Two Internet-based physical activity interventions that were continued for 12 months were compared; both interventions were delivered through the same Web site (www.cybertraining.nl). By using a personal password, the patients in the 2 groups obtained access to 2 different parts of the Web site.

Individualized training intervention. The Web pages of the individualized training (IT) intervention provided a weekly, detailed personal physical activity program consisting of muscle strengthening exercises, range-of-motion (ROM) exercises, and cycling on a bicycle ergometer. The program had to be performed 5 times a week on 5 separate days. Every week the patients sent back a completed program schedule by e-mail, and subsequently a new schedule was put on the individual's personal Web page. The muscle strengthening and ROM exercises were performed in a sitting, standing, or lying position in 3 sets of 10 repetitions per set, with 30 seconds recovery time between the sets. Patients were instructed to hold the end positions of the muscle strengthening exercises for 5 seconds. For some exercises, an elastic band (Thera-Band; Hygenic Corporation, Akron, OH) or a wooden exercise stick (Mammoet Sport, Eindhoven, The Netherlands) was used. In addition, a bicycle ergometer (Tunturi E3; Tunturi Oy, Turku, Finland) and a chest band measuring heart rate (Polar T41, Polar Electro Oy, Kempele, Finland) were given on loan to the patients during the study period. During cycling, the heart rate was kept at 60–80% of the predicted maximal heart rate (220 minus age), and the rating of perceived exertion (Borg scale range 0–10) (21) was kept at 4–5. Each cycling session was preceded by a warm-up (2 minutes) and followed by a cool-down (1 minute), with the duration of each cycling session increasing from 10 to 30 minutes per day. The program was tailor-made, meaning that depending on the average heart rate during cycling and the Borg scale, the program was adjusted in terms of duration and/or intensity. To enhance the adoption of physical activity as part of the individual's lifestyle, all patients were advised to engage in forms of physical activity other than using the bicycle ergometer, such as walking or cycling outside. Other forms of physical activity were specifically advised for the remaining 2 days of the week where the bicycle ergometer was not used and for those patients who did not like cycling on the bicycle ergometer at all.

Patients received weekly, individual distant supervision by e-mail from 2 experienced physical therapists. In addition, patients were invited to group meetings once every 3 months (3 groups in Leiden, 4 groups in The Hague, 2 groups in Delft), where new exercises were demonstrated by the physical therapists, extra information about exercise and arthritis was given, and patients' experiences were exchanged. Contacts among group members were also facilitated by a discussion forum on the IT group's Web pages. Self-management strategies tailored to the patient's needs such as management of pain and fatigue, energy conservation, and joint protection were addressed

during the group meetings as well as in individual contacts.

General training intervention. Patients allocated to the general training (GT) group had access to Web pages where general information about aerobic, muscle strengthening, and ROM exercises and the promotion of physical activity in patients with RA was presented. Patients were advised to perform the recommended activities on at least 5 days a week and suggestions were given about how intensity, frequency, and duration could be gradually increased in such a way that the goal of 30 minutes of moderate physical activity on at least 5 days a week could be reached. In addition, patients could order a free copy of the *Beweegwijzer 2002* (Movement Guide; TNO Preventie en Gezondheid, Leiden, The Netherlands), which is a CD-ROM comprising advice about increasing physical activity that was developed for the general population. Once a month the information on the Web pages was updated with new activities and exercises, news items, and online leaflets (i.e., a leaflet about walking or about physical activity at the workplace).

Cointerventions. The attending rheumatologists were informed about the treatment allocation and had free choice with respect to their medical prescriptions and other treatment strategies.

Assessment methods. All clinical assessments were performed by a single investigator (MHB, movement scientist) who was blinded to the treatment allocation. Measurements were obtained at baseline and after 3, 6, 9, and 12 months. Measures of disease activity, physical activity as measured with the activity monitor, functional ability as measured with the McMaster Toronto Arthritis (MAC-TAR) Patient Preference Disability Questionnaire (22), and the use of medication were obtained at baseline, 6 months, and 12 months only. Patients were repeatedly instructed not to discuss their treatment allocations with the investigator.

Sociodemographic and disease characteristics. Sociodemographic characteristics recorded at baseline were age (years), sex, educational level (categorized as low: up to and including lower technical and vocational training; medium: up to and including secondary technical and vocational training; and high: up to and including higher technical and vocational training and university), living situation (living alone or with other people), and employment status. In addition, body mass index (weight [kg]/height [m²]), smoking habits (active smoker defined as smoking ≥ 1 cigarettes per day), and the presence of comorbidity (assessed using a part of the Dutch Arthritis Impact Measurement Scale II [23] and defined as having ≥ 1 comorbid conditions) were registered. Disease duration at baseline, the presence of rheumatoid factor, and the previous number of disease-modifying antirheumatic drugs (DMARDs) received were recorded from the medical records.

Usage of health care. Any changes in the use of medication were registered after 6 and 12 months. The use of

health care services and visits to various health professionals over the past 3 months were measured using a diary that had to be filled in at 3, 6, 9, and 12 months.

Usage of Web site and online physical activity schedules. In both groups, the frequency of logging into the Web site was recorded by means of a questionnaire that was completed at 3, 6, 9, and 12 months. In the IT group, the amount of weekly returned physical activity schedules was recorded. Taking into account a 6-week period for getting used to filling in the schedules and an average holiday period of 6 weeks per year, the maximum number of schedules to be returned during the study period was 40. A schedule usage rate was defined as the number of returned physical activity schedules divided by 40.

Outcome measures. Primary outcome measure. The primary outcome measure was the proportion of patients meeting the physical activity recommendations, based on the Dutch public health recommendations for physical activity (4). For this purpose, 2 questions were posed. First, the participants were asked how many days a week they were physically active at a moderate intensity level for 30 minutes in succession, with physical activity at a moderate intensity level being defined as any form of physical activity that causes a small increase in breathing or heart rate (such as brisk walking, bicycling, vacuuming, or gardening). Second, participants were asked how many days a week they were physically active at a vigorous intensity level for 20 minutes in succession, with physical activity at a vigorous intensity level being defined as any activity that causes a large increase in breathing or heart rate (such as running, aerobics, or heavy yard work). Based on these 2 questions, the proportion of patients who were moderately active 30 minutes in succession on at least 5 days a week or vigorously active for 20 minutes in succession on at least 3 days a week was calculated.

Secondary outcome measures. Secondary outcome measures included the total number of days per week during which patients reported being moderately active for 30 minutes accumulated throughout the day or vigorously active for 20 minutes in succession. The amount of physical activity as measured by an activity monitor (Actilog V3.0; Radboud University Nijmegen Medical Center, Nijmegen, The Netherlands) was also a secondary outcome measure. This activity monitor is the size of a matchbox and consists of a piezo-electric sensor that is sensitive in 3 directions. Accelerations of the sensor are stored into an internal memory. The microcontroller reads and resets the counter of the activity monitor every second. The integration counter is set at 5 minutes, providing an activity score every 5 minutes that is stored into the internal memory of the activity monitor. At the end of the registration period, data are fed into an external computer (24). Accelerometers based on piezo-electric sensors were found to be reliable and valid measures of physical activity in healthy persons (25,26) as well as in patients with chronic fatigue syndrome (24,27). Furthermore, monitoring for 5 consecutive days has been described to be sufficient to achieve a reliability of 0.80 (28). In this study, the activity monitor was worn around the ankle for 24 hours on 5 consecutive

days, except during activities involving water (e.g., taking a bath). During the 1-year intervention, there were 3 measurements each consisting of 5 registration days: at baseline, 6 months, and 12 months. To retain 3 complete registration days, the first and the last registration days were omitted for the analysis. Specialized software (Actilog Analyzer V4.3; UMC St. Radboud) was used to calculate a general physical activity score over the 3-day period, expressed as the average number of accelerations per 5-minute period throughout the day, and the total number of 5-minute high (peak) activity periods throughout the day, where the average general physical activity score of the GT group was used as the cutoff level.

Another secondary outcome measure was functional ability, assessed with the MACTAR, which includes limitations in daily activities elicited from and ranked by the patient at baseline. The change scores range from -38 (maximum deterioration) to $+38$ (maximum improvement) (22). In addition, the Health Assessment Questionnaire (HAQ) was used, covering 20 activities of daily living in 8 dimensions, with the score of each activity ranging from 0 (without any difficulty) to 3 (unable to do). The total HAQ score is the average score of the 8 dimensions (range 0 [best possible function] to 3 [worst possible function]) (29).

Quality of life was measured with the Rheumatoid Arthritis Quality of Life (RAQoL) questionnaire, consisting of 30 items with a yes/no (1/0) response format. The overall score is the sum of the individual item scores, with a lower score indicating better quality of life (range 0–30) (30). In addition, a validated Dutch version of the RAND 36-Item Health Survey (31) was used, which includes 8 subscales. Each subscale generates a score from 0 to 100, with higher scores indicating better health. The RAND can be converted into 2 summary scales: the physical and mental component summary scale.

Disease activity was measured with the 28-joint Disease Activity Score (DAS28) using 4 variables: a validated composite index containing the 28-joint count for tenderness, the 28-joint count for swelling, erythrocyte sedimentation rate, and the patient's overall assessment of well-being (32).

Statistical analysis. The target study sample size was based on the proportion of participants that would meet the Dutch public health recommendation for physical activity. Based on the results of former studies (33,34), it was estimated that 50% of the patients in the IT group and 25% of the patients in the GT group would meet the recommendation after 12 months. With 80% power and a significance level of 0.05, 59 patients would be required in each group. To compensate for an expected dropout rate of 15%, we planned to enroll at least 80 patients in each group.

Differences between the groups at baseline, the use of health care services, and change in DMARD medication during the study were analyzed by the Mann-Whitney U test or chi-square test where appropriate. A Pearson's chi-square test or a Fisher's exact test was used when the 2 groups were compared with respect to a dichotomous out-

come measure. For continuous outcome measures within each group at each followup time point, change scores from baseline with the 95% confidence interval were computed. The differences between the 2 groups at the various time points were analyzed according to the change scores during followup. Effect sizes were calculated as the difference in changes from baseline between the IT and GT groups divided by the pooled SD of the change scores of the 2 groups. To compare the effectiveness over the entire 1-year period, repeated measures were analyzed with a general linear mixed model, with patient number as a random factor and treatment, time, and treatment \times time interaction as fixed effects. The interaction term was used to determine whether there was a significant change in time between the 2 groups. Furthermore, to assess the effect of time within both groups, a mixed-effects model was used with the patient number as the random effect and time as the covariate.

The primary analyses of effectiveness were based on intent-to-treat as initially assigned. All available data were used. As a secondary analysis, a per-protocol analysis of the physical activity outcome measures was performed, comparing only the patients in the IT intervention group who had a high (75–100%) schedule usage rate with all the patients in the GT intervention group. For all analyses, a *P* value less than 0.05 was adopted as the criterion for statistical significance. All data were analyzed using SPSS version 12.0 software (SPSS, Chicago, IL).

RESULTS

In total, 1,308 patients with RA were sent a questionnaire (Figure 1), with 832 questionnaires being returned (response rate 64%). Of these, 160 patients fulfilled the initial inclusion criteria, had a verified diagnosis of RA, and were subsequently invited for the final screening visit. All of these 160 patients were eligible for the study and were randomized, with 82 patients being allocated to the IT group and 78 to the GT group. There were no significant differences between baseline characteristics of patients in the IT and GT groups (Table 1). Five patients from the IT group (6%) and 3 patients from the GT group (4%) were lost to followup (Figure 1).

Concurrent interventions and usage of health care. No significant differences between the 2 groups were found with respect to the proportion of patients whose DMARDs were changed or in the proportion of patients visiting a rheumatologist, general practitioner, physical therapist, rheumatology nurse specialist, occupational therapist, dietician, or social worker 1 or more times (data not shown). A significantly greater proportion of patients in the IT group underwent surgery during the study as compared with the GT group (12% versus 5%; *P* = 0.02).

Usage of Web site and online physical activity schedules. After 3 months, 63 patients (86%) in the IT group and 9 (16%) in the GT group logged on to the Web site at least once a week. These numbers were 60 (75%) and 4 (6%) after 6 months, 46 (62%) and 3 (5%) after 9 months,

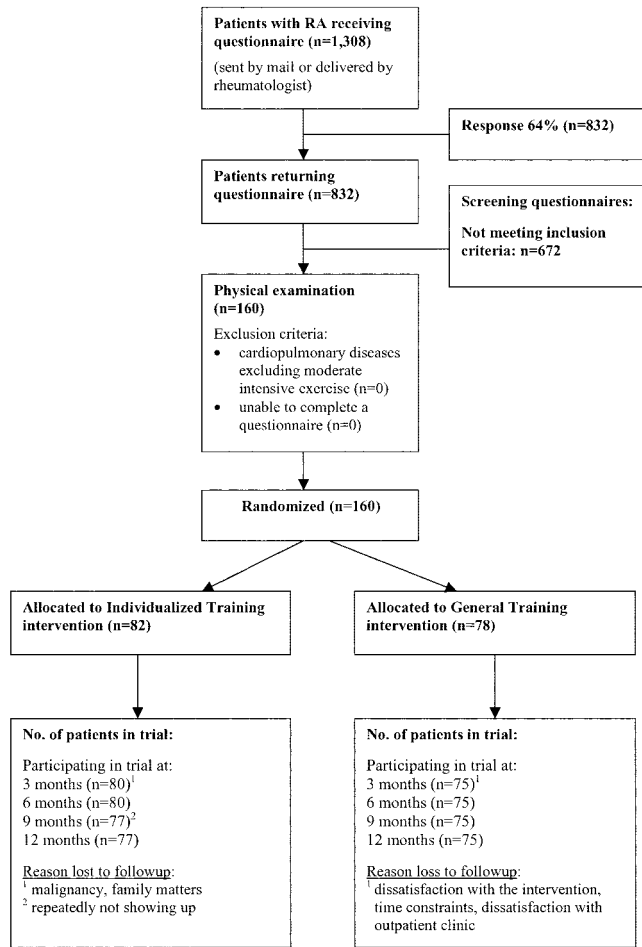


Figure 1. Flow diagram of the trial. RA = rheumatoid arthritis.

and 42 (55%) and 5 (7%) after 12 months in the IT and GT groups, respectively (all $P < 0.001$). The median schedule usage rate of the patients in the IT intervention group was 55% (interquartile range 74.4). The schedule usage rate was high (75–100%) in 35 patients (43%), sufficient (50–75%) in 8 patients (10%), and low (<50%) in 39 patients (48%).

Primary outcome measure. The proportion of patients who were physically active at a moderate intensity level for 30 minutes in succession on at least 5 days a week was significantly greater in the IT group than in the GT group at 6 months (38% versus 22%; $P = 0.041$) and 9 months (35% versus 11%; $P = 0.001$) (Table 2). Due to a logistic failure during the study, no data at 3 months were available. In addition, the proportion of patients meeting this activity level at any followup time point was significantly greater in the IT group.

The proportion of patients who were physically active at a vigorous intensity level for 20 minutes in succession on at least 3 days a week was significantly greater in the IT group than in the GT group at 6 (35% versus 13%), 9 (40% versus 14%), and 12 months (34% versus 10%; all $P < 0.005$). Moreover, the proportion of patients who met this recommendation at any followup time point was significantly greater in the IT group.

Secondary outcome measures. The changes in the average number of days per week on which patients were physically active at a moderate intensity level for 30 minutes accumulated are shown in Table 3. The increase was significantly greater in the IT group than in the GT group at 6 months (mean difference between groups 1.1 days a week). The changes in the average number of days on which patients were physically active at a vigorous intensity level for 20 minutes in succession were significantly greater in the IT group than in the GT group at all followup time points (mean difference between groups 1.0, 1.1, 1.1, and 0.9 days a week at 3, 6, 9, and 12 months, respectively) and over the total followup period ($P = 0.001$). The change in the number of days on which patients were physically active at a moderate intensity level declined in both groups after 3 months, with the overall decline between 3 and 12 months reaching statistical significance in the IT group ($P = 0.02$).

A per-protocol analysis, comparing the 35 patients in the IT group who had a high schedule usage rate with all the patients in the GT group, demonstrated that the differences between the 2 groups in favor of the IT intervention increased (Tables 2 and 3). Excluding the patients in both groups who underwent surgery during the study did not

Table 1. Baseline demographic and clinical characteristics of 160 patients with RA participating in a randomized controlled trial comparing the effectiveness of 2 Internet-based physical activity programs*

Characteristic	IT group (n = 82)	GT group (n = 78)	P†
Age, median (IQR) years	49.5 (12.9)	49.8 (13.9)	0.66
Duration of RA, median (IQR) years	7.6 (8.8)	5.5 (11.3)	0.09
Past number of DMARDs, median (IQR)	1.0 (1.3)	1.0 (2.0)	0.098
Body mass index, median (IQR) kg/m ²	25.7 (5.5)	25.1 (7.3)	0.47
Female sex	62 (76)	60 (77)	0.85
Rheumatoid factor positive	53 (65)	46 (60)	0.46
Current treatment			
NSAIDs	58 (71)	50 (64)	0.37
DMARDs	74 (90)	70 (90)	0.92
Presence of comorbidity	38 (46)	29 (37)	0.24
Current smoker	17 (21)	20 (26)	0.46
Living alone	15 (18)	12 (15)	0.62
Education level‡			
Low	15 (18)	15 (19)	
Medium	50 (61)	42 (54)	0.60
High	17 (21)	21 (27)	
Gainfully employed	47 (57)	46 (59)	0.83

* Values are the number (percentage) of patients unless otherwise indicated. IQRs are expressed as the net result of 75th percentile minus 25th percentile. RA = rheumatoid arthritis; IT group = individualized training group; GT group = general training group; IQR = interquartile range; DMARDs = disease-modifying antirheumatic drugs; NSAIDs = nonsteroidal antiinflammatory drugs.

† Differences were analyzed using Mann-Whitney U test or chi-square test where appropriate.

‡ Low = up to and including lower technical and vocational training; medium = up to and including secondary technical and vocational training; high = up to and including higher technical and vocational training and university.

Table 2. Patients with RA who were moderately active for 30 minutes in succession on at least 5 days a week and who were vigorously active for 20 minutes in succession on at least 3 days a week*

	IT group		GT group	P value, IT group all vs. GT group†	P value, IT group schedule users vs. GT group‡
	All patients	Schedule users			
Moderate activity for 30 minutes in succession at least 5 days a week					
Baseline	0 (0)	0 (0)	0 (0)		
3 months	No data	No data	No data		
6 months	29 (38)	17 (52)	15 (22)	0.041‡	0.003‡
9 months	26 (35)	18 (51)	7 (11)	0.001‡	< 0.001‡
12 months	19 (26)	14 (42)	11 (15)	0.120	0.002‡
At least on one time point§	42 (54)	25 (71)	21 (30)	0.003‡	< 0.001‡
Vigorous activity for 20 minutes in succession on at least 3 days a week					
Baseline	5 (6)	1 (3)	1 (1)	0.109	0.557
3 months	27 (39)	16 (46)	14 (25)	0.093	0.036‡
6 months	27 (35)	17 (49)	9 (13)	0.002‡	< 0.001‡
9 months	29 (40)	22 (65)	9 (14)	0.001‡	< 0.001‡
12 months	26 (34)	22 (65)	7 (10)	< 0.001‡	< 0.001‡
At least on one time point§	45 (64)	29 (85)	25 (38)	0.002‡	< 0.001‡

* Values are the number (percentage) unless otherwise indicated. Vs. = versus; see Table 1 for additional definitions.
† Chi-square test performed for intent-to-treat analysis (IT group all versus GT group) and per-protocol analysis (IT group schedule users versus GT group). Schedule users = the 35 patients in the IT group who had a high (75–100%) schedule usage rate.
‡ $P < 0.05$ for IT group versus GT group.
§ At least on one time point = number of patients meeting the physical activity recommendation on at least one of the followup time points.

cause any major changes in the reported outcome measures (data not shown).

The results regarding changes in physical activity according to the activity monitor are shown in Table 4. No statistical differences between the IT and the GT groups were found with respect to the changes in the general activity score, the peak amplitude, or the number of peaks found during the 3 days of analysis.

In general, the improvement of functional ability and quality of life was greater in the IT group than in the GT group (Table 5), with none of the differences reaching statistical significance, except for a greater improvement of the RAQoL in favor of the IT group at 9 months. There were no statistical differences in changes of the RAND 36-item physical and mental summary scales, or in the DAS28 score between the groups.

DISCUSSION

This study demonstrates that in patients with RA, an Internet-based physical activity intervention with the provision of individually tailored supervision, exercise equipment, and group contacts is more effective with respect to the proportion of patients who report meeting physical activity recommendations than an Internet-based program without these additional elements. No differences were found with respect to the total amount of physical activity as measured with an activity monitor. There were no sustained differences between the 2 programs regarding functional ability and quality of life.

Our findings confirm the results of earlier studies on the effectiveness of programs in which the promotion of daily

physical activity for patients with arthritis played a major role. The PACE program (14), developed by the Arthritis Foundation in the US, appeared to have positive effects on psychosocial status and physical functioning in patients with arthritis. In patients with osteoarthritis, physical activity programs including the use of a pedometer (15) or individual physical activity counseling (16) were also shown to be effective. Due to the absence or the use of different measures of physical activity in the abovementioned studies, a direct comparison with the outcomes of the present study is not possible.

So far, no studies regarding the use of the Internet to promote physical activity in patients with arthritis are available. Studies of healthy adults demonstrated the effectiveness of Internet-based physical activity interventions consisting of an interactive Web site plus weekly e-mail messages (17), 3 tailored electronic newsletters (35), or weekly e-mail messages (36). Another study found no differences with respect to reported physical activity between a printed versus a Web site version of a physical activity intervention in healthy individuals (37). In patients with type 2 diabetes, McKay et al (19) demonstrated the potential of an 8-week Internet-based personalized physical activity program including online personal counseling and support. Two other studies of healthy adults that used more conventional methods to enhance physical activity reported their physical activity outcomes in similar terms as our study (38,39). In comparison with these studies, in which the increase of the proportion of patients meeting the physical activity recommendations ranged between 19% and 23%, our results seem to be fairly favorable.

Table 3. Baseline and change scores regarding the number of days per week on which patients were physically active at a moderate intensity level for 30 minutes accumulated or at a vigorous intensity level for 20 minutes in succession*

	IT group		GT group	Difference in IT group change in all and change in GT group, mean; effect size (95% CI)†	Difference between change in IT group schedule users and change in GT group, mean; effect size (95% CI)†
	All patients	Schedule users			
No. of days/week of moderate activity for 30 minutes accumulated					
Baseline, median (IQR)					
3 months	2.0 (3.0)	2.0 (3.0)	3.0 (4.0)	0.7; 0.3 (-0.1, 0.7)	0.5; 0.2 (-0.2, 0.6)
6 months	1.7 (1.12, 2.23)‡	1.5 (0.70, 2.27)‡	1.0 (0.35, 1.58)‡	1.1; 0.5 (0.1, 0.8)‡	1.4; 0.6 (0.2, 1.0)‡
9 months	1.6 (1.03, 2.22)‡	1.9 (1.01, 2.70)‡	0.5 (-0.07, 1.04)	0.7; 0.3 (-0.1, 0.6)	1.3; 0.6 (0.1, 1.0)‡
12 months	1.2 (0.64, 1.69)‡	1.8 (1.04, 2.49)‡	0.5 (-0.10, 1.08)	0.4; 0.2 (-0.2, 0.5)	1.2; 0.5 (0.1, 0.9)‡
<i>P</i> for all time points§	1.1 (0.58, 1.61)‡	1.9 (1.17, 2.54)‡	0.7 (0.06, 1.28)‡	0.051	0.011‡
No. of days/week of vigorous activity for 20 minutes in succession					
Baseline, median (IQR)					
3 months	0 (1.0)	1.0 (1.0)	0 (1.0)	1.0; 0.6 (0.3, 1.0)‡	1.3; 0.8 (0.4, 1.3)‡
6 months	1.8 (1.35, 2.21)‡	2.1 (1.47, 2.76)‡	0.8 (0.41, 1.14)‡	1.1; 0.7 (0.4, 1.1)‡	1.9; 1.3 (0.9, 1.8)‡
9 months	1.4 (0.98, 1.80)‡	2.2 (1.47, 2.88)‡	0.3 (0.06, 0.52)‡	1.1; 0.7 (0.3, 1.0)‡	2.3; 1.6 (1.1, 2.1)‡
12 months	1.6 (1.13, 2.10)‡	2.8 (2.16, 3.47)‡	0.5 (0.22, 0.76)‡	0.9; 0.5 (0.2, 0.9)‡	2.1; 1.3 (0.9, 1.7)‡
<i>P</i> for all time points§	1.3 (0.84, 1.74)‡	2.5 (1.86, 3.14)‡	0.4 (0, 0.72)	0.001‡	< 0.001‡

* Values are the mean (95% CI) change from baseline values unless otherwise indicated. IQRs are expressed as the net result of 75th percentile minus 25th percentile. 95% CI = 95% confidence interval; see Table 1 for additional definitions.

† Mean difference between change in the IT group and change in the GT group (intent-to-treat analysis) and between change in the IT group schedule users and in the GT group all (per-protocol analysis). Schedule users = the 35 patients in the IT group who had a high (75–100%) schedule usage rate. Effect size (95% CI) = difference in change score from baseline between IT group and GT group divided by pooled SD of change scores.

‡ *P* < 0.05 for IT group versus GT group.

§ By linear mixed-effects model (test for interaction between group and time).

Table 4. Results of 3 activity parameters as measured by the activity monitor (Actilog V3.0; UMC St. Radboud, Nijmegen, The Netherlands) in patients with RA*

	IT group	GT group	Difference between change in IT group and change in GT group, mean; effect size (95% CI)†
General physical activity score‡			
Baseline, median (IQR)	72.0 (33.5)	79.0 (25.8)	
6 months	-3.0 (-9.3, 3.4)	-7.3 (-13.3, -1.3)§	4.3; 0.2 (-0.2, 0.5)
12 months	0.3 (-7.1, 7.6)	1.7 (-5.1, 8.5)	-1.5; -0.1 (-0.4, 0.3)
<i>P</i> for all time points¶			0.46
Peak amplitude‡			
Baseline, median (IQR)	163.0 (48.0)	167.5 (25.0)	
6 months	2.2 (-6.9, 11.3)	-4.5 (-13.6, 4.6)	6.7; 0.2 (-0.2, 0.5)
12 months	-1.7 (-10.4, 7.0)	2.8 (-6.0, 11.6)	-4.5; -0.1 (-0.5, 0.2)
<i>P</i> for all time points¶			0.06
Number of peaks found			
Baseline, median (IQR)	22.0 (8.0)	24.0 (7.0)	
6 months	0.6 (-0.8, 1.9)	-1.1 (-2.9, 0.8)	1.6; 0.3 (-0.1, 0.6)
12 months	0.6 (-0.9, 2.0)	-0.9 (-2.5, 0.7)	1.5; 0.2 (-0.1, 0.6)
<i>P</i> for all time points¶			0.34
* Values are the mean (95% CI) change from baseline unless otherwise indicated. IQRs are expressed as the net result of 75th percentile minus 25th percentile. 95% CI = 95% confidence interval; see Table 1 for additional definitions.			
† Mean difference (95% CI) between change in the IT group and change in the GT group. Effect size (95% CI) = difference in change score from baseline between IT group and GT group divided by pooled SD of change scores.			
‡ Expressed as the number of accelerations per 5-minute period.			
§ <i>P</i> < 0.05 for IT group versus GT group.			
¶ By linear mixed-effects model (test for interaction between group and time).			

In our study, a decline in the proportion of patients meeting the physical activity recommendation after 3 months was found, especially in the IT group. Other studies have reported decreasing compliance with exercise or physical activity programs as well (40,41). Suggested strategies to improve and maintain compliance include developing more theory-based physical activity interventions, promoting self-regulatory skills, and utilizing phone contacts for home-based activity programs (42). In parallel with the declining compliance with physical activity recommendations, usage of the Web site decreased. Declining Web site usage over time has also been reported in other studies that were aimed at influencing health-related behavior by means of a Web site (19,43). More interactive Web site features, incentives, and newsletters are some of the suggested tools to stimulate regular use (19,43).

In our study, physical activity was measured both by a questionnaire and by an activity monitor. It is known that individuals filling in questionnaires tend to overreport physical activity and underestimate sedentary pursuits such as watching television (44). Although we used a control group for comparison, more overestimation of the amount of physical activity in the IT group than in the GT group cannot be totally ruled out, due to the high demand characteristics of the IT intervention. In our study, the results regarding self-reported physical activity did not run parallel with those of the activity monitor in either of the groups. One source of discrepancy may be related to the fact that the activity monitor cannot record activities involving water, such as swimming. Because swimming is a rather popular activity among patients with arthritis, an underestimation of the total amount of physical activity as

measured with the activity monitor could have occurred. Moreover, a period of 5 days (yielding only 3 full registration days) may have been too short. However, in other studies in which activity monitors were used, similar discrepancies with questionnaires were found (45,46), even if activity monitors were worn for as long as 12 days (24). The discrepancy between the total amount of physical activity as reported by patients and that recorded with a physical activity monitor points at the need for more research into outcome measurement of physical activity.

In this study, improvements in functional ability and quality of life were greater in the IT group than in the GT group; however, the differences did not reach statistical significance. It could be hypothesized that the sample size was too small to detect any treatment effect; however, because the absolute differences were small, their clinical relevance could still be doubtful. Overall, improvements in functional ability and quality of life were small in both groups, a finding that could be related to the fact that there were relatively high baseline values in both groups, leaving little room for improvements. Because the promotion of physical activity is in part targeted at influencing long-term health benefits, such as the prevention of cardiovascular diseases, diabetes mellitus, and osteoporosis, it is questionable whether clinical effectiveness regarding functional ability and quality of life was to be expected. In fact, to demonstrate the long-term health benefits of physical activity interventions, studies should encompass a long followup period and probably use other outcome measures.

The results of our study show that delivering a home-based physical activity program by means of the Internet

Table 5. Functional ability, quality of life, and disease activity in patients with RA*

	IT group	GT group	Difference between change in IT group and change in GT group, mean; effect size (95% CI)†
Functional ability by MACTAR score			
Baseline, median (IQR)	51.0 (4.0)	50.0 (4.0)	
6 months	2.4 (0.5, 4.4)‡	3.4 (1.5, 5.3)‡	-1.0; -0.1 (-0.4, 0.2)
12 months	4.2 (2.5, 6.0)‡	2.5 (0.2, 4.7)‡	1.8; 0.2 (-0.1, 0.5)
<i>P</i> for all time points§			0.32
Functional ability by HAQ score			
Baseline, median (IQR)	0.75 (1.13)	0.75 (0.75)	
3 months	0.02 (-0.06, 0.10)	-0.01 (-0.07, 0.06)	0.02; 0.08 (-0.26, 0.42)
6 months	-0.04 (-0.12, 0.04)	-0.03 (-0.10, 0.03)	-0.01; -0.02 (-0.35, 0.30)
9 months	-0.05 (-0.12, 0.02)	-0.03 (-0.11, 0.05)	-0.02; -0.06 (-0.40, 0.27)
12 months	-0.09 (-0.16, -0.01)‡	-0.04 (-0.11, 0.04)	-0.05; -0.15 (-0.47, 0.18)
<i>P</i> for all time points§			0.41
Quality of life by RAQoL score			
Baseline, median (IQR)	10.0 (10.2)	10.0 (9.5)	
3 months	-1.1 (-2.15, 0)	-0.4 (-1.10, 0.28)	-0.7; -0.2 (-0.5, 0.2)
6 months	-1.0 (-2.06, 0.04)	-0.5 (-1.33, 0.28)	-0.5; -0.1 (-0.4, 0.2)
9 month	-2.0 (-2.92, -0.98)‡	-0.3 (-1.18, 0.58)	-1.7; -0.4 (-0.8, -0.1)‡
12 months	-1.3 (-2.35, -0.34)‡	-0.6 (-1.37, 0.24)	-0.8; -0.2 (-0.5, 0.1)
<i>P</i> for all time points§			0.12
Quality of life by RAND-36 score:			
physical summary scale			
Baseline, median (IQR)	52.8 (40.1)	54.4 (42.8)	
3 months	1.6 (-2.0, 5.2)	4.6 (1.1, 8.1)‡	-3.0; -0.2 (-0.6, 0.1)
6 months	3.2 (-0.1, 6.5)	4.1 (0.3, 7.9)‡	-0.8; -0.1 (-0.4, 0.3)
9 months	6.4 (2.6, 10.1)‡	2.4 (-1.7, 6.6)	3.8; 0.2 (-0.1, 0.6)
12 months	4.9 (1.1, 8.7)‡	4.0 (0, 8.1)‡	1.2; 0.1 (-0.3, 0.4)
<i>P</i> for all time points§			0.08
Quality of life by RAND-36 score:			
mental summary scale			
Baseline, median (IQR)	75.1 (26.2)	73.0 (30.5)	
3 months	1.1 (-2.8, 5.0)	3.9 (0.4, 7.5)‡	-2.8; -0.2 (-0.5, 0.2)
6 months	1.9 (-2.0, 5.8)	3.3 (-1.1, 7.7)	-1.5; -0.1 (-0.4, 0.2)
9 months	1.3 (-2.7, 5.2)	-2.0 (-6.9, 2.9)	3.3; 0.2 (-0.2, 0.5)
12 months	-0.2 (-4.8, 4.3)	0.8 (-2.9, 4.5)	-0.9; -0.1 (-0.4, 0.3)
<i>P</i> for all time points§			0.38
Disease activity by DAS28 score			
Baseline, median (IQR)	3.5 (2.3)	3.3 (2.1)	
6 months	-0.3 (-0.5, -0.1)‡	-0.4 (-0.6, -0.1)‡	0.1; 0.1 (-0.2, 0.4)
12 months	-0.4 (-0.6, -0.1)‡	-0.5 (-0.7, -0.2)‡	0.1; 0.1 (-0.3, 0.4)
<i>P</i> for all time points§			0.63

* Values are the mean (95% CI) change from baseline values unless otherwise indicated. IQRs are expressed as the net result of 75th percentile minus 25th percentile. 95% CI = 95% confidence interval; MACTAR = McMaster Toronto Arthritis Patient Preference Disability Questionnaire; HAQ = Health Assessment Questionnaire; RAQoL = Rheumatoid Arthritis Quality of Life Questionnaire; RAND-36 = RAND 36-Item Health Survey; DAS28 = Disease Activity Score in 28 joints; see Table 1 for additional definitions.

† Mean difference (95% CI) between change in the IT group and change in the GT group. Effect size (95% CI) = difference in change score from baseline between IT group and GT group divided by pooled SD of change scores.

‡ *P* < 0.05 for IT group versus GT group.

§ By linear mixed-effects model (test for interaction between group and time).

with the provision of individualized supervision is a promising intervention strategy to promote physical activity in patients with RA. Although it is generally acknowledged that advising adults with arthritis to become more physically active should be a fixed element in the management of this condition (12), other studies have demonstrated that a considerable number of patients do not receive such advice (47). It appears that the rheumatologist might play an important part in the education on physical activity (48). However, it has been found that advice alone

is not enough to increase physical activity levels in patients with arthritis (47), and in that respect the Internet and e-mail could be used for sustained individual guidance and reinforcement. Although the present study only included patients who had a computer with Internet access so that the results could not be generalized to all patients with arthritis, currently almost half of the arthritis population has access to the Internet, and this proportion seems to be growing (49,50). Our results suggest that future research should further explore the optimal strategy for the

use of Internet and e-mail communication for promoting physical activity and maintaining or improving participants' compliance with these programs over time. Moreover, cost-effectiveness analyses of Internet-based physical activity interventions are urgently needed to determine the surplus value for daily practice.

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