Exercise adherence improves long-term patient outcome in patients with osteoarthritis of the hip and/or knee

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ABSTRACT

Objective: To determine the effect of patient exercise adherence within the prescribed physical therapy treatment period and after physical therapy discharge on patients' outcome on pain, physical function and patient self-perceived effect in individuals with osteoarthritis (OA) of the hip and/or knee. Methods: Prospective observational follow-up study, in which 150 patients with OA of the hip and/or knee receiving exercise therapy were followed 60 months. Data were obtained from a randomized controlled trial, with assessments at baseline, 3, 15, and 60 months follow-up. The association between exercise adherence and patients' outcome on pain, physical function and self-perceived effect was examined using generalized estimating equations (GEE) analyses. Results: Adherence to recommended home exercises and being more physically active was significantly associated with better treatment outcome on pain, self-reported physical function, physical performance and self-perceived effect. The association between adherence and outcome was consistent over time. Adherence to home activities was only associated with better self-perceived effect. Conclusion: Better adherence to recommended home exercises as well as being more physically active improves the long-term effectiveness of exercise therapy in patients with osteoarthritis of the hip and/or knee. Both within and after the treatment period better adherence is associated with better patients' outcome on pain, physical function, and self-perceived effect. Since exercise adherence declines over time, future research should focus on how exercise behavior can be stimulated and maintained in the long-term.

INTRODUCTION

  Osteoarthritis (OA) of the hip or knee is a common chronic and degenerative disease (1). OA causes impairments in body functions and/or structures (such as pain, reduced muscle strength, range of joint motion, and joint instability) and has a major impact on physical functioning in daily life (2-4). Patients with OA of the hip or knee are often referred to physical therapy to reduce impairments and improve overall physical function, so that individuals can better meet the demands of daily living. To reduce impairments which limit patients' physical functioning, physical therapy treatment can consist of exercise therapy and patient education on the importance of being physically active. Several studies have demonstrated beneficial short-term effects of exercise therapy on pain, physical function and patients self-perceived effect (5-7). However, the positive post-treatment effects of exercise therapy seem to decline over time and gradually disappear in the long term (8).

  Several authors have hypothesized that non-adherence to self-directed exercise is one of the main reasons for poor long-term effectiveness of exercise therapy in patients with OA (8-11). Although it is well documented in the context of other chronic conditions, research to identify the extent to which adherence to self-directed exercise is a predictor of outcome in the management of OA remains limited (9;10). In most existing studies in patients with OA, adherence was defined as attendance to treatment sessions (12-17). These studies demonstrated that consistent participation in exercise programs results in better outcomes (18-23). It can, however, be expected that the success of exercise therapy also depends on the extent to which a person's behavior corresponds with the recommendations made by the patient's physical therapist, such as: completing therapeutic home exercises (e.g. muscle strengthening exercises), and being more physical active (e.g. walking, or cycling, etc). At present, only two well designed studies in patients with OA investigated the relationship between the extent to which a person's behavior corresponds with agreed recommendations by the patient's physical therapist and the effectiveness of exercise therapy (24;25). These studies demonstrated that patients who adhered within the treatment period to the recommended home exercises reported more improvement in pain and muscle strength than non-adherent patients. However, a limitation of the existing studies is that they focused on the relationship between exercise adherence and patients' outcome within the treatment period. To our knowledge, no studies are available on adherence to self-directed exercise after discharge and the impact on pain and physical functioning. Therefore, the objective of the current study was to determine the effect of patient adherence within the prescribed physical therapy treatment period and after physical therapy discharge on patients' outcome on pain, physical function and patient self-perceived effect in individuals with osteoarthritis (OA) of the hip and/or knee.

METHODS

Design

  Prospective observational follow-up study investigating the association between adherence to self-directed exercise (within the prescribed physical therapy treatment period and after physical therapy discharge) on patients outcome in individuals with osteoarthritis of the hip or knee. Data were obtained from a single blinded randomized clinical trial comparing two different exercise therapy interventions in patients with OA of the hip or knee, namely an operant behavioral graded activity program and usual exercise therapy according to the Dutch physical therapy guideline (26). The study was approved by the medical ethics committee of the VU University Medical Center, Amsterdam.

Study sample

  A random sample of six hundred physical therapists from the region of Utrecht was drawn from our Institute's National Database of Primary Care Physical Therapists and was invited to participate in the study. This sample was representative for all primary care physical therapists in the Netherlands. Eighty-seven primary care physical therapists (working in 72 practices) were willing and able to participate in the study. Patients with OA of the hip or knee were recruited in two ways. First, patients referred to physical therapy were recruited by the participating physical therapist at their first visit to a physical therapist. Because the recruitment rate was rather slow, a second recruitment strategy was used, i.e. patients responded to articles about exercise therapy and the performed study, published in local newspapers. The main inclusion criterion was that patients had OA of hip or knee in accordance with the clinical criteria of

the American College of Rheumatology (27;28). Two hundred patients with OA of the hip or knee were included in the study. Assessments took place at baseline, 3, 15 and 60 months follow-up, by research assistants blinded for the kind of exercise treatment patients' received. Patients were instructed not to give information about the content of the treatment to the research assistants. More information about the sampling and recruitment, data-collection, and the study findings of the original randomized controlled trial have been reported in detail elsewhere (26;29).

Exercise therapy

Because the data were obtained from a randomized controlled trial comparing two different exercise treatments, the type of exercise therapy patients' received (allocated treatment: behavioral graded activity or usual exercise therapy according to the Dutch physical therapy guideline) was included as independent variable in all analyses to control for the influence of the differences in the content of exercise therapy. Both exercise treatments consisted of an individually tailored exercise treatment given by primary care physical therapists. Both treatments consisted of a 3 months period with a maximum of 18 sessions. Patients were advised to perform home exercises, home activities and a more physically active lifestyle was stimulated. After the 3 months treatment period physiotherapists advised patients to maintain the recommended exercise behavior. Patients treated with behavioral graded activity received after the 3 months treatment period 5-7 booster sessions (respectively given in week 18, 25, 34, 42, and 55). More specific information on the interventions has been published elsewhere (26;30).

Adherence

Adherence was defined as the extent to which a person's behavior corresponds with agreed recommendations by the patient's physical therapist (31). Three different forms of adherence were measured: 1. adherence to home exercises (exercise adherence), 2.adherence to home activities (activity adherence), and 3. adherence to the recommendation of being more physically active (physical activity).

Adherence to home exercises and home activities was measured with a self-report questionnaire, asking patients whether they performed the instructed home exercises or activities as recommended by their physical therapist, assessed on a 5-point scale (1 = almost never; 2 = occasionally adherent; 3 = regularly adherent; 4 = often adherent; 5 = very often) (32). Patients were asked separately about their adherence to the instructed home exercises(e.g. muscle strengthening exercises) and home activities (e.g. walking, or cycling). The ratings on exercise adherence and activity adherence were dichotomized as 'adherence' (often adherent and very often adherent) versus non-adherence (regularly adherent, occasionally adherent, almost never adherent).

Patients' level of physical activity was assessed by the SQUASH (Short Questionnaire to Assess Health Enhancing Physical Activity) (33). The SQUASH consists of three main queries, namely days per week, average time per day, and self reported intensity. The SQUASH measures the amount of physical activity for commuting activities, leisure time and sport activities, household activities, and activities at work or school. The amount of physical activity was estimated by calculating the hours per week of moderate- or vigorous-intensity physical activity. For older adults moderate-intensity is defined as activities with a intensity of 3 – 5 metabolic equivalents (MET's) and vigorous-intensity is defined as activities with a intensity of ≥ 5 MET (34). A metabolic equivalents (MET's) can be defined as the ratio of work metabolic rate to a standard resting metabolic rate of 1.0 $(4.184 kJ) \cdot kg^{-1} \cdot h^{-1} \cdot 1$. One MET is considered as resting metabolic rate obtained during quiet sitting. Using the Ainsworth Compendium of Physical Activities (35), an intensity score was assigned to all physical activities. Hours per week of moderate or vigorous intensity physical activity was calculated by the sum of hours per week patients performed physical activities with an intensity score of at least 3 MET.

Pain, physical functioning and patients self-perceived effect

Pain within 48 hours before assessment was measured with the pain subscale of the Western Ontario and McMaster universities osteoarthritis index (WOMAC; scoring range 0-20). Self-reported physical function was assessed with the subscale physical function of the WOMAC (scoring range 0-68) (36;37). Physical performance was measured with the 5-meter walking test (38). Each patient was asked to walk to the end of the pre-set distance of 8 meter (consisting of 1.5 meter acceleration distance, 5 meter measurement distance, and 1.5 meter deceleration distance), at his or her ''natural walking speed''. A stopwatch was used

to measure in seconds the time patients walked the 5 meter measurement distance. Patient self-perceived effect was assessed by patients on a 8-point scale (1=vastly worsened; 8=completely recovered)(39). The ratings of patient self-perceived effect were dichotomized as improved ("completely recovered", "very much improved" and "much improved") versus not improved ("slightly improved", "not changed", slightly worsened", "much worsened" and "vastly worsened").

Demographic and clinical data
Demographic and clinical data were collected for each patient including age, gender, location of OA (hip, knee, or both), recruitment method (physical therapist or newspaper) and duration of complaints (number of years that patients experience complaints due to OA).

Statistical analyses
Descriptive analyses were used to describe the main characteristics of the study population. All patients were included in the analysis; irrespective of deviations of the treatment protocol. The only exception is that patients who underwent a joint replacement surgery during the study period were considered as lost to follow-up from their operation date, because adherence to self-directed exercise as recommended within the physical therapy treatment no longer applies in this phase and a joint replacement surgery positively influences patients outcome as demonstrated in earlier research (40). To study the relationship between adherence and patients outcome on pain, physical function and patient self-perceived effect generalized estimating equations (GEE) were used (41-43). GEE corrects for the dependency of individual observations; the relationships are investigated for each individual separately, and the final result is obtained by getting the population average of all individual relationships. For the longitudinal GEE analyses, an autoregressive model was used. This indicates that the outcome variables (pain, self-report physical function, and physical performance) were corrected in the analysis for the scores on the same outcome variable one time point earlier, so the outcome variable in the analysis can be considered as the change in outcome between two time points. The relation between adherence and patient self-perceived effect was explored using logistic GEE analysis, because patients self-perceived effect was dichotomized as improved versus not improved.

Three separate models were performed to explore the relationship between exercise adherence, activity adherence, physical activity and the outcome measures (pain, self-report physical function, physical performance, and patients self-perceived effect). In model 1, only the allocated treatment was included as a possible confounding variable. In model 2, the allocated treatment, age, and gender were included. In model 3, location of OA, recruitment method, and duration of complaints were entered in the analyses as well. Recruitment method was included because earlier research has shown that different recruitment methods attract different subjects (44). To investigate if the relationship between adherence and patients outcome was consistent over time, similar for patients treated with treated with behavioral graded activity or usual exercise therapy and similar for patients with hip OA and patients with knee OA; possible interaction terms were explored (e.g. time, allocated treatment, location of OA). Because an autoregressive model was used, an independent correlation structure was assumed in all GEE analysis (43).

Exercise and activity adherence was measured on a 5-point scale, which was arbitrarily dichotomized as 'adherence' (often adherent and very often adherent) versus non-adherence (regularly adherent, occasionally adherent, almost never adherent). To determine the robustness of the results two sensitivity analyses were performed. Namely, the analyses were repeated (1) with exercise adherence dichotomized as 'adherence' (regularly adherent, often adherent and very often adherent) versus non-adherence (occasionally adherent and almost never adherent); and (2) with exercise adherence dichotomized as 'adherence' (very often adherent) versus non-adherence (often adherent, regularly adherent, occasionally adherent and almost never adherent). All analyses were performed using Stata 10.0, College Station, Texas, USA.

RESULTS
Baseline characteristics of the study population are shown in table 1. From the 200 patients included in the study 4.0%, 10.5% and 25.5% of the participants were lost to follow-up at 3, 15 and 60 months follow-up, respectively. For the present study, patients who underwent a joint replacement surgery during the study

period were excluded from the analyses from the operation date. Therefore, the total number of patients who were considered as lost to follow-up was 5% (n = 10), 17.5% (n = 35) and 43% (n = 86) at 3, 15 and 60 months follow-up, respectively. Patients who were considered as lost to follow-up did not differ significantly from those who remained in the study on most of the baseline characteristics: gender, age, duration of OA, radiological evidence, baseline pain and baseline physical function. However, patients who were lost to follow-up tended to have more often hip OA or both hip and knee OA.

[TABLE 1]

   The majority of patients were adherent to recommended exercises within the period of treatment (57.8 % at 3 months follow-up). After the treatment period at 15 and 60 months follow-up a minority of the patients still performed the recommended exercises, 44.1 and 30.1 percent of the patients respectively. Adherence to the recommended activities showed a similar pattern: within the period of treatment (3 months follow-up) 53.8% of the patients was adherent to the recommended activities and after the treatment period at15 and 60 months follow-up activity adherence was 29.5 and 36.0 % respectively. At baseline patients were on average 5.8 (sd;5.9) hours per week physically active (moderate or vigorous intensity; $\geq$ 3 MET). Within the period of treatment the average hours per week of moderate or vigorous intensity physical activity increased to 7.3 (6.3) hours per week. After the treatment period at 15 and 60 months follow-up the average hours per week of moderate or vigorous intensity physical activity was respectively 6.8 (7.0) and 5.5 (5.0). The course of patients' outcome on pain, self-reported physical function, and physical performance within and after the treatment period is shown in table 2. The percentage of patients who rated their self-perceived effect as 'improved' at 3, 15 and 60 months follow-up, was 38.9%, 51.2%, and 38.7% respectively.

[TABLE 2]

Model I: Analyses adjusted for differences in the content of exercise therapy
   Adherence to recommended exercises was significantly associated with a decrease in pain (-0.9 points), self-reported physical function (-2.3 points) and physical performance (-0.24 seconds), as presented in table 3 and 4. The relation between exercise adherence and self-perceived effect was not statistically significant. The association between activity adherence and pain, self-reported physical function and physical performance was not statistically significant. Activity adherence was only associated with a better self-perceived effect. A higher level of moderate or vigorous intensity physical activity was significantly associated with a decrease in pain, self-reported physical function and physical performance (see table 3 and 4). For example, one hour per week more physically activity with an intensity of at least 3 MET results in a decrease in self-reported physical function of -0.256 (95 CI; -0.366 to -0.146). A higher level of moderate or vigorous intensity physical activity was also significantly associated with a positive self-perceived effect.

[TABLE 3]

Model II and Model III
   The analyses in model II (adjustment for differences in the content of exercise therapy, gender and age) and model III (adjustment for differences in the content of exercise therapy, gender, age, duration of complaints, location of OA and recruitment method) did not change most of the results (see table 3 and 4). Only the relationship between exercise adherence and self-perceived effect became statistically significant (OR=1.725 [1.067; 2.788]) after adjusting for possible confounding variables (model III).

[TABLE 4]

   A possible interaction with time was investigated in all analyses. No significant interactions with time were found, meaning that the association between adherence and outcome is consistent over time (both within and after the treatment period). Figure 1 demonstrates that patients who adhere to recommended exercises show consistently more improvement in physical function over time. Finally, possible interaction terms with the allocated treatment and location of OA were explored in all analyses. No significant

interaction terms were found, which means that the relationship between adherence and patients outcome was similar for patients treated with behavioral graded activity and patients treated with usual exercise therapy and was similar for patients with knee OA and patients with hip OA.

[FIGURE 1]

Sensitivity analyses.

Both sensitivity analyses resulted in mostly similar results. However, when adherence was dichotomized as 'adherence' (regularly adherent, often adherent and very often adherent) versus non-adherence (occasionally adherent and almost never adherent), the association between activity adherence and pain and physical performance became statistically significant and the association between activity adherence and self-perceived effect became not statistically significant.

DISCUSSION

Earlier research has shown that the positive post-treatment effects of exercise therapy seem to decline after discharge and finally disappear in the long-term (8). In literature, it is often hypothesized that a lack of adherence to recommended exercises and a more physically active lifestyle could be one of the main reasons for poor long-term effectiveness of exercise therapy (8-10;45). The current study shows that exercise adherence is an important predictor for the long-term effectiveness of exercise therapy: not only within the period of treatment, but also after the treatment period adherence was significantly associated with better outcome on pain, physical function and self-perceived effect. The results of the current study also show that adherence declines over time. To improve the long-term effectiveness of exercise therapy, future research should focus on how exercise behavior can be stimulated and maintained in the long-term. Recently, it was demonstrated that the integration of operant behavioral graded activity principles and booster sessions in exercise therapy results in better exercise adherence and a more physically active lifestyle, both within and after the treatment period (30). However, more research is needed.

Adherence to recommended activities was not significantly associated with better outcome on pain, self-reported physical function and physical performance. Activity adherence measures whether patients adhere to recommended activities: this could be a general advise to be more physically active (e.g. walk more often) or a more specific advise such as gradually increasing patients' most problematic activities. A possible explanation why we could not demonstrate the relation between activity adherence and outcome in the current study could be the transition from doing the recommended activities to a more physically active lifestyle. After all, it seems logical that adherent patients who experience less pain and impairments in physical function in the course of time will better be able to meet the demands of daily living better. Consequently, they will adapt a more physically active lifestyle, but will probably not experience this as being adherent to the recommendation of their physical therapist. This explanation seems reasonable, because a significant association was found between the amount of moderate or vigorous intensity physical activity and better outcome on pain, self-reported physical function and physical performance. However, the results also demonstrate that the effect of being one hour per week more physically active is small, which suggests that for a clinically relevant effect patients need to increase their physical activity level with at least a few hours per week.

The results demonstrate that, in addition to adherence to exercises, activities and a more physically active lifestyle were associated with patients' self-perceived effect, although the relationship with adherence to exercise was only significant after controlling for potentially confounding characteristics. Self-perceived effect is one of the recommended outcome dimensions for clinical studies by the Outcome Measures in Rheumatology Clinical Trials (OMERACT) group in patients with hip or knee OA. However, we believe that asking patients about their self-perceived effect is vulnerable for recall bias and bias due to a changing perspective of patients about their complaints, especially with a long-term follow-up assessment as used in our study. Therefore, we believe that the results on self-perceived effect should be interpreted with caution, because the presented association could be a under- or overestimation of the actual relationship between adherence and patients self-perceived effect.

There are a few limitations to this study that need to be mentioned. First of all, a golden standard in measuring exercise adherence does not exist (46). In this study, exercise adherence was measured with a

self-report questionnaire. Although widely used, the quality of self-report questionnaires to measure exercise adherence is debatable. They are known to overestimate adherence and to be susceptible to bias caused by patients' memory, social desirability and social approval (46). On the other hand, a self-report questionnaire has the advantage that it is a simple method to evaluate exercise adherence. Other possible measures include diaries, interviewing, or more objectively monitoring with a accelerometer. Compliance to diaries over time is poor and diary data have shown to be vulnerable to patient deceit and inaccuracies. Interviews increase the risk for socially desirable answers, while accelerometers or pedometers are reasonably accurate for measuring walking activities, but can not evaluate other types of movement. For these reasons we decided to use a self-report questionnaire. Secondly, only the analyses of the relationship between physical activity and patients outcome the dosage and intensity was taken into account. It is expected, however, that the relationship between adherence to recommended exercises or activities and patients' outcome also depends on the quality, dosage and intensity of recommended exercises. Because these aspects were not measured in the questionnaire used, it was not possible to adjust the analyses for these characteristics. This may have led to an underestimation of the association between adherence and patients' outcome on pain, physical function and patients self-perceived effect. For future research, it is therefore recommended to develop a self-report questionnaire to measure adherence to recommended exercise and activities which takes the quality, dosage and intensity of recommended exercise behavior into account.

In conclusion, better adherence to recommended home exercises as well as being more physically active improves the long-term effectiveness of exercise therapy in patients with osteoarthritis of the hip and/or knee. Both within and after the treatment period better adherence is associated with better patients' outcome on pain, physical function, and self-perceived effect. Since exercise adherence declines over time, future research should focus on how exercise behavior can be stimulated and maintained in the long-term. Furthermore, potential predictors of adherence within and after the treatment period should be explored, so that physical therapists knows which type of patients are at risk for non-adherence.

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TABLES AND FIGURE

Table 1 Baseline characteristics of study population (n=200)

Characteristics	
Female, n (%)	154 (77.0)
Age, mean (sd)	64.8 (7.9)
Location of osteoarthritis, n (%)	
knee	130 (65.0)
hip	50 (25.0)
both	20 (10.0)
Duration of complaints, n (%)	
< 1 year	47 (23.7)
1 – 5 years	72 (36.4)
> 5 years	79 (39.9)

Table 2 Course of pain, self-reported physical function and physical performance within and after the period of treatment

	Within the period of treatment		After the period of treatment	
	Baseline scores	Change from baseline to 3 months follow-up* (n=190)	Change from 3 to 15 months follow-up* (n=165)	Change from 15 to 60 months follow-up* (n=114)
Pain, mean (sd):range 0-20	8.9 (3.2)	-2.28 (3.16)	-0.75 (3.17)	1.66 (3.62)
Self-reported physical function, mean (sd): range 0-68	28.9 (11.2)	-5.61 (8.93)	-0.34 (9.30)	1.83 (10.33)
Physical performance (5 meter walking in seconds), mean (sd)	4.8 (1.4)	-0.29 (0.94)	0.02 (0.69)	0.45 (0.94)

* Negative signs indicate improvement

Table 3 Generalized estimating equations regression models of adherence and physical activity on pain and patient self-perceived effect

	Change in pain			Self-perceived effect		
	B	95 % CI	p	OR	95 % CI	p
Exercise adherence						
Model 1	-0.966	-1.642 to -0.290	0.005	1.327	0.852 to 2.067	0.210
Model 2	-0.932	-1.609 to -0.255	0.007	1.353	0.862 to 2.123	0.188
Model 3	-0.962	-1.644 to -0.279	0.006	1.725	1.067 to 2.788	0.026
Activity adherence						
Model 1	-0.656	-1.435 to 0.122	0.098	1.755	1.130 to 2.726	0.012
Model 2	-0.583	-1.368 to 0.202	0.145	1.797	1.157 to 2.792	0.009
Model 3	-0.653	-1.445 to 0.139	0.106	1.983	1.242 to 3.164	0.004
Hours per week of moderate or vigorous intensity physical activity						
Model 1	-0.096	-0.137 to -0.055	< 0.001	1.041	1.004 to 1.080	0.028
Model 2	-0.095	-0.137 to -0.054	< 0.001	1.050	1.012 to 1.089	0.009
Model 3	-0.092	-0.133 to -0.052	< 0.001	1.055	1.014 to 1.098	0.008

Model 1: adjusted for allocated treatment

Model 2: adjusted for allocated treatment,, gender, and age.

Model 3: adjusted for allocated treatment, gender, age, duration of complaints, the location of OA (hip, knee, or both) and recruitment method.

Negative signs or odds ratios > 1 indicates improvement

CI = Confidence interval

OR = Odds ratio

Table 4 Generalized estimating equations regression models of adherence and physical activity on self-report physical function and physical performance

	Change in self-reported physical function			Change in physical performance		
	B	95 % CI	p	B	95 % CI	p
Exercise adherence						
Model 1	-2.385	-4.388 to -0.382	0.020	-0.240	-0.419 to -0.062	0.008
Model 2	-2.308	-4.280 to -0.337	0.022	-0.237	-0.410 to -0.064	0.007
Model 3	-2.287	-4.289 to -0.285	0.025	-0.285	-0.463 to -0.107	0.002
Activity adherence						
Model 1	-2.184	-4.399 to 0.031	0.053	-0.125	-0.291 to 0.041	0.140
Model 2	-1.961	-4.196 to 0.273	0.085	-0.094	-0.256 to 0.068	0.255
Model 3	-1.941	-4.187 to 0.305	0.090	-0.132	-0.293 to 0.028	0.106
Hours per week of moderate or vigorous intensity physical activity						
Model 1	-0.256	-0.366 to -0.146	< 0.001	-0.012	-0.024 to -0.000	0.050
Model 2	-0.249	-0.359 to -0.139	< 0.001	-0.011	-0.023 to 0.000	0.051
Model 3	-0.241	-0.349 to -0.133	< 0.001	-0.011	-0.022 to 0.000	0.058

Model 1: adjusted for allocated treatment

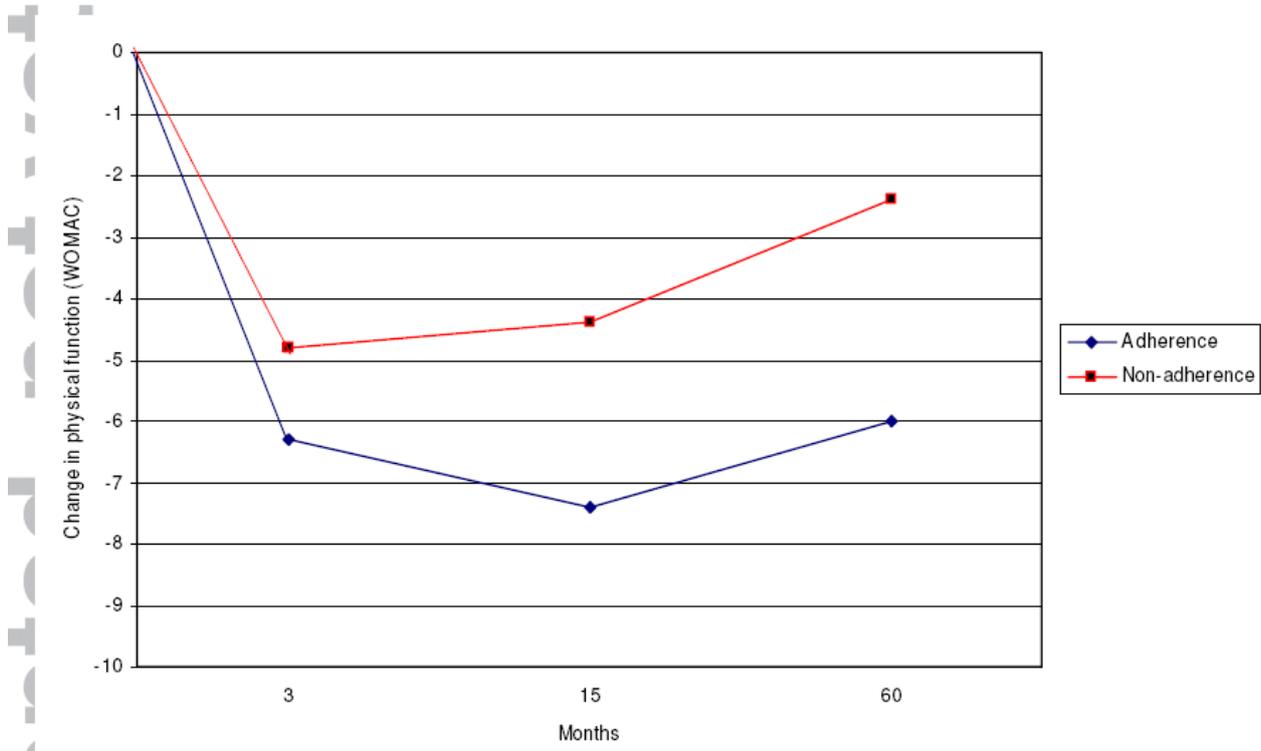*Model 2: adjusted for allocated treatment,, gender, and age.*

Model 3: adjusted for allocated treatment, gender, age, duration of complaints, the location of OA (hip, knee, or both) and recruitment method.

Negative signs indicates improvement

CI = Confidence interval

OR = Odds ratio

Figure 1 Mean change in physical function over time: differences between adherent and non-adherent patients *

* Negative signs indicates improvement