Predictive Value of the Western Ontario and McMaster Universities Osteoarthritis Index for the Amount of Physical Activity After Total Hip Arthroplasty

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**Background and Purpose**

Despite the recognized health benefits of physical activity, little is known about the amount of physical activity that patients perform after total hip arthroplasty (THA). To this end, the ability of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) to predict the amount of physical activity that patients with a THA perform, as measured by the Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH), was determined.

**Subjects and Methods**

Three hundred sixty-four patients who had a THA returned questionnaires. Pearson correlation coefficients were calculated between scores on the WOMAC and SQUASH. Binary logistic regression modeling was used to determine the extent to which the WOMAC score could predict that patients would meet national and international guidelines for health-enhancing physical activity.

**Results**

Scores on the WOMAC and SQUASH showed a significant, but low, correlation ($r=.14-.24$). Although the WOMAC score was a significant predictor for meeting national and international guidelines for physical activity, the odds ratio was low (1.022, 95% confidence interval=1.012–1.033) and only 6.9% of the variance could be explained (Nagelkerke $r^2=.069$).

**Discussion and Conclusion**

The results suggest that the WOMAC is not suitable for predicting the amount of physical activity after THA, requiring the use of an additional outcome measure.
Physical Activity After Total Hip Arthroplasty

There is a growing societal awareness of the importance of physical activity for general health. Regular physical activity has proven to be effective in the primary and secondary prevention of several chronic conditions (eg, cardiovascular disease, type-2 diabetes, colon and breast cancer, hypertension, obesity, depression, osteoporosis) and is linked to a reduction in mortality from all causes.\(^1\) \(^5\) Regular physical activity can enhance musculoskeletal fitness and is positively associated with functional autonomy, mobility, and bone health and negatively associated with the risk for falls.\(^6\) \(^7\) Because of these beneficial effects of physical activity, national and international guidelines have recommended 30 minutes or more of moderately intense physical activity on at least 5, but preferably all, days of the week.\(^8\) \(^9\)

The ability to be physically active can be severely hindered by chronic conditions such as osteoarthritis (OA) of the hip. This joint disorder is one of the most prevalent age-related musculoskeletal conditions, leading to a significant impairment in patients’ ability to perform activities of daily living and having a high impact on health-related quality of life.\(^10\) \(^11\) In the 1990s, symptomatic OA of the hip was estimated to affect 0.7% to 5.5% of men and 0.7% to 3.6% of women 55 years of age and older in the US population.\(^12\) In 2000, these prevalence rates among the Dutch population varied between 2.45% for men and 5.0% for women.\(^13\)

Total hip arthroplasty (THA) is a highly successful and widely applied treatment for advanced OA of the hip, with 202,500 primary THAs performed in the United States in 2003\(^14\) and 22,500 performed in the Netherlands in 2005\(^15\); however, little is known about the amount of physical activity performed by patients after THA. Until now, outcome studies after THA have focused on the assessment of self-reported physical functioning, using generic and diseasespecific outcome instruments. These instruments primarily give information about the patients’ limitations, but not about their amount of physical activity. A large part of the population undergoing THA are older adults, whose functional autonomy is often threatened and whose falls may result in complications with the implanted hip prosthesis. Physical activity for the prevention of disease and enhancement of musculoskeletal fitness in this population is of utmost importance to ensure independent living.

One of the most widely used diseasespecific outcome instruments in people with osteoarthritis is the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).\(^16\) Although the WOMAC does not provide direct information about amount of physical activity, it can be hypothesized that when patients experience more pain, stiffness, and limitations in physical functioning, as measured by the WOMAC, this will have an adverse effect on the amount of physical activity they can perform. In this way, the WOMAC score could predict the amount of physical activity. The aims of this study, therefore, were: (1) to determine the correlation between WOMAC scores and amount of physical activity after THA and (2) to determine the ability of the WOMAC to predict whether patients will meet national and international guidelines for health-enhancing physical activity.

Method

Subjects

The study sample comprised 506 patients who had undergone a primary or revision THA at the University Medical Center Groningen between February 1998 and October 2003. For all patients, the operation occurred at least 1 year before this study. The total group of 506 patients consisted of 372 patients with a primary THA and 134 patients with a revision THA. Patients were sent a questionnaire with an explanatory letter.

Eventually, 71.9% (n=364) of the patients returned their questionnaire, 8.5% (n=43) responded by telephone or letter but did not fill in the questionnaire for various reasons, and 19.6% (n=99) did not respond. Analysis of the nonrespondents did not show any differences in main characteristics (age, sex, Charnley class, and comorbidity) between respondents and nonrespondents.

The study was executed in accordance with the regulations of the Medical Ethical Board of University Medical Center Groningen. Patients were informed in the explanatory letter that return of the completed questionnaire would be taken as consent to participate.

Instruments

Demographic characteristics (eg, sex, age), general comorbidity, and self-reported physical functioning and amount of physical activity were assessed by means of a self-administered questionnaire. The subjects’ preoperative, joint-specific comorbidity was assessed from the medical record using the Charnley classification.\(^17\) This classification consists of 5 categories:

- Category A denotes patients with only one hip involved and no other condition interfering with physical activity;
- Category B denotes patients with both hips involved, but with rest of the body unimpaired and, therefore, not responsible for any defect in the ability to be physically active; and
• Category C denotes patients with some factor, such as rheumatoid arthritis or hemiplegia, contributing to failure to achieve normal locomotion.

General comorbidity was measured with a translated version of the 12-item list of Nilsson et al.\textsuperscript{18} Questions were asked about conditions or body areas with problems. The questions were multiple-choice (yes/no/don’t know). To measure postoperative outcome, the Dutch-language version of the WOMAC\textsuperscript{19} was used. The WOMAC is one of the most widely used disease-specific, health-related quality-of-life questionnaires for measuring outcome after THA.\textsuperscript{20} It has proven to be valid, reliable, and responsive.\textsuperscript{16,21} and the Dutch-language version has shown satisfactory cross-cultural validity.\textsuperscript{19} Using a Likert scale, subjects rate themselves on multiple items grouped into 3 domains: pain (5 items), stiffness (2 items) and physical functioning (17 items). Each subscale is scored as a summation of items. The scores of the 3 subscales make up the total score of the WOMAC. In this study, the total score was recoded into a 100-point scale, with a higher score representing better physical functioning.

The Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH)\textsuperscript{22} was used to determine amount of physical activity. The SQUASH measures habitual physical activity level and is structured in a way that allows the results to be compared with national and international physical activity guidelines. Subjects are considered to be meeting the national or international guidelines if they spent 30 minutes or more on moderately intense or vigorously intense physical activity on 5 to 7 days of the week.

The SQUASH contains questions on commuting activities, leisure-time and sports activities, household activities, and activities at work and school (Appendix). It consists of 3 main queries: days per week, average time per day, and intensity (effort). In order to keep the questionnaire short and easy to complete, intensity of household activities and activities at work and school are prestructured into 2 categories, light or intense, while time spent on activities at work and school is depicted as average time per week. Using the Ainsworth Compendium of Physical Activities,\textsuperscript{23} activities are then assigned an intensity score, based on the reported effort in the questionnaire. This intensity score is expressed in metabolic equivalents (METs). One MET is defined as the energy expenditure for sitting quietly. Metabolic equivalents higher than 1 are activities defined as multiples of the resting metabolic rate. Activities can be subdivided into 3 intensity categories:

- **Light**: 2 to \( <4 \) METs for adults and 2 to \( <3 \) METs for older adults (age 55 and older)
- **Moderate**: 4 to \( <6.5 \) METs for adults and 3 to \( <5 \) METs, and
- **Vigorous**: \( \geq6.5 \) METs for adults and \( \geq5 \) METs.

Activities with a MET value lower than 2 are not included because they are considered to contribute negligibly to habitual physical activity level. A total activity score as well as activity scores for separate questions can be calculated by multiplying total minutes of activity by the intensity score.

The total activity score on the SQUASH has shown a Spearman correlation coefficient (\( r \)) for overall reproducibility of .58 (range \( =.36-.74, P<.05 \)). Correlations (\( r \)) for the reproducibility of separate questions varied between .44 and .96, with a mean value of .75 (\( P<.05 \)). The SQUASH has been validated using an accelerometer, showing a Spearman correlation coefficient (\( r \)) between accelerometer readings and total activity score of \( .45 \) (95% confidence interval \( =-.17-.66 \)). These values are comparable to those of other physical activity questionnaires.\textsuperscript{22} Therefore, for the purpose of our study, we considered the scores on the SQUASH to be sufficiently reliable and valid to measure the level of physical activity of an adult population.

**Data Analysis**

The data were analyzed using the Statistical Package for the Social Sciences (version 12)* software. Descriptive statistics were used to describe the main characteristics of the sample. To determine the correlation between the total WOMAC score and the main outcomes of the SQUASH (total duration of physical activity a week and total time spent doing light, moderate, and vigorous physical activities a week), a Pearson correlation coefficient was used.

Binary logistic regression modeling was used to determine the extent to which the total score on the WOMAC can predict that a person will meet national and international guidelines for health-enhancing physical activity. In that respect, the dependent variable (meeting the guidelines) was coded as 0 (not meeting the guidelines) and 1 (meeting the guidelines). Subjects were considered to meet the guidelines if they spent 30 minutes or more on moderately or vigorously intense physical activity on 5 to 7 days of the week, as assessed by the SQUASH. The odds ratio was used to express the results of the binary logistic regression. An odds ratio of 1 indicates no association between the total score on the WOMAC and meeting the guidelines. An odds ratio of \( >1.0 \)

* SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.
connotes a direct association and an odds ratio of \( <1.0 \) indicates an inverse association of the total score on the WOMAC and meeting the guidelines. Confounding effects and effect modification of group (primary or revision THA), general comorbidity, Charnley classification, age, and sex were assessed. A \( P \) value of \( <.05 \) was considered to be statistically significant.

**Results**

Baseline characteristics, comorbidities, and Charnley classification of the study population are shown in Table 1. The mean age of the subjects was 64.4 years, with 62.4% female subjects. A primary THA was performed in 75% of the subjects and a revision THA was performed in 25% of the subjects. The mean total score on the WOMAC was 71.2. The total score on the WOMAC and the subscale scores and total score on the SQUASH are reported in Table 2.

Pearson correlation coefficients were calculated between the total score on the WOMAC and the total time spent doing light, moderate, and vigorous physical activities a week, as well as the total time spent on physical activity a week. Correlations between the WOMAC and the subscale scores and total score on the SQUASH were significant (2-tailed \( P<.05 \)) and were as follows: .14 for light-intensity physical activity, .19 for moderate-intensity physical activity, .15 for vigorous-intensity physical activity, and .24 for total time spent on physical activity.

Binary logistic regression modeling was used to determine the extent to which the total score on the WOMAC (independent variable) predicted whether subjects met the guidelines (dependent variable). The results showed that the WOMAC score significantly predicts whether subjects met the guidelines (odds ratio = 1.022, 95% confidence interval = 1.012–1.033). This is also reflected in the Hosmer-Lemeshow goodness-of-fit statistic (\( \chi^2 = 1.797, P = .987 \)), which tests the hypothesis that the observed data are significantly different from the predicted values from the model. A nonsignificant value for this test indicates that the model predicts “real-world” data fairly well. Interaction terms were not significant, indicating no effect modification or confounding effects.

### Table 1.
Baseline Characteristics of the Study Population (n=364)

| Characteristic                  | n (%)          |
|---------------------------------|----------------|
| Age (mean±SD)                   | 64.4±13.7      |
| Sex, male/female                | 137 (37.6)/227 (62.4) |
| Primary THA/revision THA        | 273 (75)/91 (25) |
| Charnley classification         |                |
| Category A                      | 254 (69.8)     |
| Category B                      | 76 (20.9)      |
| Category C                      | 34 (9.3)       |
| General comorbidities           |                |
| Heart and vascular diseases     | 46 (12.6)      |
| Hypertension                    | 105 (28.8)     |
| Peripheral vascular problems    | 8 (2.2)        |
| Lung problems                   | 37 (10.2)      |
| Diabetes mellitus               | 35 (9.6)       |
| Neurological disease            | 22 (6.0)       |
| Any form of cancer              | 24 (6.6)       |
| Stomach ulcers                  | 4 (1.1)        |
| Renal disease                   | 8 (2.2)        |
| Vision problems                 | 70 (19.2)      |
| Back pain                       | 142 (39.0)     |
| Psychological problems          | 14 (3.8)       |

\(^{a}\)THA=total hip arthroplasty.

### Table 2.
Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH) Scores (mean±SD) (n=361–364)

| Scale                          | Score               |
|--------------------------------|---------------------|
| WOMAC total score (scale 0–100)| 71.19±21.62         |
| SQUASH                         |                     |
| Total physical activity (min/wk)| 1,498.72±1,289.04   |
| Light-intensity physical activity (min/wk)| 948.01±1,022.80   |
| Moderate-intensity physical activity (min/wk)| 340.91±512.77  |
| Vigorous-intensity physical activity (min/wk)| 209.79±393.51  |
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Discussion

Currently, the outcome after THA is considered successful when there is a marked improvement in the scores on generic or disease-specific, health-related quality-of-life outcome instruments such as the WOMAC. With respect to physical functioning, these instruments only provide information about the limitations that patients experience; however, there is a growing societal awareness of the benefits of physical activity and the negative effects of a lack of physical activity on general health. For this reason, it is important to obtain information about the amount of physical activity that patients perform after a THA. Literature on this aspect of physical functioning is very sparse, however, and has focused mainly on the determination of realistic loading conditions for hip prostheses instead of the importance of physical activity for general health.25–30 The objective of this study, therefore, was to investigate whether the score on the WOMAC could predict the amount of physical activity after a primary or revision THA.

We studied a large population with a high response rate of 71.9%. Although the correlations between the WOMAC and SQUASH were significant and the results of the logistic regression analysis showed that the total score on the WOMAC was a significant predictor of patients fulfilling national and international guidelines on physical activity, it can be concluded from the results that the clinical usefulness of the WOMAC for predicting the amount of physical activity in patients after THA is very limited. Correlations between the total score on the WOMAC and the subscale and total scores on the SQUASH varied only between 0.14 and 0.24 and, therefore, must be considered low.31,32 Additional analysis in which we correlated the physical functioning subscale score of the WOMAC (instead of its total score) with the score on the SQUASH resulted in a correlation coefficient (r) in the same range (.26). With respect to the binary logistic regression analysis, an odds ratio of only 1.022 (95% confidence interval = 1.012–1.033) was found, indicating that the score on the WOMAC is not clinically useful in predicting the fulfillment of national or international guidelines on health-enhancing physical activity. This is confirmed by the Nagelkerke $R^2$ of .069 for this model, which means that only 6.9% of the variance could be explained and that only 60.2% of the subjects could be classified correctly.

To our knowledge, this is the first study to investigate the ability of the WOMAC to predict the amount of physical activity that patients would perform after a primary or revision THA as assessed by the SQUASH. In the literature, we found only 2 studies in which a similar comparison was made between an instrument measuring limitations that patients experience and amount of physical activity. Morlock et al30 compared the Harris Hip Score (HHS) with the results of a portable activity monitoring system and found a significant correlation with only some of the activity parameters. There was a high variability in activity parameters between patients with similarly high HHS, limiting the predictive power of the HHS on activity levels. It can be concluded that these results are in line with those found in our study, reflecting a low correlation between physical functioning and amount of physical activity. This may reflect the fact that people’s physical activity pattern is determined not solely by their physical abilities or inabilities, but also by demographic, social, psychological, and environmental factors.53–55 Recently, Beaule et al36 determined the relationship between patient activity level as measured by the University of California–Los Angeles (UCLA) activity score and the Harris Hip Score (HHS), as well as the 12-Item Short-Form Health Survey (SF-12). They found a strong correlation between the UCLA activity score and both the HHS and the SF-12 physical component scores, with Pearson correlation coefficients of .57 and .62. However, compared with the SQUASH, the UCLA activity score can be considered to be a less detailed estimate of physical activity. The study by Beaule et al,36 however, emphasizes the value of assessing patient activity as part of the outcome of THA.

In Western societies, the coming decades will show a steadily increasing demand for primary as well as revision THA.14,37 From an individual as well as a societal perspective, it is important that these patients remain physically active after a THA, not only to improve their general health, but also to maintain their ability to live independently. The results of this study have shown that using the WOMAC to evaluate functional status postoperatively gives only information on whether patients experience limitations in their physical functioning, not on their physical activity patterns. To that end, we recommend including an additional measure that gives information about the patient’s amount of physical activity. In this study, we used the SQUASH. Advantages of this questionnaire are that it is self-administered and short and takes only a few minutes to complete. A shortcoming is the fact that, until now, research has only been done into its reliability and validity in an adult population that is healthy and not in a population of patients after THA. Furthermore, the reliability of the data for the SQUASH has only been determined using Spearman
correlation coefficients, and it can be argued that this is an inappropriate statistic to measure reliability.\textsuperscript{38,39} Finally, a limitation of our study is the fact that we did not test the reliability of our own data collected by means of the WOMAC and the SQUASH.

The SQUASH was developed in the Netherlands and is used nationwide by institutions to measure the physical activity pattern of the Dutch population. From an international perspective, the International Physical Activity Questionnaire (IPAQ)\textsuperscript{40} may be considered to be an alternative, comparable questionnaire. The IPAQ is the result of an international attempt, supported by the World Health Organization, to standardize the measurement of physical activity internationally. There are 4 long and 4 short versions of the IPAQ, administered by telephone interview or self-administered, recalling physical activity either during the last 7 days or during a usual week. As in the SQUASH, energy expenditure is expressed in METs and scores on the IPAQ can be compared with the national and international guidelines on physical activity. However, no standard measure to assess physical activity after THA has been determined so far.

Conclusions

Despite the recognized benefits of regular physical activity on general health and musculoskeletal fitness, little is known about the amount of physical activity performed by patients after THA. For this reason, we determined whether the WOMAC, which is one of the most widely used disease-specific, health-related quality-of-life questionnaires for measuring outcome after THA, can be used to predict amount of physical activity performed after THA. We concluded that the WOMAC is not clinically useful for this goal, necessitating the use of additional measures.

Dr Wagenmakers, Dr Stevens, and Dr Groothoff provided concept/idea/research design. Dr Wagenmakers provided writing and subjects. Dr Wagenmakers, Dr Stevens, and Dr van den Akker-Scheek provided data collection and analysis. Dr Wagenmakers, Dr Zijlstra, and Dr Groothoff provided project management. Dr Groothoff provided facilities/equipment. Dr Zijlstra and Dr Groothoff provided institutional liaisons. Dr Stevens, Dr van den Akker-Scheek, and Dr Groothoff provided consultation (including review of manuscript before submission).

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Appendix.
The Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH)\textsuperscript{a}

Think about an average week in the past few months. Please indicate \textbf{how many days per week} you performed the following activities, how much time \textbf{on average} you were engaged in them, and (if applicable) how strenuous this activity was for you.

| COMMUTING ACTIVITIES | Days per week | Average time per day | Effort (circle please) |
|----------------------|---------------|----------------------|------------------------|
| Walking to/from work/school | \ldots days | \ldots hours \ldots minutes | slow/moderate/fast |
| Bicycling to/from work/school | \ldots days | \ldots hours \ldots minutes | slow/moderate/fast |
| Not applicable |

| LEISURE-TIME ACTIVITIES | Days per week | Average time per day | Effort (circle please) |
|-------------------------|---------------|----------------------|------------------------|
| Walking | \ldots days | \ldots hours \ldots minutes | slow/moderate/fast |
| Bicycling | \ldots days | \ldots hours \ldots minutes | slow/moderate/fast |
| Gardening | \ldots days | \ldots hours \ldots minutes | light/moderate/intense |
| Odd jobs | \ldots days | \ldots hours \ldots minutes | light/moderate/intense |
| Sports (please write down yourself) | | | |
| eg, tennis, fitness, skating, swimming, dancing |
| 1. | \ldots days | \ldots hours \ldots minutes | light/moderate/intense |
| 2. | \ldots days | \ldots hours \ldots minutes | light/moderate/intense |
| 3. | \ldots days | \ldots hours \ldots minutes | light/moderate/intense |
| 4. | \ldots days | \ldots hours \ldots minutes | light/moderate/intense |

| HOUSEHOLD ACTIVITIES | Days per week | Average time per day |
|----------------------|---------------|----------------------|
| Light household work | \ldots days | \ldots hours \ldots minutes |
| (cooking, washing dishes, ironing, child care) |
| Intense household work | \ldots days | \ldots hours \ldots minutes |
| (scrubbing floors, carrying heavy shopping bags) |

| ACTIVITY AT WORK AND SCHOOL | Average time per week |
|-----------------------------|----------------------|
| Light work (sitting/standing with some walking, eg, a desk job) | \ldots hours \ldots minutes |
| Intense work (regularly lifting heavy objects at work) | \ldots hours \ldots minutes |
| Not applicable |

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