

Assessing Preoperative Mobility in Total Hip Arthroplasty: A SAFE T database study

Edward M. Vasarhelyi^{a,*}, Mina W. Morcos^a, Joel T. Phillips^a, Steven J. MacDonald^a,
Lyndsay Somerville^a, Hans Kreder^b, James L. Howard^a, And the SAFE T Investigators

^a Department of Surgery, Division of Orthopaedic Surgery, London Health Sciences Centre – University Hospital, Western University, London, ON, Canada

^b Sunnybrook Health Sciences Centre, Division of Orthopaedic Surgery, University of Toronto, Toronto, ON, Canada

ARTICLE INFO

Keywords:

Total hip arthroplasty
Highly active
Self-reported physical activity
WOMAC
6-Minute walk test

ABSTRACT

This study examined whether individuals undergoing total hip arthroplasty who are self-rated as “highly active”, demonstrated higher pre-operative activity levels than others.

Methods: 483 patients were retrospectively identified; 241 were “highly active” and 242 were not. They were compared using WOMAC, self-reported activity and 6-Minute Walk Test (6MWT).

Results: Self-reported highly active adults demonstrated statistically significant higher WOMAC scores (48.85 vs 43.79), increased mean number of activities performed and mean 6MWT (348.14 m vs 274.64 m).

Conclusions: The positive correlation between subjective and objective measures of mobility increase our confidence in the latter as valid indicator of patient's preoperative activity level.

Source of funding

There was no external funding source.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

1. Introduction

In 2000, arthritis and rheumatism affected approximately 4 million Canadians aged 15 years and older.¹ Compared with those unaffected, arthritis sufferers report activity limitations 2 to 10 times more frequently.¹ While non-operative treatment options exist, the definitive treatment for arthritis of the hip and knee remains Total Joint Arthroplasty (TJA). In addition to relief of pain and length of recovery, mobility remains a key concern amongst patients undergoing TJA.² Measuring and predicting mobility both pre- and post-TJA should therefore be a subject of interest both for the patient and the surgeon. Various measurement tools have been utilized including patient history, self-reported questionnaires, physician administered questionnaires, as well as standardized physical tests. Overall, the Western McMaster

Osteoarthritis Index (WOMAC) is the most extensively studied questionnaire and has received the best ratings for its descriptive and psychometric qualities.³ The 6-min walk test (6MWT) is a commonly used objective measure of mobility. While patient mobility post-TJA is influenced by a host of pre-operative, intra-operative and post-operative factors, known predictors of post-operative mobility have been documented in the literature. Of these, pre-operative level of mobility is recognized as an important predictor.⁴ Therefore, accurate measurement of pre-operative mobility is important in not only serving as a baseline measurement but also in predicting patient outcomes post-TJA. This is becoming especially important as many TJA patients seek to achieve a higher level of physical activity compared with TJA patients in the past.⁵

Review of the literature indicates a paucity of data examining pre- and post-operative activity levels in patients who participated in high-intensity physical activity as adults. Amongst the data that does exist, there is disagreement whether patients participate in a higher level of physical activity post-operatively compared with pre-operatively with some reporting increased levels while others report a decline.^{5–13} Also, there is a lack of information examining whether individuals who were highly active during their adult life are more likely to be highly active both in the pre-operative and post-operative time periods.

The purpose of the current study is to assess whether individuals

* Corresponding author. Department of Surgery, Division of Orthopaedic Surgery London Health Sciences Centre, University Hospital Western University 339 Windermere Road London Ontario, Canada, N6A 5A5, Canada

E-mail address: edward.vasarhelyi@lhsc.on.ca (E.M. Vasarhelyi).

<https://doi.org/10.1016/j.jor.2019.04.012>

Received 19 January 2019; Accepted 15 April 2019

Available online 02 May 2019

0972-978X/© 2019 Professor P K Surendran Memorial Education Foundation. Published by Elsevier B.V. All rights reserved.

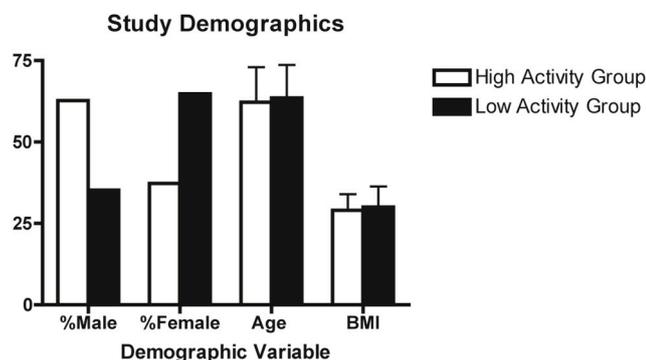


Fig. 1. Study demographics for the high and low activity groups.

undergoing Total Hip Arthroplasty (THA) who are self-rated as “highly active adults”, demonstrate higher levels of pre-operative physical functioning as evidenced by their WOMAC functional score, self-reported high impact, low impact and total activity involvement as well as their 6-min walk test. Correlation of WOMAC scores with self-reported high-impact, low-impact and total physical activity as well as 6-min walk test will be examined. Finally, an analysis of prevalence of gait aids and mobility-limiting comorbidities will be completed. Our hypothesis is that the self-reported highly active adults will demonstrate higher levels of pre-operative physical activity as evidenced by a higher number of self-reported high impact physical activities as well as higher WOMAC scores and 6-Minute Walk Test scores.

2. Methods

We retrospectively identified 483 individuals in the SAFE T database who were assessed pre-operatively. Patients were divided into two groups based on whether or not they were self-reported as “highly active adults”. Based on these criteria, 241 individuals were identified as “high-activity adults” and 242 individuals were “low-activity adults”. Both groups were analyzed for gender, age and BMI (Fig. 1). We then compared the two groups using both subjective and objective measures of mobility contained within the database.

Subjective measures of mobility included WOMAC scores as well as self-reported frequency and duration of high and low impact activity involvement. WOMAC function, pain, stiffness and total scores collected at patient’s pre-operative visit (2–3 weeks pre-operative) were analyzed in both groups with the functional score being used to specifically assess mobility in each group. WOMAC scores were transformed as per our institutional protocol so that higher scores indicate improved function, less pain and less stiffness. Participation in high impact, low impact and total activities in the year prior to surgery was assessed using the extensive patient self-reported activity information contained in the SAFE T database. Activities were defined as high impact or low impact in the database in accordance with the Minnesota Leisure Time Physical Activity Questionnaire (MLTPAQ), modified by Dr. Iris Weller (Table 1).¹⁴ Also, the number of minutes spent in the year prior to surgery performing each of these activities (high impact, low impact and total activity) was recorded. A further assessment of mobility used in the current study involved analysis of self-reported prevalence of gait aid usage amongst the two groups. Objective measurement of mobility included mean 2–3week pre-operative SAFE T database 6-Minute Walk Test results.

We calculated descriptive statistics for demographic variables including gender, age and Body Mass Index (BMI). An Independent Students t-test was used to assess the differences between the two groups with respect to frequency of high and low impact activities, WOMAC and the 6MWT. The duration (min/year) of the high and low activity between the two groups was evaluated by means of a Mann-Whitney U test for nonparametric data. Analyses of possible

Table 1

Activity intensity classification divides activities that were reported by patients into high impact or low impact classes based on the work of Dr. Iris Weller.¹⁴

	Activity Classification
Walking for pleasure	low
Walking for exercise	high
Stairs	low
Hiking (carrying < 20lbs)	high
Backpacking (carrying > 20lbs)	high
Horseback riding	high
Dancing	high
Cycling	low
Martial arts	high
Swimming laps	low
Aqua fitness class	low
Jogging/running	high
Aerobic classes	high
Home aerobics	high
Home weights	lifting
Weight training	high
Golf:pulling clubs	low
Golf:carrying clubs	low
Golf: riding in cart	low
Bowling	low
Table tennis/ping pong	low
Badminton	high
Tennis singles	high
Tennis doubles	high
Squash/raquetball	high
Water skiing	high
Sailing	low
Canoeing/rowing/kayaking	low
Scuba diving	low
Snorkeling	low
Fishing from boat	low
Fishing standing	low
Skiing downhill	high
Skiing cross-country	low
Skate = ice skating (not hockey)	low
Sled/toboggan	low
Weeding/planting	low
Spading/digging	high
Raking	high
Shoveling snow	low
Lawn mowing	low
Light housework	low
Washing windows	high
Scrubbing floors	low
Lifting laundry/boxes etc	low
Painting	low
Carpentry	high
Lifting a dependant	low
Assisting someone bathing	high
Other- if sport isn't listed above	

confounding variables such as gender, employment status, comorbid conditions and gait aids were also performed between each group with a Chi-square test. Pearson correlation analysis was performed on activity variables (duration and frequency) against functional scores (WOMAC and 6MWT). This analysis was also performed on gender subgroups to assess whether the results differed between sexes. All analyses were performed with SPSS (v 20.0; Chicago, Ill) with $p < 0.05$ considered statistically significant.

3. Results

Patients who were self-reported as high-activity adults, demonstrated statistically significant higher levels of physical activity based on both subjective and objective measurements. When compared with the low-activity adult group, individuals who belonged to the high-activity adult group, demonstrated statistically significant higher WOMAC mean functional scores of 48.85 vs 43.79 ($p = 0.003$) (Fig. 2). Mean WOMAC pain and total scores were also found to demonstrate a

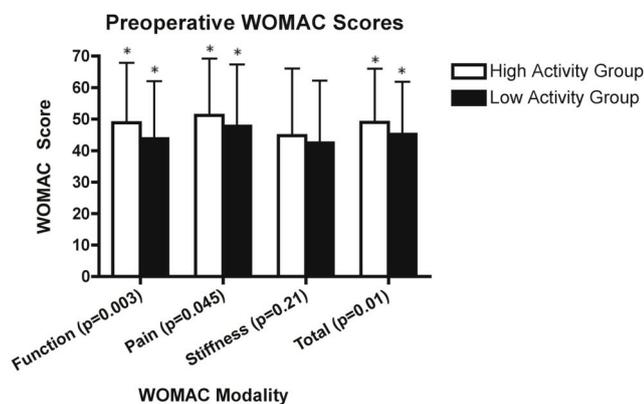


Fig. 2. Mean pre-operative WOMAC scores in both the high-activity adult group and low-activity groups.

statistically significant increase in the highly active adult group compared with the low-activity adult group, with pain scores of 51.18 vs 47.72 ($p = 0.045$) and total scores of 48.97 vs 45.15 ($p = 0.01$) (Fig. 2). WOMAC stiffness scores did not demonstrate a significant difference between the two groups: 44.78 vs 42.42 ($p = 0.21$) (Fig. 2).

A second subjective measure of physical activity involved patient self-reported pre-operative high impact and low impact physical activity (Fig. 3A). Patients in the high-activity adult group demonstrated a statistically significant increase in the mean number of high activities performed pre-operatively when compared with the low-activity adult group: 0.98 vs 0.57 ($p < 0.001$). The same was observed with respect to the number of preoperative low impact activities performed: 4.04 vs 3.54 ($p = 0.003$). With respect to high and low impact activity duration (Fig. 3B) there were significant outliers in both groups and mean values were non-significant. For this reason we examined the median values for each group. Median duration of pre-operative high impact activity did demonstrate a numerical difference between the high-activity adult group and the low-activity adult group: 90 h/year vs 64 h/year ($p = 0.07$). Median duration of low impact activity and median duration of total activity were also found to be higher amongst the high activity adult group. Median low impact activity duration was 703.25 h/year amongst the high group vs 644 h/year amongst the low group ($p = 0.62$). Median total activity duration was 752 hrs/year in the high group vs 672 h/year in the low group ($p = 0.19$). However, the observed differences in median duration of high-impact activity, low-impact activity and total activity between the two groups were not

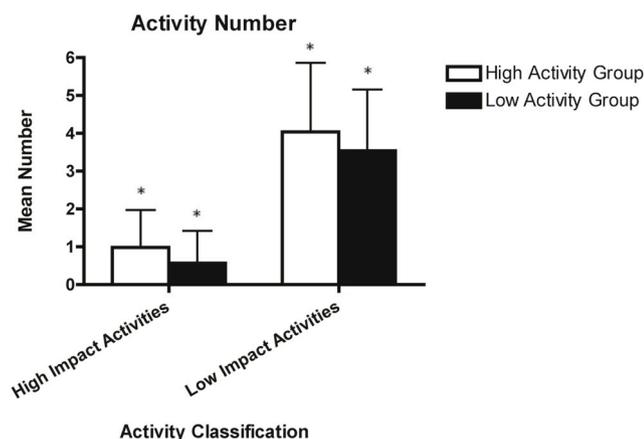


Fig. 3. A - Preoperative mean number of self-reported high impact and low impact activities amongst the high-activity adult group and low-activity groups. Fig. 3B - Preoperative mean and median activity duration in minutes/year of self-reported high impact and low impact activities amongst the high-activity adult group and low-activity group.

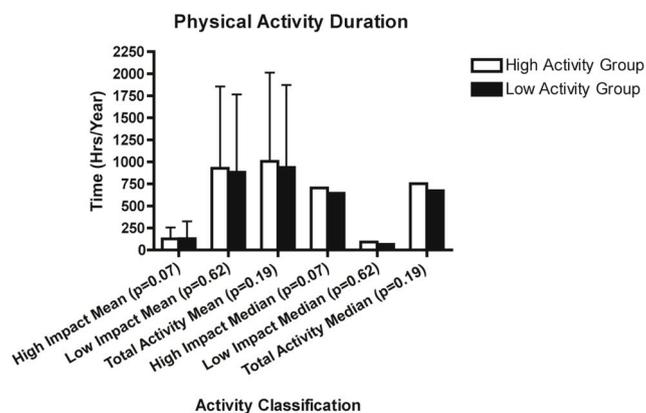


Fig. 3. (continued)

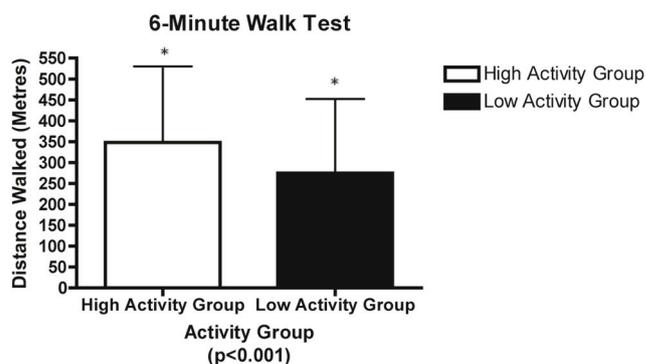


Fig. 4. Histogram – Preoperative Mean 6-Minute Walk Test Scores (in metres walked) taken in both the high-activity adult group and low-activity group.

statistically significant ($p > 0.05$).

Objective measurement of patients' pre-operative physical activity via their 2–3 week preoperative 6-min walk test (Fig. 4) revealed similar results to those we observed with respect to WOMAC scores and number of activities (high impact activity, low impact activity and total activity). Individuals in the high-activity adult group demonstrated a statistically significant increase in their 6-min walk test scores when compared with their low-activity counterparts: 348.14 m vs 274.64 m ($p < 0.001$).

The use of a gait aid (Fig. 5) amongst individuals in the high-activity adult group demonstrated a statistically significant lower when compared with the low-activity adult group, with 161 individuals (66.8%) using no gait aid and 80 individuals (33.2%) requiring a minimum of one cane intermittently. 131 individuals (54.1%) within the low-activity group did not require the use of a gait aid, whereas 111

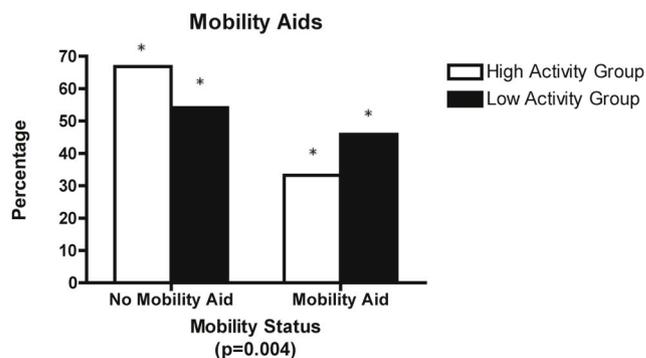


Fig. 5. of individuals requiring a mobility aid preoperatively vs those not requiring a mobility-aid preoperatively in both the high-activity adult group and low-activity group.

Table 2
Correlation coefficients examining the relationship between both subjective and objective measures of mobility used in this study.

Correlated Variables	Correlation Coefficient
WOMAC Function Scores: 6-min Walk Test Scores	0.52
Number of Low Impact Activities: 6-min Walk Test Scores	0.37
Number of High Impact Activities: 6-min Walk Test Scores	0.36
Number of Low Impact Activities: WOMAC Function Scores	0.24
Number of High Impact Activities: WOMAC Function Scores	0.24

individuals (45.9%) required a minimum of one cane intermittently ($p = 0.004$). The total number of patients not requiring the use of a gait aid preoperatively was 292 (60.5%). 191 individuals (39.5%) required a minimum of one cane intermittently ($p = 0.004$).

Correlation coefficients (Table 2) calculated for WOMAC function, number of activities (high impact, low impact, total), activity duration and 6-Minute Walk Test yielded several statistically significant values. WOMAC functional scores were found to have a weak correlation yet positive relationship (higher functioning correlated with higher activity number) with the number of high impact activities and low impact activities (0.24). A higher 6-Minute Walk Test was found to have a positive and moderate correlation strength with both the number of high impact activities and the number of low impact activities (0.36 and 0.37 respectively). WOMAC functional scores were also found to have a positive and strong correlation with 6-Minute Walk Test scores (0.52).

Gender was found to be statistically significant between both groups with 62.7% males in the high-activity adult group when compared with 35.2% in the low-activity adult group (Fig. 1). Correlation coefficients between WOMAC scores and 6-Minute Walk Test scores with self-reported high impact and low impact preoperative activities were calculated and did not demonstrate a statistically significant difference between genders.

Employment status (Fig. 6) between the two groups was not statistically significant with 47.7% of individuals in the high-activity adult group being employed compared with 42.4% in the low-activity adult group. Distribution of employment (Fig. 7) was also not significantly different between the two populations. The percentage of patients reporting having a comorbid condition that limited their mobility was not different between the highly active adult population and the control population (49.5% vs 48.1%).

4. Discussion

Accurate measurement of pre-operative mobility is not only

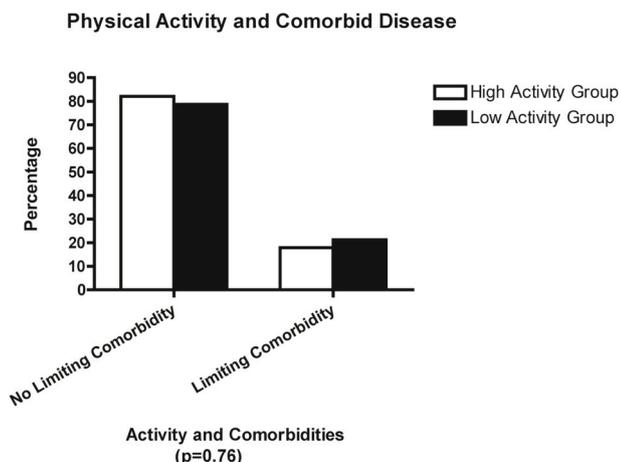


Fig. 6. of individuals in both the high-activity adult group and the low activity adult group with comorbidities that limited their mobility preoperatively.

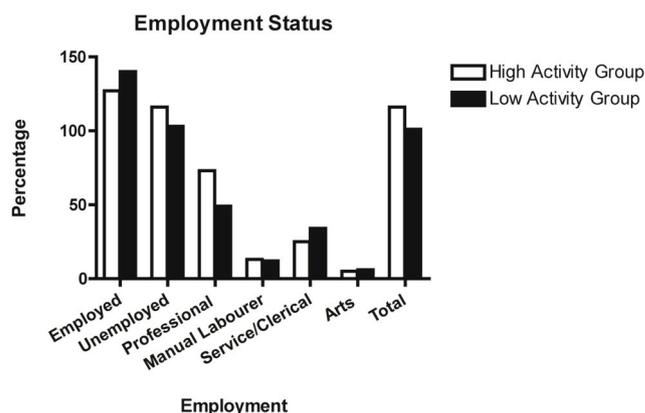


Fig. 7. Preoperative employment status in high-activity adult group and low-activity group.

important as a baseline measurement but also as a predictor of post-operative mobility.⁴ With post-operative mobility being an outcome of significant interest to both the patient and surgeon, understanding and accurately measuring pre-operative mobility is therefore important as it serves as a predictor of postoperative mobility.² This is particularly true given that knee and hip arthroplasty remain steadily on the rise in Canada, with an 87% increase from 31 463 cases in 1994–1995, to 58 714 cases in 2004–2005.¹⁵ Also, for an increasing number of patients, achieving only a baseline level of mobility necessary for activities of daily living is no longer acceptable with many wishing to participate in athletics post operatively.¹⁶ The current study attempted to examine whether THA patients who were self-rated as highly active adults displayed higher levels of pre-operative mobility as assessed by subjective and objective measures. Correlations between these various measurements were calculated and analysis of potential confounding variables was performed.

Subjective measurement tools of mobility did demonstrate statistically significant differences between the two groups with the highly-activity adult group demonstrating higher WOMAC functional and WOMAC total scores as well as higher self-reported mean number of preoperative high and low impact activities. Prevalence of the use of 1 or more gait aids was also significantly lower in the high-activity group when compared with the low-activity group. These observed differences were most likely real as the objective measure of mobility; the 6-min walk test, also demonstrated a statistically significant difference with the highly active adult group achieving a greater distance walked at their 2–3 week preoperative assessment. A number of statistically significant correlation coefficients observed further strengthened the relationship between the highly active adult group and increased pre-operative physical activity. Higher WOMAC functional and WOMAC total scores demonstrated a positive correlation with a higher number of pre-operative high impact and low impact activities as well as walking distance observed in the 6-Minute Walk Test. The 6-Minute Walk Test also correlated positively with the number of pre-operative high impact and low impact physical activities.

Interestingly however, we did not find a significant difference in mean time or median time spent performing either high or low impact

activity between the two groups. Potential explanations for this included non-normal distribution of pre-operative activity duration data as well as patient difficulty accurately reporting activity duration. We feel the latter is likely, as some activities were performed infrequently during the year prior to surgery, making duration difficult to estimate. WOMAC stiffness scores also were not significantly different between the two groups and therefore were unlikely to be a confounding variable.

Other potential confounding variables between the two populations included differences in pain, gender, employment status, as well as comorbid conditions between the two groups. Analysis of WOMAC pain scores did demonstrate a statistically significant difference between the two groups with the low-activity group experiencing more pain (lower corrected WOMAC score: 47.72 vs 51.18). However, the clinical significance of this is likely minimal. Demographic analysis of the two groups indicated a significantly higher number of males in the high-activity adult group when compared with the low-activity adult group (62.7% vs 35.2%). To ensure that the observed increase in number of self-reported preoperative high impact and low impact activities was not secondary to a male preponderance to over-report; correlation coefficients were calculated. Correlation between WOMAC scores and 6-Minute Walk Test scores with self-reported high impact and low impact preoperative activities did not demonstrate a statistically significant difference between genders. Therefore it is unlikely that gender was the source of any reporting differences between the two groups. Employment status as well as the number of individuals with mobility-limiting comorbidities, were unlikely to be significant confounders as there was no statistically significant differences between the two groups. This serves to reinforce our confidence that the observed difference in activity-level observed between the two groups was indeed real.

This study is one of the largest studies of its kind to examine pre-operative mobility, utilizing data from a large multi-centre prospective database. This database contained detailed pre-operative mobility information consisting of both subjective and objective measures. It used validated instruments of mobility measurement in conjunction with the extremely detailed patient self-reports. In-depth data collection pertaining to patient demographics, comorbid conditions, employment status and mobility aid usage allowed us to identify and analyze potential confounding variables.

Based on our findings it is reasonable to conclude that a self-reported high-level of activity may have predictive value with respect to a patient's mobility in the pre-operative period. The observed positive relationship between WOMAC functional scores and objective mobility as measured by the 6-Minute Walk Test further emphasizes the validity of the WOMAC screening tool in assessing patient mobility.³ A positive correlation was observed between pre-operative WOMAC scores, 6-Minute Walk Test and self-reported pre-operative high and low impact activity participation. This correlation of subjective and objective measures of mobility serves to modestly increase our confidence in the

latter as valid indicator of patient's preoperative activity level. Clinically, these findings are important as they enable the surgeon and patient to better understand the patient's pre-operative level of functioning and consequently develop realistic individualized post-operative expectations with respect to mobility. This may be especially important in the highly active patient who wishes to return to athletic activities that are higher impact. Future studies using the SAFE T Database will seek to perform the same analysis of both the high-activity group and low-activity group in the post-operative period. Also, comparison of the pre- and post-operative values amongst the two groups will be assessed.

Grants/Acknowledgements

Canadian Institute for Research Health (CIHR) Research Grant. Grant ID - MOP/FRN 84315.

References

- Legace C, Perruccio A, DesMeules M, Badley EA. *Arthritis in Canada- an Ongoing Challenge*. Public Health Agency of Canada; 2000http://www.phac-aspc.gc.ca/publicat/ac/ac_3e-eng.php.
- United States Bone and Joint Decade. *The Burden of Musculoskeletal Diseases in the United States*. Rosemont, IL: American Academy of Orthopaedic Surgeons. 2008; 2008.
- Veenhof C, Bijlsma J, van den Ende CHM, van Dijk GM, Pisters MF, Dekker J. Psychometric evaluation of osteoarthritis questionnaires: a systematic review of the literature. *Arthritis Rheum*. 2006;55(3):480–492.
- Papalia R, Del Buono A, Zampogna B, Maffulli N, Denaro V. Sport activity following joint arthroplasty: a systematic review. *Br Med Bull*. 2012;101:81–103.
- Mont MA, Marker DR, Seyler TM, Jones LC, Kolisek FR, Hungerford DS. *The Effect of High Impact Sports on Total Knee Arthroplasties*. Presented at the Annual Meeting, November. Dallas, TX: American Association of Hip and Knee Surgeons (AAHKS); 2007.
- Bauman S, Williams D, Petruccioli D, Elliott W, de Beer J. Physical activity after total joint replacement: a cross-sectional survey. *Clin J Sport Med*. 2007;17:104–108.
- Huch K, Muller KA, Stürmer T, Brenner H, Puhl W, Gunther KP. Sports activities 5 years after total knee or hip arthroplasty: the Ulm Osteoarthritis Study. *Ann Rheum Dis*. 2005;64:1715–1720.
- Bradbury N, Borton D, Spoo G, Cross MJ. Participation in sports after total knee replacement. *Am J Sports Med*. 1998;26:530–535.
- Chatterji U, Ashworth MJ, Lewis PL, Dobson PJ. Effect of total knee arthroplasty on recreational and sporting activity. *ANZ J Surg*. 2005;75:405–408.
- Dahm DL, Barnes SA, Harrington JR, Sayeed SA, Berry DJ. Patient-reported activity level after total knee arthroplasty. *J Arthroplast*. 2008;23:401–407.
- Sechrist 2nd VF, Kyle RF, Marek DJ, et al. Activity level in young patients with primary total hip arthroplasty: a 5 year minimum follow-up. 2007;22:39–47.
- Diduch DR, Insall JN, Scott WN, et al. Total knee replacement in young, active patients. Long-term follow-up and functional outcome. *J Bone Joint Surg Am*. 1997;79:575–582.
- Dubs L, Gschwend N, Munzinger U. Sport after total hip arthroplasty. *Arch Orthop Trauma Surg*. 1983;101:161–169.
- Weller I, Kunz M. Physical activity and pain following total hip arthroplasty. *Physiotherapy*. 2007;93:23–29.
- Mukhi S, Marin M, Keresteci M. Hip and knee replacements in Canada: distributions and clinical characteristics findings from the 2006 CJRR Annual Report. 2006;75 (no page number).
- Trousdale RT, McGrory BJ, Berry DJ, Becker MW, Harmsen WS. Patients' concern prior to undergoing total hip and total knee arthroplasty. *Mayo Clin Proc*. 1999;74:978–982.