Ethnic Differences in the Relationship Between Obesity and Joint Pain and Function in a Joint Arthroplasty Population

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ABSTRACT. ***Objective.*** We investigated the influence of obesity on joint pain and function in Asians as compared to Caucasians with degenerative hip and knee arthritis.

Methods. We surveyed 1983 patients (1876 Caucasians and 107 Asians) undergoing primary hip or knee replacement surgery. Relevant covariates including demographic data, body mass index (BMI), sex, comorbidities, education, and ethnicity were recorded. Pain and joint functional status were assessed at baseline and at 1-year followup with the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) pain and function scores.

Results. Asian patients presented for surgery at a significantly younger age and lower mean BMI, and reported greater pain and dysfunction than Caucasian patients. Multivariate linear regression modeling showed that for every level of BMI, Asian patients reported greater levels of joint pain and dysfunction. At a BMI of 30 kg/m^2, this translated to a 16.6% higher WOMAC score ($p < 0.001$).

Conclusion. Among patients with endstage osteoarthritis, at every level of BMI, joint pain and dysfunction are greater in Asians than in Caucasians. This difference is likely mediated through both mechanical and inflammatory effects. (First Release Aug 1 2008; J Rheumatol 2008;35:1874–7)

Key Indexing Terms:
ARTHROPLASTY ETHNICITY OBESITY OUTCOMES

Obesity has been clearly defined as an independent risk factor for the development and progression of hip and knee osteoarthritis (OA)[1-4]. The World Health Organization (WHO) has used body mass index (BMI) as a method of grading the level of adiposity, with a BMI ≥ 25 kg/m^2 defined as overweight and ≥ 30 kg/m^2 as obese. These cutpoints were derived from a primarily Caucasian (individuals whose ancestry is White/European) population as predictors of chronic disease and mortality[5]. It is presently unclear if these BMI cutpoints can be extrapolated to other ethnic groups in terms of degree of risk for chronic disease[6].

It is well established that Asians (South Asians and East Asians) are at higher risk for type 2 diabetes, hypertension, and dyslipidemia at a lower BMI threshold compared to Caucasians[7-9]. Further, evidence suggests that for every level of BMI, Asians have a greater relative excess of adipose tissue and less lean muscle mass (LMM)[10,11]. This excess adipose tissue may lead to a heightened inflammatory state through greater systemic levels of C-reactive protein (CRP) and interleukin levels[12,13].

Emerging literature demonstrates that the effect of obesity on OA is mediated by both mechanical and chemical effects, and that dyslipidemia can affect joint homeostasis[11-14]. Fat cells release proteins called adipokines, of which leptin, adiponectin, and resistin are the most studied. Leptin has been shown to promote inflammation in arthritic joints, while adiponectin works to control the level of inflammation. Both proteins are found in synovial fluid and elevated levels of leptin have been found to be a key regulator of chondrocyte metabolism[11-16]. South Asians, Chinese, Japanese, and Taiwanese have all been shown to have high circulating levels of leptin[17-21]. We hypothesized *a priori* that among a population awaiting knee and hip replacement surgery, for any given BMI, Asian patients would report greater pain and physical dysfunction than Caucasians.

MATERIALS AND METHODS

Study sample. Study patients were recruited from a single Canadian academic institution, the Toronto Western Hospital, prior to undergoing primary hip or knee replacement surgery. Our inclusion criteria for the study were ages 18–85, a diagnosis of primary or secondary OA, and ethnicity self-report as being either Asian or Europid (Caucasian).

All patients gave informed consent to participate in our study. All data were collected by an independent assessor not involved in the medical care

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of the patients. The study protocol was approved by the local ethics committee.

Collection of data. Baseline demographic data of age, sex, BMI, level of education, and ethnicity were recorded. Height and weight were collected through patient self-report and BMI was then calculated. Highest level of education was recorded as either higher education level (university or above) or low education level (high school or below). Ethnicity was recorded by patient self-report. "Asian" refers to individuals who classified themselves as South Asian (India, Pakistan, Bangladesh, and Sri Lanka) or East Asian (China, Japan, Taiwan, Korea). Baseline medical health was scored on the Charlson Comorbidity Illness Index[22]. A lower score on the Charlson Index represents a better health state. Functional status and pain level were assessed preoperatively and at 1-year followup with the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) function and pain scores, respectively.[23] A higher WOMAC pain score indicates greater pain and a higher WOMAC function score indicates greater dysfunction.

Statistical analysis. Continuous data such as age, Charlson Index, and WOMAC pain and function scores were compared between groups using t-tests. Means and standard deviations are reported for all continuous variables. Binary data such as sex and level of education are reported with frequencies, and groups were compared with the corrected chi-squared test. Multivariate linear regression modeling was used to determine the influence of ethnicity and BMI on preoperative and 1-year WOMAC scores. The 6 dependent variables analyzed in separate models were preoperative and 1-year WOMAC pain, function, and overall scores. The independent variables entered into the models were age, sex, BMI, education, ethnicity, and Charlson Index.

All statistical analysis was done with SPSS version 13.0 (SPSS, Chicago, IL, USA). All reported p values are 2 tailed with an alpha of 0.05.

RESULTS

In our registry, we had complete data on 1983 out of 2825 (70.2%) total patients who composed our study cohort. Participants and nonparticipants were not significantly different in age, BMI, sex, or Charlson Index. There were 1876 (94.6%) Caucasian patients and 107(5.4%) Asian patients.

The mean age of the Caucasian patients was 70.5 years as compared to 66.9 years for the Asian patients ($p = 0.003$). There were significantly more men in the Caucasian group compared to the Asian group ($p = 0.008$) and the mean BMI was significantly greater in the Caucasian group at the time of surgery, 30.1 kg/m^2 versus 28.7 kg/m^2, respectively ($p = 0.023$).

Preoperatively, the WOMAC total score was 59.3 in the Asian patients and 50.8 in the Caucasian patients ($p < 0.001$). At 1-year followup postsurgery, the mean WOMAC total score was 25.1 in the Asian patients and 21.9 in the Caucasian patients ($p = 0.23$).

The overall data for our 2 cohorts is shown in Table 1.

In multivariate linear regression models, Asian ethnicity independently predicted a greater preoperative WOMAC pain, function, and total score after adjusting for age, sex, BMI, Charlson Index, and education ($p = 0.001$) At 1-year followup, Asian ethnicity was not predictive of WOMAC scores for any of 3 domains ($p > 0.05$). Table 2 shows the beta coefficients with 95% confidence intervals for the ethnicity variable from the adjusted analysis.

Table 1. Overall data comparing Caucasians and Asians.

Characteristics	Caucasians, n=1876	Asians, n=107	p
Mean age (SD), yrs	70.5 (12.0)	66.9 (12.1)	0.003
Male, %	42.7	29.6	0.008
Mean BMI, kg/m^2 (SD)	30.1 (6.6)	28.7 (4.6)	0.023
% Higher education	48.9	51.4	0.625
Mean Charlson index score (SD)	0.71 (0.97)	0.79 (0.93)	0.384
Baseline WOMAC			
Mean pain	10.3 (4.0)	11.8 (3.8)	< 0.001
Mean function	40.6 (14.5)	47.5 (14.6)	< 0.001
Mean overall	50.8 (17.9)	59.3 (17.7)	< 0.001
1 yr WOMAC			
Mean pain	3.7 (3.7)	4.2 (3.6)	0.353
Mean function	18.3 (14.6)	20.9 (14.4)	0.223
Mean overall	21.9 (17.9)	25.1 (17.4)	0.233

BMI: body mass index; WOMAC: Western Ontario and McMaster University Osteoarthritis Index.

At the conventional threshold for obesity (BMI $\geq$ 30.0 kg/m^2), the Asian cohort showed 16.6% greater overall level of pain and dysfunction as measured by the WOMAC score (Figure 1).

DISCUSSION

Our results demonstrate that Asians (South Asians and East Asians) report greater pain and dysfunction for every level of BMI as compared to Caucasian patients before joint replacement surgery. After the degenerative cartilage has been removed and replaced with a metallic implant, Asians and Caucasians show no significant differences in pain and level of function at 1 year. Other authors have shown that preoperative functional status predicts postoperative functional outcome in joint replacement surgery[24-26]; however, our data showed that the Asian population had a greater relative benefit from surgery than the Caucasian population.

We believe there are many potential contributing reasons for Asians to report greater pain and dysfunction despite a lower BMI compared to the Caucasian patients. For every level of BMI, Asians have a greater proportion of adipose tissue and less LMM[10,11], and LMM is known to be protective against joint pain and dysfunction[2]. The greater level of adipose tissue in Asians also contributes to pain via a biochemical effect. Obesity has been shown to be associated with greater systemic levels of CRP, interleukins, and matrix metalloproteinases (MMP), factors that can all contribute to increased joint pain and inflammation[12-14]. Moreover, visceral adipocytes secrete leptin, a hormone shown to be involved in the degenerative process of chondrocytes[15,16], and large epidemiologic studies have shown that Asian populations have greater levels of circulating leptin than White populations[17-21].

It is interesting to note that the Asian patients present for joint replacement surgery at a significantly younger age than

Table 2. Linear regression modeling reporting beta coefficient for Asians compared to Caucasians adjusted for age, sex, BMI, Charlson Index, and education.

	Preoperative Beta Coefficient (95% CI) Asian vs Caucasian	p	1-year Postoperative Beta Coefficient (95% CI) Asian vs Caucasian	p
WOMAC scores				
Mean pain	1.3 (0.5, 2.1)	0.001	0.4 (–0.77, 1.5)	0.456
Mean function	6.9 (4.0, 9.9)	< 0.001	3.2 (–1.0, 7.4)	0.135
Mean overall	8.2 (4.6, 11.8)	< 0.001	3.6 (–1.5, 8.7)	0.166

WOMAC: Western Ontario and McMaster University Osteoarthritis Index.

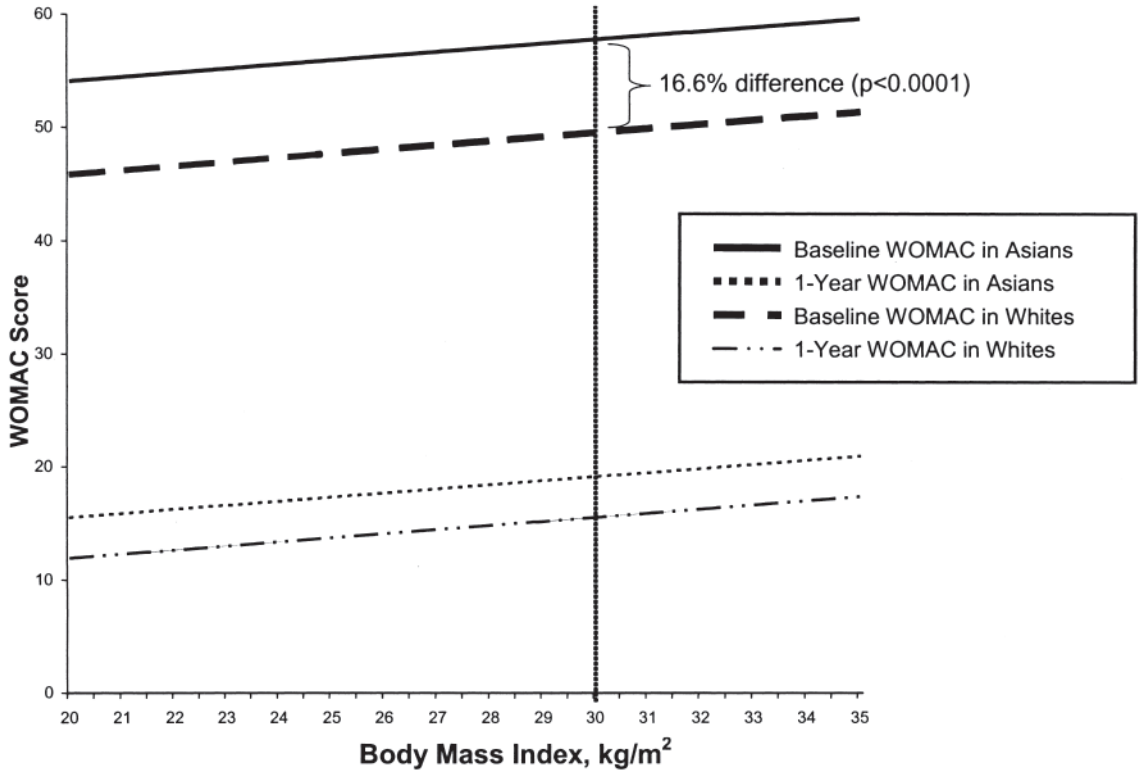

Figure 1. Total WOMAC scores at baseline and 1-year followup in Caucasians and Asians adjusted for age, sex, education, and Charlson Index.

the Caucasian patients. This may demonstrate that Asians develop degenerative arthritis at a younger age or that they have a more rapid course of progression and joint degeneration compared to Caucasian patients. These hypotheses warrant further study.

Our study has important clinical implications for physicians in that it suggests that although an Asian patient may present with a non-obese BMI (< 30.0 as currently defined by the WHO), he or she would still benefit from a weight loss and exercise program designed to reduce abdominal and general adipose levels and improve LMM. Further, we believe that the obesity cutpoints as defined by the WHO should be amended for the various ethnicities to more accurately reflect body habitus and risk of disease.

One potential limitation of our study is the 70% response rate among both the Caucasian and Asian patients. However, we demonstrated no difference in participants and nonparticipants in terms of age, sex, BMI, or baseline medical comorbidity, and we believe our conclusions remain valid and generalizable. Moreover, our population of 5% Asians is consistent with that of the downtown neighborhood of our hospital. Future large studies should be done separating the South and East Asian populations to confirm the same findings across groups.

We demonstrate that Asian patients present for surgery at a younger age and at a lower mean BMI, and complain of

more joint pain and dysfunction prior to surgery compared to Caucasian patients. However, Asians and Caucasians both obtain significant benefit from joint replacement and have similar levels of function and pain 1-year postsurgery.

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