Obesity and Other Cardiovascular Disease Risk Factors and their Association with Osteoarthritis in Southern California American Indians, 2002–2006

Jennifer L. Reid, PhD; Deborah J. Morton, PhD; Deborah L. Wingard, PhD; Mario D. Garrett, PhD; Denise von Muhlen, PhD; Donald Slymen, PhD

Objective: Assess age and sex differences in the association of obesity and other CVD risk factors with osteoarthritis (OA) in Southern California American Indian/Alaska Native (AIAN) adults.

Design: Cross-sectional study.

Setting: Southern California.

Participants: 6,299 AIAN adults aged 35+ years from health clinic system.

Main Outcome Measures: Osteoarthritis prevalence.

Results: Age-adjusted OA prevalence was 16.5% in women and 11.5% in men. OA prevalence increased with age and was higher in women. Very and morbid levels of obesity were associated with higher OA prevalence in some age groups. Hypertension was strongly associated with increased OA and current smoking tended to be associated with increased OA. For men, we found no association between diabetes and OA; however, diabetes was associated with more OA for women aged 35–54 years.

Conclusions: Southern California AIANs may have lower OA prevalence than the US population as a whole. Comparisons of OA prevalence with other AIAN communities were not possible due to lack of other similar published results. Further studies are needed to determine the impact of OA within this understudied minority population. (*Ethn Dis.* 2010;20:416-422)

Key Words: Indians, North American, Obesity, Osteoarthritis, Imputation

From Family and Preventive Medicine, University of California, San Diego (JLR) (DJM, DLW, DVM); Gerontology, San Diego State University (MDG); Public Health, San Diego State University (DS).

Address correspondence to Jennifer Reid, PhD; 12198 Loire Ct, San Diego, CA, 92131; 858-271-0023; jen@reidsonline.com

Introduction

Osteoarthritis (OA) is the most common form of arthritis, the leading cause of disability in the US, with increased risk in women and older adults.[1,2] Obesity is a known modifiable risk factor for OA of the knee and hand; however, results are inconsistent for hip OA.[3] Obesity is also a known risk factor for type 2 diabetes and hypertension.[4] Approximately half of adults with diabetes or hypertension also have arthritis.[1] According to NHANES III results, hypertension and diabetes prevalence were both significantly higher in those with OA compared to the general population without OA.[5] In contrast, those with OA reported less cigarette smoking than the general population, although not significantly.[5]

Prevalence of OA in American Indian/Alaska Native (AIAN) populations is difficult to establish as data on this population are limited and do not differentiate OA from the broader category of arthritis.[6,7] However, cardiovascular disease (CVD) risk factors that are associated with OA, such as obesity, diabetes, and hypertension,[3,5] are considerably more prevalent in AIANs compared to the overall US population or their corresponding state's population prevalence.[8–11]

A study of AIANs aged 18+ years from Alaska and the southwestern United States found age-sex adjusted self-reported arthritis prevalence (including but not limited to OA) was higher among those from Alaska (26.1%) but lower among those from Southwest US (16.5%), compared to the 2003–2005 National Health Interview Survey (21.5%).[6] In Alaska, arthritis prevalence increased with age and was higher in women than men.[6] In the southwestern United States, arthritis prevalence increased with age but was only higher in women compared to men aged ≥55 years.[6] Among more than 8,000 AIANs aged ≥55 years from across the US, 43.5% had arthritis, which is slightly higher than similarly aged US elders at 40%.[7] Similarly, arthritis prevalence increased with age and rates were higher in women than men (50.2% vs 35.4%).[7]

The Women's Health Initiative (WHI) collected information specific to OA for more than 140,000 postmenopausal women aged ≥50 years. Of the 632 AIAN women in this cohort, 49.8% self-reported OA, compared to 45.1% of non-Hispanic White women. In the entire WHI cohort, odds of OA increased with age and higher levels of obesity. This trend was evident, if not statistically significant, within all ethnic groups.[12] Other than WHI, no studies address the prevalence of OA and associated risk factors in AIANs.

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from one Indian health clinic system during a recent five-year period, hereafter referred to as the Southern California American Indian Health Clinics (SCAIHC). More specifically, the association of obesity and other CVD risk factors with OA was assessed in this unique group of AIAN adults who have previously not been studied.

METHODS

Data Source

Patient visit data at the SCAIHC are managed by the IHS Resource Patient Management System (RPMS) and stored in the Patient Care Component Package (PCC). The Native American Data Extraction and Surveillance (NADXS) software program was applied to the RPMS system at SCAIHC, and extracted more than 250 clinical variables from 2002–2006. NADXS has been validated and found to have greater than 97% accuracy when compared with data reviewed from the actual paper chart.[13]

NADXS extracted a total of 572,200 visits. The unique chart number for each patient was used to consolidate visit data from 2002–2006, yielding a sample of 18,811 patients. Non-Indian patients (n=3,153) or those whose residence was outside of two designated Southern California counties (n=513) where the majority of patients from the clinic system reside were excluded. From the remaining 15,145 eligible patients, 6,462 were aged 35+ years. Of these, 61 had type 1 diabetes and 102 indicated diabetes with no ICD-9 codes to corroborate, leaving 6,299 patients. There were 1,872 patients who were missing weight and/or height measurements. In order to include all patients in the analyses, an imputation method for height and/or weight was implemented (described below). Lack of BMI was primarily due to a predominance of dental or vision visits where height and weight were not measured.

To protect the confidentiality of specific tribal communities, tribes are not named. No patient names, addresses, or social security numbers were extracted. The academic institutional review boards (IRB) based on the author's affiliations, University of California, San Diego and San Diego State University, a local federally registered tribal-community IRB, and the tribal health board of the SCAIHC approved this study.

Measures

Diagnosis of OA was determined from the patients' records by the presence of ICD-9 codes 715, 716, or 721 at any time during the five-year period. These ICD-9 codes were selected to minimize inclusion of other common forms of arthritis, such as rheumatoid (ICD-9=714, 720), gout (ICD-9=274), and fibromyalgia (ICD-9=729). OA ICD-9 codes can differentiate for location but within these data, it was insufficient for further analysis. Diagnosis of type 2 diabetes was determined similarly from ICD-9 code 250. Hypertension was determined from the presence of one of the following criteria: 1) ICD-9 code=401, 402; 2) two or more visits with either SBP >140 or DBP >90; 3) hypertension indicated on the problem list where information is recorded at the practitioner's discretion; or 4) hypertension medication (ACE inhibitor) indicated by a prescription filled at the SCAIHC pharmacy. Patients who did not meet disease criteria were categorized as not having the disease.

Body mass index (BMI) (weight [kg] divided by height [m^2]) measurements from the five-year period were averaged together to derive the mean BMI. Mean BMI was categorized as underweight (<18.5 kg/m^2), normal weight (18.5–<25 kg/m^2), overweight (25–<30 kg/m^2), obese (30–<35 kg/m^2), very obese (35–<40 kg/m^2), morbidly obese (≥40 kg/m^2).[14] The underweight and normal weight BMI categories were combined for data analysis.

Current smoking status was determined from four health factor variables, or from tobacco use indicated on the problem list variables at any time during the five-year period. This method for determining smoking status from RPMS Indian Health Clinic data has been previously established.[15] Age was derived as of June 30, 2004, the midpoint of the five-year period.

Data Analysis

Prevalence of OA was determined for each CVD risk factor (BMI, diabetes, hypertension, current smoking) stratified by age group and sex. Direct age adjustment to the overall population was used for prevalence rates not stratified by age group. Sex-specific multivariable logistic regression models stratified by age group were used to assess the adjusted odds of osteoarthritis associated with increasing BMI category (reference category: under/normal weight), diabetes, hypertension, and current smoking status. BMI category was included as a categorical variable as linearity was not evident. Models were generated separately for men and women to examine the differential effect of CVD risk factors on OA. Preliminary modeling indicated an age by BMI interaction resulting in the stratification by age.

All analyses were conducted after the multiple imputation method proposed by Rubin[16,17] was used to impute height and/or weight for subjects missing one or both of these results for calculation of BMI. Data were imputed using the Markov Chain Monte Carlo method to create a monotone missing pattern[18]; missing heights and/or weights were then imputed from nonmissing height, weight, sex, age, diabetes, and hypertension status using a multivariable normal regression model. Imputation was repeated to generate five complete datasets. Logistic regression analysis was performed on each of the five datasets to

Table 1. Sample characteristics of a SCAIHC population

Variable	Total (*N*=6,299) Mean (95% CI)	Women (*n*=3,439) Mean (95% CI)	Men (*n*=2,860) Mean (95% CI)	*P**
Age (years)	51.7 (51.4, 52.0)	51.7 (51.3, 52.1)	51.7 (51.3 52.2)	.885
Mean BMI (kg/m^2)†	32.0 (31.6, 31.9)	32.1 (31.8, 32.4)	32.0 (31.7, 32.3)	.783
	% (*n*)	% (*n*)	% (*n*)	
Age group (yrs)				.309
35–44	35 (2201)	35 (1208)	35 (993)	
45–54	29 (1829)	29 (990)	29 (839)	
55–64	20 (1233)	20 (696)	19 (537)	
≥65	16 (1036)	16 (545)	17 (491)	
BMI category†				<.001
Under/normal	17 (1084)	20 (692)	14 (392)	
Overweight	27 (1726)	25 (875)	30 (851)	
Obese	25 (1573)	23 (776)	28 (797)	
Very obese	16 (1015)	16 (549)	16 (466)	
Morbidly obese	14 (901)	16 (547)	12 (354)	
Osteoarthritis	14 (898)	16 (567)	12 (331)	<.001
Type 2 diabetes	22 (1369)	21 (718)	23 (651)	.071
Hypertension	47 (2944)	46 (1581)	48 (1363)	.182
Current smoking	17 (1093)	17 (589)	18 (504)	.605

* Tests for sex differences using analysis of variance F-test for continuous variables and chi-square test for categorical variables.

† Mean BMI (kg/m^2) measurements from 2002–2006. Under/Normal Weight: <25; Overweight: 25 to <30; Obese: 30 to <35; Very Obese: 35 to <40; Morbidly Obese ≥40.

generate parameter estimates with standard errors. To combine the five analyses, parameter estimates were averaged and standard errors pooled to generate an overall standard error accounting for variability both between and within the five analyses. Pooled results were used for the analyses described above. All computations were performed using SAS Software Version 9.1 (Cary, North Carolina). Results of imputed analyses are presented; however analyses were also performed without imputed data and resulted in similar trends. The mean percent difference in BMI category odds ratios between the imputed and non-imputed analyses was 12%, with a mean difference in odds ratios of 0.17.

RESULTS

Of the 6,299 subjects aged 35+ years, 55% were women and mean age was 51.7 years with no difference by sex (Table 1). Although men and women had similar mean BMI (~32 kg/m^2), they differed in distribution among BMI categories ($P<.001$). More women than men were under/normal weight (women: 20%, men: 14%) and morbidly obese (women: 16%, men: 12%), whereas more men than women were overweight (women: 25%, men: 30%) and obese (women: 23%, men: 28%), with no sex difference in the very obese. OA prevalence was higher for women than men (women: 16%, men: 12%, $p<0.001$), whereas diabetes (22%), hypertension (47%), and current smoking (17%) prevalence were similar between women and men.

OA prevalence increased with age for both sexes and with increasing BMI in some age groups (Table 2). More specifically, in those aged 45–64 years, OA prevalence more than doubled from under/normal weight (women: 7–9%, men: 3–7%) to obese (women: 17–22%, men: 9–19%) and further increased for the morbidly obese (women: 30–36%, men: 16–28%). OA prevalence was considerably higher for those who had hypertension (women: 27%, men: 20%), diabetes (women: 29%, men: 19%), and currently smoked (women: 26%, men: 23%) compared to those who did not (women: 6%, 13%, 15%; men: 3%, 9%, 10%, for hypertension, diabetes, and current smoking, respectively). These associations were evident at all age groups for both sexes.

Using sex-specific multivariable logistic regressions stratified by age group, the impact of increasing BMI and other CVD risk factors on OA prevalence was assessed (Table 3). Due to the stratification by sex and associated reduced sample size, some elevated odds do not attain statistical significance but will still be discussed.

Obesity was associated with increased odds of OA in those aged 45–64 years, although only some of the more extreme levels of obesity were significantly associated. Morbidly obese women aged 45–54 years were more than twice as likely to have OA compared to normal weight, whereas at age 55–64, very and morbidly obese women were more than three times as likely to have OA. Morbidly obese men aged 55–64 years were nearly four times more likely to have OA compared to normal weight men. Very and morbidly obese men aged 45–54 years had increased odds of OA although they did not reach significance. Increasing BMI was not significantly associated with OA for either the youngest (35–44 years) or the oldest (65+ years) group of women and men. Although not statistically significant, the morbidly obese in the youngest age group had elevated odds of OA for both women and men.

Hypertension was significantly associated with OA in both women and men – an association that increased substantially with age. Specifically, the odds of OA increased from 2.65 in

Table 2. Prevalence of osteoarthritis by CVD risk factor, age group, and sex in a SCAIHC population

	Total (*N*=6299)	35–44 years (*n*=2201)	45–54 years (*n*=1829)	55–64 years (*n*=1233)	≥65 years (*n*=1036)
			WOMEN		
Total	16.5	6.3	17.0	23.6	29.2
BMI category*					
Under/normal	5.9	3.7	6.8	9.1	25.0
Overweight	8.2	5.9	10.6	16.7	29.6
Obese	10.3	5.3	16.8	22.4	32.6
Very obese	12.6	5.4	23.4	38.3	21.4
Morbidly obese	17.3	12.4	30.3	35.5	43.8
Type 2 diabetes					
Yes	29.0	15.0	34.5	36.9	40.0
No	13.0	5.0	12.5	18.4	24.7
Hypertension					
Yes	26.8	12.5	30.6	33.7	42.6
No	5.5	3.7	5.1	7.4	8.0
Current smoking					
Yes	25.6	10.7	25.0	41.5	39.1
No	14.7	5.2	14.9	20.3	28.3
			MEN		
Total	11.5	4.7	10.3	17.1	22.0
BMI category*					
Under/normal	3.7	2.0	2.8	6.6	16.0
Overweight	6.6	2.9	9.8	11.8	24.3
Obese	7.6	4.9	8.9	18.9	22.4
Very obese	8.7	4.1	12.3	23.2	24.7
Morbidly obese	11.6	11.9	16.4	28.0	23.9
Type 2 diabetes					
Yes	18.9	11.2	16.6	20.4	36.7
No	9.2	3.8	8.1	15.6	14.9
Hypertension					
Yes	19.5	9.9	17.5	26.8	34.7
No	2.8	1.9	3.2	3.6	3.1
Current smoking					
Yes	22.6	9.4	16.3	29.9	52.2
No	9.6	3.6	8.5	14.0	18.9

* Mean BMI (kg/m^2) from 2002–2006. Under/Normal Weight: <25; Overweight: 25 to <30; Obese: 30 to <35; Very Obese: 35 to <40; Morbidly Obese ≥40.

women aged 35–44 years to 8.46 in women aged 65+ years. Correspondingly for men, the odds increased from 4.07 to 12.63.

Diabetes was significantly associated with OA in women aged 35–54 years with 1.90 odds of OA in 35–44 year olds and 1.62 in 45–54 year olds. This same association was not present in men, although men aged 65+ years had 1.63 odds of OA that were borderline significant.

Current smokers were more likely to have OA, although results were not significant in all sex and age groups. Generally, current smokers were approximately twice as likely to have OA.

DISCUSSION

AIANs aged 35+ years living in two Southern California counties and attending Indian Health clinics from 2002–2006 had OA prevalence that increased with age and was higher in women than men (age-adjusted OA prevalence of 16.5% and 11.5%, respectively). Obesity was associated with higher OA prevalence in those aged 45–64 years, and significantly so for the most obese. Hypertension was strongly and significantly associated with increased OA among women and men. Current smoking was associated with increased OA, although not significant in every subgroup. For men, there was no association between diabetes and OA; however, diabetes was associated with more OA for women (significantly for those aged 35–54 years).

OA prevalence increased with age and was higher in women than men (age-adjusted OA prevalence of 16.5% and 11.5%, respectively).

In our study, age-adjusted OA prevalence for AIAN aged 35+ years was 16.5% for women and 11.5% for men. Osteoarthritis prevalence for those aged 55–64 years was 23.6% for women and 17.1% for men, and for those aged 65+ years, was 29.2% for women and 22.0% for men. These prevalence rates are considerably lower than found in the few existing studies on arthritis in AIAN populations, all of which were based on self-report and included more than OA in their case definition. One cross-sectional national survey of 8,305 AIAN elders aged 55+ years found an overall arthritis prevalence of 43.5%.[7] Arthritis prevalence increased with age and was higher in women. Those who were overweight, obese, or were hypertensive had significantly increased odds of arthritis.[7] Another study used a survey for health-related questions and measured weight, height, and blood pressure for AIAN from Alaska (N=3,695) and the southwestern United States (N=6,273).[6] Age-adjusted arthritis prevalence was 26.9% in Alaska and 16.7% in southwestern United States with prevalence for those aged 55+ years was 48.4% in Alaska and 32.8% in southwestern United States. Arthritis prevalence increased with age in both regions; however, arthritis prevalence was increased for women compared to men in Alaska but not southwestern United States until aged 55+ years. Neither region had statistically significant increased arthritis associated with overweight or obesity but trends were evident. Diabetes and hypertension could not be evaluated as they were only reported within a count of chronic medical conditions.[6] Another study of

Table 3. Adjusted association of BMI and other CVD risk factors with osteoarthritis stratified by age group and sex in a SCAIHC population

	Odds of Osteoarthritis*: OR (95% CI)			
	35–44 years (*n*=2201)	**45–54 years (*n*=1829)**	**55–64 years (*n*=1233)**	**≥65 years (*n*=1036)**
		WOMEN		
BMI category†				
Under/normal weight	1.00	1.00	1.00	1.00
Overweight	1.36 (0.58–3.19)	1.14 (0.52–2.51)	1.45 (0.65–3.26)	0.86 (0.47–1.57)
Obese	0.99 (0.40–2.44)	1.56 (0.74–3.28)	2.01 (0.90–4.46)	0.95 (0.52–1.73)
Very obese	0.82 (0.31–2.13)	2.00 (0.94–4.26)	**3.88 (1.73–8.70)**	0.43 (0.20–0.93)
Morbidly obese	2.01 (0.86–4.68)	**2.40 (1.12–5.14)**	**3.09 (1.38–6.94)**	1.33 (0.60–2.94)
Type 2 diabetes	1.00	1.00	1.00	1.00
Yes (vs no)	**1.90 (1.06–3.40)**	**1.62 (1.09–2.42)**	1.31 (0.87–1.99)	1.25 (0.80–1.94)
Hypertension	1.00	1.00	1.00	1.00
Yes (vs no)	**2.65 (1.54–4.54)**	**5.40 (3.36–8.66)**	**4.24 (2.50–7.21)**	**8.46 (4.81–14.90)**
Current smoking				
Yes (vs no)	**1.75 (1.04–2.97)**	**1.52 (1.01–2.30)**	**2.15 (1.34–3.47)**	1.25 (0.63–2.47)
		MEN		
BMI category†				
Under/normal weight	1.00	1.00	1.00	1.00
Overweight	0.93 (0.18–4.82)	2.79 (0.80–9.78)	1.26 (0.37–4.24)	1.21 (0.58–2.54)
Obese	1.38 (0.29–6.51)	2.12 (0.60–7.51)	2.05 (0.63–6.72)	1.03 (0.47–2.25)
Very obese	1.02 (0.20–5.37)	2.88 (0.78–10.61)	2.51 (0.73–8.66)	1.35 (0.54–3.39)
Morbidly obese	2.95 (0.60–14.53)	3.31 (0.91–12.03)	**3.94 (1.07–14.51)**	1.06 (0.38–2.97)
Type 2 diabetes				
Yes (vs no)	1.36 (0.66–2.80)	1.04 (0.62–1.74)	0.60 (0.35–1.01)	1.63 (1.00–2.67)
Hypertension				
Yes (vs no)	**4.07 (1.94–8.51)**	**5.35 (2.81–10.17)**	**8.79 (3.98–19.38)**	**12.63 (5.25–30.37)**
Current smoking				
Yes (vs no)	**1.96 (1.03–3.74)**	1.30 (0.76–2.21)	**2.05 (1.20–3.52)**	**2.99 (1.52–5.89)**

Note: Values are odds ratios (95% confidence interval). Odds ratios significant at α= 0.05 are bolded.

* Results of a logistic regression model stratified by age category and sex for the adjusted odds of osteoarthritis.

† Mean BMI (kg/m^2) from 2002–2006. Under/Normal Weight: <25; Overweight: 25 to <30; Obese: 30 to <35; Very Obese: 35 to <40; Morbidly Obese ≥40.

comorbidity in 1,039 American Indian elders aged 60+ years from a single tribe found arthritis/rheumatism prevalence of 49.6%.[19] From the 1988–1991 National Health Interview Survey of more than 2,000 AIAN aged 24+ years, age-adjusted self-reported arthritis prevalence was 17.5%.[20]

The OA prevalence among women in our study was much lower compared to the study of OA that reported results for AIAN women. As part of the Women's Health Initiative (WHI), OA was reported for a small group of AIANs where OA status was determined from a general arthritis question with exclusion of women indicating rheumatoid arthritis. Self-reported OA prevalence was 49.8% in 632 postmenopausal AIAN women aged 50+ years.[12] In this study the odds of OA increased with age and higher levels of overweight/obesity. Women taking diabetes treatments had increased odds of OA. Current smokers were not at increased odds of OA and hypertension was not evaluated.[12]

Our study found a low OA prevalence of 16.5% for women and 11.5% for men aged 35+ years and a higher prevalence of hypertension (85%), diabetes (41%), and current smoking (27%) in those with OA compared to those without OA (hypertension: 40%, diabetes: 19%, current smoking: 16%) (data not shown). In comparison, NHANES III conducted from 1988–1994 had higher self-reported OA prevalence in similarly aged US adults, 26% for women and 17% for men but lower prevalence of hypertension, diabetes, and current smoking in those with OA.[5] For those with OA from NHANES III, prevalence of hypertension, diabetes, and current smoking was 40%, 11%, and 20%, respectively, whereas those without OA had prevalence of 25%, 6%, and 26%, respectively.[5] While it is surprising that an elevated OA prevalence is not evident in the SCAIHC population, this may be explained by our use of actual OA diagnosis, not self-report, and the specific inclusion of only OA in our disease definition.

The lack of association between BMI and OA in the youngest age group (35–44 years) is not surprising for two reasons. Increased risk of symptomatic OA may be due to elevated obesity experienced earlier in life[21] that has not yet manifested itself at this younger age. Also, the low OA prevalence in this group makes achieving significance difficult. The lack of association between BMI and OA in the oldest age group (65+ years) may be explained by subsequent weight loss in those previously diagnosed with OA. Men and women aged 65+ years with normal BMI have more than a two-fold increase in OA prevalence compared to the 55–64 year subgroup. In contrast, very obese women and morbidly obese men aged 65+ years have decreased OA prevalence compared to the 55–64 year subgroup. Also of note are the very high odds of OA associated with hypertension in the oldest subgroup, particularly when compared to the younger age groups. This could be an indicator of CVD and related to a hypothesis by Conaghan et al, that OA progression is related to vascular disease of subchondral bone.[22]

Our study did not exhibit as strong an association between OA and obesity as expected. This may have been due to reduced sample sizes from stratifying by age group and sex. Additional analyses adjusted by sex but not stratified identified additional associations between obesity and OA. Morbid obesity in those aged 35–44 years, very obese in those aged 45–54 years, and obesity in those aged 55–64 years was now associated with higher odds of OA (results not shown). Combining the obese, very, and morbidly obese categories, however, did not result in any further associations between obesity and OA.

The few studies of arthritis in AIAN populations, as well as many studies in other populations, do not differentiate for OA and are based on self-report. For example, subjects were asked whether a doctor has told them they have arthritis or some form of arthritis including OA, rheumatoid arthritis, gout, lupus, or fibromyalgia. The National Arthritis Data Workgroup reviewed data from national surveys to determine prevalence of arthritic conditions in US adults. The estimated self-reported doctor-diagnosed overall arthritis prevalence was 21.6%.[23] Clinically defined OA prevalence was 12.1%, with rheumatoid arthritis and lupus prevalence each $<1\%$ and gout and fibromyalgia prevalence estimated between 2–3%.[23,24] Therefore, while arthritis definitions include OA with other conditions, OA is the most prevalent. The use of self-report may overestimate prevalence. March et al found that rheumatologist examination confirmed 81% of "definite" self-reported OA cases and 57% of "possible" self-reported cases.[25] They also found more reliability in self-report of general OA than joint-specific OA.[25] In addition to other studies reporting more than just OA, their use of self-report may explain the higher prevalence found in other studies.

The major limitation of these data is that the results represent AIAN adults who attended their local SCAIHC and lived in two Southern California counties. Within the same tribe, some members attended SCAIHC and other members attended off-reservation healthcare facilities depending on their insurance. Therefore, this sample does not contain AIANs from all areas of Southern California. The California IHS estimates their registered population of AIANs residing in Southern California from 10/1/2003 to 9/30/2006 at approximately 40,000.[26] This study includes 6,299 AIAN patients aged 35+ years residing in Southern California and consists of some of the best current data. Although not fully representative of all Southern California AIANs, it is reasonable to generalize these results to the Southern California AIAN population.

The large proportion of missing BMI information was a limitation of this

study. However, the impact was minimized by the use of a multiple imputation method allowing all subjects with disease to be included in the analyses, rather than excluding them due to missing BMI. Use of this method did not alter trends as shown in comparisons of imputed to non-imputed results.

There are several strengths of this study. Of particular importance is that OA prevalence from a large sample of AIANs has not been previously reported. Results are very relevant as they arise from a current time period with a large sample size from an ethnic minority population that is underrepresented in national surveys. This large sample size allowed for more informative comparisons between sexes and age groups. The use of disease status based on actual diagnosis with the specific inclusion of only OA rather than self-report is also a strength of this study. While it creates limitations in the direct comparability to other studies, it does result in more reliable estimates than self-report.[25] However, use of ICD-9 codes did not allow for determination of OA at specific joint locations.

Southern California AIANs may have lower OA prevalence than the US population as a whole. Comparisons of OA prevalence to other AIAN communities were not very reliable due to lack of other similar published results. Further studies are needed to determine the impact of OA within this understudied minority population.

ACKNOWLEDGMENT

We gratefully acknowledge the Southern California American Indian Health Clinics for providing the data for this project, which would not have been possible without their willingness to participate.

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AUTHOR CONTRIBUTIONS

Design concept of study: Reid, Morton, Wingard, Garrett
Acquisition of data: Morton, Garrett
Data analysis and interpretation: Reid, Morton, Wingard, von Muhlen, Slymen
Manuscript draft: Reid, Morton, Wingard, von Muhlen, Slymen
Statistical expertise: Reid, Morton, Slymen
Acquisition of funding: Garrett
Administrative: Morton, von Muhlen
Supervision: Morton, Wingard